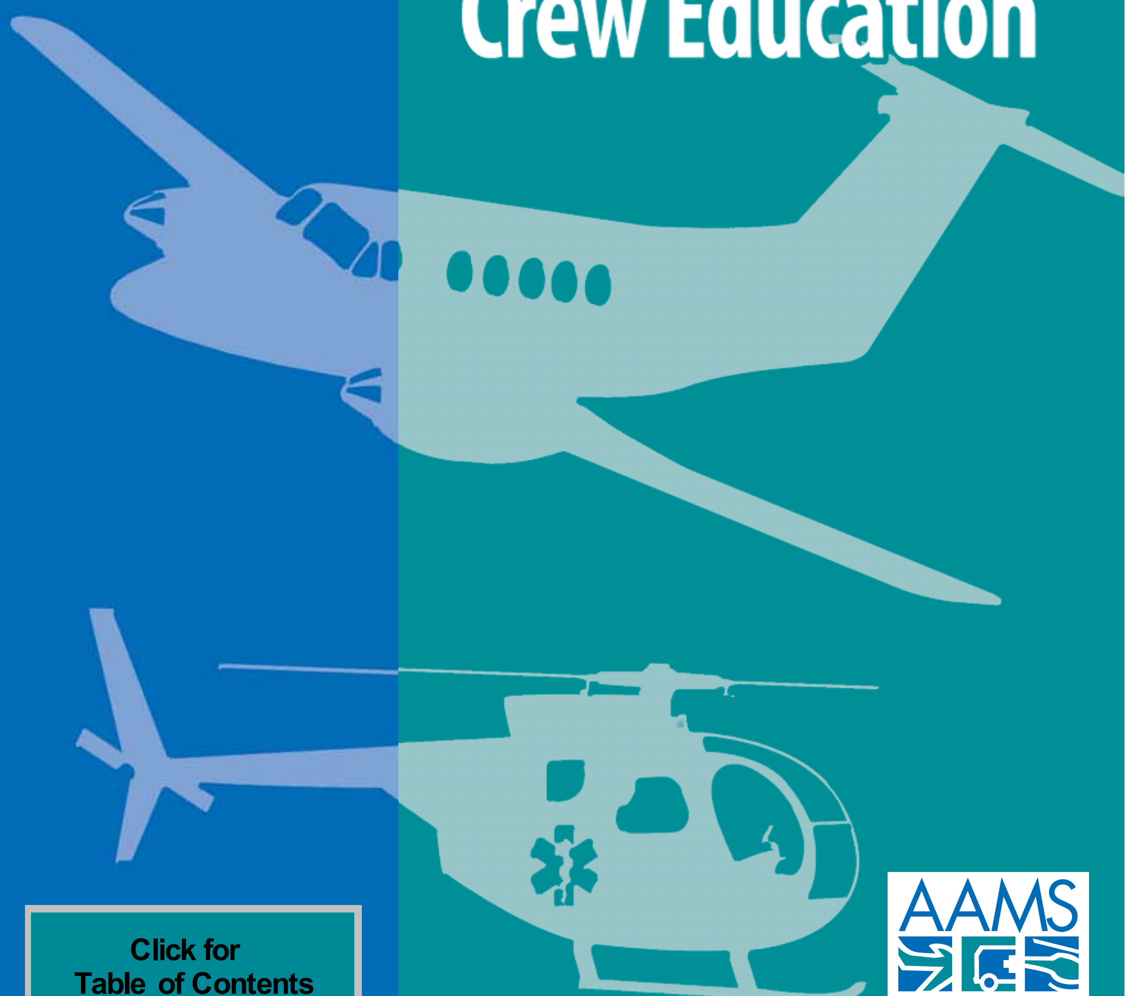
GUIDELINES

for Air Medical Crew Education



Click for
Table of Contents

AAMS

KENDALL/HUNT PUBLISHING COMPANY
4050 Westmark Drive Dubuque, Iowa 52002

Copyright ©2004 by Association of Air Medical Services

ISBN 0-7575-0783-2

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner.

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

TABLE OF CONTENTS

INTRODUCTION

PURPOSE

Air medical transport is an essential component of a well-developed Emergency Medical Services (EMS) system. Air medical transport requires well-trained medical personnel; proper transportation and patient care equipment, as well as an efficient means of communicating with and dispatching transportation. *The Guidelines for Air Medical Crew Education*, published with support from National Highway Traffic Safety Administration (NHTSA), is designed to help air medical programs develop consistent education and skills training programs that enable air medical crew members to develop the many competencies needed to perform their local missions. While these guidelines will be extremely useful for air medical programs, they are not intended to be a NHTSA National Standard Curriculum or to serve as the basis for an additional level of state licensure or certification.

These *Guidelines* set forth a template for the *initial* training of advanced life support (ALS) level air medical crew members to extend their knowledge and skills beyond existing EMT-P, RN, and respiratory care training curricula. This publication covers the knowledge and competencies required for air medical programs to provide appropriate patient care at altitude and in the transport environment. It includes information, bibliographies, and suggestions for skills development in the following broad areas:

- Background and history of air medical transport
- Safety considerations
- Community, public relations, cultural competency, and legal issues
- Patient assessment and packaging
- The physiology of transport in the air medical environment
- Assessment and care of patients with a wide range of diseases and traumatic injuries
- Knowledge and competencies required by air medical programs that transport specialized and high-risk patient groups

Because the information in the 1988 Guidelines for Air Medical Crew Education is not up-to-date, and because substantial work had been completed, these revised Guidelines could not await the completion of the EMS Education Agenda for the Future: A Systems Approach. These guidelines recommend education that supplements existing provider’s knowledge; they are not intended to constitute a separate level of licensure or certification. Additional national levels of EMS licensure and certification should await the completion of the EMS Education Agenda for the Future. The information contained in these guidelines may be one set of information considered during the EMS Education Agenda for the Future consensus process.

Air medical programs vary, and each program needs to develop competency lists and training that prepare crew members to successfully fulfill their mission and scope. The guidelines in this publication are designed as a starting point for this activity.

HISTORY OF THIS EDITION

The guidelines for an air medical transport were published in 1981 by the National Highway Traffic Safety Administration (NHTSA), in conjunction with the American Medical Association's Commission on Emergency Medical Services. A more extensive curriculum was then published in 1988. By the mid-1990's NHTSA and representatives of the Association of Air Medical Services (AAMS) and other professional industry associations recognized the need to revise the curriculum to acknowledge the rapid changes occurring in the industry.

A decision was made to assure that the new version would reflect current practices and standards in a broad range of different types of air medical programs. In 1999, a group of industry leaders was invited to meet and review the existing curriculum, analyze changes in air medical crew tasks, and to recommend changes.

A call for authors and reviewers for the topics to be included in the new edition was then made through professional associations in the field. Each module in this publication was written and reviewed by at least two different levels of providers. For example, if an air medical physician was the author, a flight nurse or paramedic reviewed the module. In addition, reviewers and authors were selected to represent different parts of the country and different types of program experience. Names of authors and reviewers appear at the beginning of each module.

The result of this effort is a publication considerably wider in scope than the 1988 curriculum. New technology and new protocols for assessment and treatment of specific injuries and diseases have been included. Readers should remember that medical research, patient care standards, treatment modalities and modes of transportation are constantly being reviewed, revised and updated to ensure that prehospital care of the critically ill and injured patient is appropriate and reflects state-of-the-art treatment.

DISCLAIMER

This publication is distributed by the Association of Air Medical Services, Inc. ("AAMS") with support from the National Highway Traffic Safety Administration in the interest of information exchange. The opinions, data, findings, and conclusions expressed in this publication are those of the author(s) and not necessarily those of the National Highway Traffic Safety Administration and/or AAMS. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. Neither the United States Government nor AAMS endorses products or manufacturers.

The authors, reviewers and editors have made every attempt to ensure that the content reflects the most recent and most widely accepted standards of practice, treatment modalities and pharmacological interventions. However, it is recognized that the increase in evidence-based research in EMS will necessitate changes in practice prior to subsequent revisions. This is particularly true in the area of pharmacology. Therefore, all recommended interventions and medications should be reviewed and approved by each air medical program medical director on a regular basis. In addition to these evolutionary changes, it is also recognized that possible errors may occur during the publication process. As a result, program medical directors, program administrators, and educational staff need to review the document thoroughly and regularly. This document is not intended as a U.S. DOT National Standard Curriculum nor should is it intended as the basis for a level of licensure or certification.

ACKNOWLEDGMENTS

The *Guidelines for Air Medical Crew Education* is the result of contributions by many air medical professionals who represent all facets of the air medical industry and every type and size of program. In addition to the authors and reviewers listed for each module, many others throughout the industry provided feedback, comments, and suggestions during the revision process. The interest and support from across the United States and internationally have been overwhelming.

A formal Memorandum of Understanding was signed between the U.S. Department of Transportation and the U.S. Department of Health and Human Services in June 1995. Since that time the National Highway Traffic and Safety Administration (NHTSA) and the Health Resources and Services Administration's Maternal Child Health Bureau have worked as close partners in supporting the nation's EMS systems. NHTSA recognizes the Maternal Child Health Bureau's support of this project.

Ms. Norma Battaglia, RN, BSN deserves special thanks for her dedicated and sustained efforts during the course of this project. Special thanks also go to Bessie Aquino and Gloria Pearlstein at Star Mountain for support and assistance with the editorial aspects of an undertaking of this size.

HOW TO USE THE AIR MEDICAL CREW EDUCATION GUIDELINES

The *Guidelines for Air Medical Crew Education* provides a uniform template for the initial training of ALS level air medical providers who are already licensed or certified as nurses, paramedics and respiratory care practitioners. Air medical transport requires a unique set of skills, distinct from the traditional training of most hospital-based or prehospital providers. It is essential that personnel utilized to provide care be properly trained, familiar with the unique demands of providing care during air transport, and prepared to handle the variety of patient contingencies that may arise. Additional education is needed to prepare all traditional providers, whether hospital or prehospital based, for air medical transport care. However, education outlined in these guidelines may vary depending on the provider's existing knowledge base.

The purpose of this document is to provide guidelines for the delivery of patient care at altitude, regardless of aircraft type. This document should not be perceived as a critical care paramedic training program, or as a level or prehospital training and certification for hospital personnel. Both of these issues are beyond the scope of this document and should be addressed in other venues. This education template should serve as the basis for both scene-response and inter-facility transports regardless of specialty focus. In addition to delivery of care, the flight crew member should be prepared to respond appropriately to an in-flight emergency or difficult landing situation. Suggested professional qualifications of entry-level air medical team members follow. Although certain levels of knowledge and skill are contained in these guidelines, state licensing/certification laws, administrative rules and medical direction determine what is authorized in a given state or locality.

PRE-REQUISITES FOR ENTRY LEVEL AIR MEDICAL TEAM MEMBERS

Registered Nurse (RN)

- Graduation from an NLN-accredited, registered, professional nursing program
- Licensure or certification in the state of the base of operations
- Minimum of 3 years critical care or emergency nursing
- Basic Life Support (BLS) provider
- Advanced Cardiac Life Support (ACLS), Pediatric Advanced Life Support (PALS), or Neonatal Resuscitation Program (NRP) provider, as appropriate for the program mission and scope

Emergency Medical Technician-Paramedic Level (EMT-P)

- Completion of a paramedic training program based on the U.S. DOT *EMT-Paramedic National Standard Curriculum*
- Certification or licensure in the state of the base of operations. In addition National Registry EMT-Paramedic credentials are preferred.
- Minimum of 3 years as a paramedic in the pre-hospital setting
- ACLS, PALS, or Pediatric Education for Pre-hospital Professionals (PEPP) provider

Respiratory Care Practitioner

- Completion of a respiratory care practitioner program
- Certification by the National Board of Respiratory Care (must be registry eligible) OR registration/licensure in the state of the base of operations
- Minimum 3 years as a certified respiratory care practitioner in acute care and critical care settings
- BLS provider
- ACLS, PALS, or NRP provider, as appropriate for program mission and scope of practice

CONTENTS OF GUIDELINES

This document contains 36 modules covering basic skills and knowledge for air-crew members. Air medical education coordinators and instructors can adapt these to fit the specific mission and scope of their program.

Each module includes the following:

- **Didactic information** that crew members can read or that can be used in lectures, discussions, and demonstrations presented by physicians, flight nurses, paramedics, respiratory technicians, and others involved in air medical transport. This material usually includes key words and their definitions, a bibliography, and questions that can be used to test student understanding of the concepts presented.

- **Listings of competencies** (skills and knowledge) that crew members should acquire in order to become proficient in the topic area covered. Typically, these competencies will initially be acquired during **skills labs** and then practiced during **supervised patient care** in critical care units, emergency departments, operating rooms, **the prehospital arena,** and other settings under the supervision of hospital personnel, prehospital personnel or the course coordinator/instructor.

- **Estimates of the time required** for education and training in the topic area, including amount of didactic instruction time required for the material, number of lab skills hours needed to acquire competencies in the topic area, and amount of supervised patient care recommended for the topic area. Additional information about these time estimates follows.

AIR MEDICAL TRAINING TIME ESTIMATES

Following are the estimated hours needed to teach each of the 36 modules in this document. Medical directors and education staff of individual programs should adjust these time estimates as needed, depending on the program’s mission and scope of practice.

For these estimates, the modules in this book are categorized as:

- Introductory material
- Transport of medical patients
- Transport of trauma patients
- Transport of maternal, neonatal, and pediatric patients
- Supplemental training in specialty and high-risk areas

A listing of the modules in these areas and time estimates follow.

INTRODUCTION: Estimated Course Hours

	Didactic Hours	**Pt. Care Hours**	**Skill Lab Hours**	**Notes**
Module 1: History of Air medical Transport	2	0	0	Discussion of locality specific EMS system overview, population demographics, referral patterns, referring agencies and facilities
Module 2: Industry Standards	2	0	0	
Module 3: Public Relations	2	0	As needed	
Module 4: Diversity and Cultural Issues	2	0	As needed	
Module 5: Personnel and Aircraft Standards	1	0	As needed	Review of aircraft and personal safety, emergency procedures, egress, crash, loading, unloading, triage, special missions and decision making
Module 6: Aircraft Safety Training	2	0	As needed	
Module 7: Air medical Resource Management	2	0	As needed	
Module 8: Hazardous Materials	2	0	As needed	
Module 9: Environmental Factors & Survival	4	0	As needed	
Module 10: Mass Casualties/Search and Rescue	3	4	As needed	
Module 11: Communications Systems and Technologies	2	0	As needed	Radio/telemetry practice and role-playing; review and practice with computer/PDA based charting systems, as applicable
Module 12: Ethical and Legal Issues	2	0	As needed	Discussion about locality specific cultural/ethnic groups and healthcare practices
Module 13: Quality Assurance and Utilization Review	2	0	As needed	Review of program specific monitoring tools; attendance at program safety meetings and/or QI meetings
Module 14: Air Physiology	2	0	0	Discussion of practical applications and examples
Module 15: Patient Assessment and Preparation	2	8	As needed	Patient assessment and packaging practice, including: spinal immobilization, helmet removal, traction, splints, etc.
TOTAL INTRODUCTION HOURS	**32**	**12**	**As needed**	

MEDICAL PATIENTS—INITIAL TRAINING

	Didactic Hours	Pt. Care Hours	Skill Lab Hours	Notes
Module 16: Cardiovascular Patients	4	36	As needed	Assessment of heart sounds; review of cardiac medications, central and invasive line lab; CXR review
Module 17: Respiratory Patients	4	8	As needed	Assessment of breath sounds; review of respiratory medications, advanced airway lab; CXR review
Module 18: Neurological Patients	4	36	As needed	Neuro. assessment: GCS practice; pupil exam practice; review of TBI Guidelines
Module 19: Toxic Exposures and Envenomations	2	0	0	Tour/discuss poison control resources and response; Review locality specific risks and required responses
Module 20: Metabolic, Endocrine, Immune-Suppressed	4	8	As needed	Review demographics of patient populations and facility resources for immune-suppressed, bone-marrow transplant, and other at-risk patients
Module 21: Hypothermic and Hyperthermic Patients	2	0	As needed	Discuss locality specific environment, temperature, concerns
Module 22: Restraint and Care Within a Confined Space	1	0	As needed	Review of psychiatric patient care techniques; discuss locality specific populations requiring transport (prisoners, etc.); restraint practice
TOTAL MEDICAL PATIENT HOURS	**21**	**88**	**As needed**	

TRAUMA PATIENTS—INITIAL TRAINING

	Didactic Hours	Pt. Care Hours	Skill Lab Hours	Notes
Module 23: Mechanism of Injury: Blunt Force/Penetrating Injuries	2	36	As needed	Patient care hours in medical/surgical or trauma ICU; ground ALS ride-along
Module 24: Orthopedic Trauma: Amputations and Deformities	2	8	As needed	Patient care hours in medical/surgical or trauma ICU, orthopedics
Module 25: Burns: Thermal/Chemical/Electrical	2	12-24	As needed	Patient care hours in medical/surgical or trauma ICU, burn unit
Module 26: Head, Neck, and Facial Trauma	2	12-24	As needed	Patient care hours in medical/surgical or trauma ICU, operating room, ear/nose/throat or plastics clinic, advanced airway lab
Module 27: Thoracic Trauma	2	12-24	As needed	Patient care hours in medical/surgical or trauma ICU, operating room, chest tube/needle thoracostomy lab
Module 28: Abdominal Trauma	2	12-24	As needed	Patient care hours in medical/surgical or trauma ICU; operating room
TOTAL TRAUMA PATIENT HOURS	**12**	**92-140**	**As needed**	

MATERNAL/CHILD-INITIAL TRAINING

	Didactic Hours	Pt. Care Hours	Skill Lab Hours	Notes
Module 29: Obstetrics and Childbirth	16	16-24	As needed	Patient care hours in ante-partum and/or labor and delivery; review of labor support; introduction to fetal monitoring lab
Module 30: Neonatal Care	16	16-24	As needed	Patient care hours in newborn nursery, neonatal intensive care and/or delivery room; age/size appropriate equipment and supply review
Module 31: Pediatric Care	16	16-24	As needed	Patient care hours in pediatrics or pediatric intensive care; pediatric assessment skills lab with child volunteers (with parents); age/size appropriate equipment and supply review
TOTAL MATERNAL/CHILD HOURS	**48**	**48-72**	**As needed**	

SUPPLEMENTAL TRAINING IN SPECIALTY/HIGH-RISK AREAS

	Didactic Hours	Pt. Care Hours	Skill Lab Hours	Notes
Module 32: High-Risk Obstetrics and High-Risk Deliveries	16	72-144	As needed	Supplemental knowledge, competencies and clinical hours required for programs accepting the responsibility of high-risk or critical care patients as part of their program mission and scope of practice. Advanced level of care required on every high-risk or critical care mission regardless of team configuration. Skills lab and patient care hours to focus on advanced practice level assessment, treatment and interventions
Module 33: High-Risk Neonatal Care	16	72-144	As needed	
Module 34: Critical Care Pediatrics	16	72-144	As needed	
Module 35: Device-Dependent Cardiovascular Patients	16	72-144	As needed	
Module 36: The Mechanically Ventilated Patients	4	As needed	As needed	
TOTAL SUPPLEMENTAL HOURS	**68**	**7-14 Weeks/As needed**	**As needed**	

FLIGHT INTERNSHIP OR PRECEPTERSHIP

The training described above should be followed by a flight internship or precepted flight-hours mandated by each air medical program and the program medical director. For teams that also continue care on a ground ambulance, successful completion of a ground transport orientation that complies with state guidelines and program policies is also required.

CHAPTER 1: OVERVIEW

Module 1: History of Air Medical Transport

Module 2: Industry Standards

MODULE 1: HISTORY OF AIR MEDICAL TRANSPORT

Author: Ms. Eileen Frazer, RN, Executive Director,
Commission on Accreditation of Medical Transport Systems

Reviewer: Captain Garry Criddle, RN, USCG/USPHS, (Ret.) EMS Coordinator
National Highway Traffic Safety Administration

KEYWORDS

Fixed-wing
Rotor-wing
MAST
Accreditation
Mission Profile

OBJECTIVES

Upon completion of this module, the student will be able to:

- Discuss the evolution of air medical transport through military and civilian systems
- Identify the personnel roles involved in an air medical service program
- List at least 5 professional organizations involved in standard and practice setting for the air medical industry
- Define 3 types of air medical programs
- Differentiate between the 3 most common mission types in the air medical industry

INTRODUCTION

This module focuses on the history of air medical transport, from the original concept of vertical flight, through the military origins of rotor-wing services, to the current provider models. The emphasis is on how air medical transport developed, what influences have caused system changes, and how these changes are represented in the types of services available today and for the future.

The need to transport the ill and injured to a facility for acute care can be traced back to the horse drawn carriage. Indeed, wars created the need for faster and more effective medical transportation from the Napoleonic wars to the present. The Civil War in the United States was really the first time that wounded soldiers were transported in an organized system. The medical director for the Army of the Potomac, Jonathan Letterman, demonstrated an organized approach to outfitting horse drawn ambulances early in the Civil War. But these three-wheeled and four-wheeled carts were crude and travel was slow. In addition, technology and medical knowledge in the 1860s was rudimentary for the 600,000 plus casualties of the Civil War.

The first known air medical transport was in response to wartime needs. In 1870, during the Franco-Prussian War, a hot air balloon was first used to evacuate the wounded over enemy lines.

There was limited use of air transport for wounded soldiers during World War I, but in World War II, the war department started to train flight surgeons, nurses, and enlisted personnel for air evacuation on fixed-wing aircraft. The helicopter was just being developed and was used minimally.

In Korea, in the early 1950s, helicopters were used extensively to pick up downed pilots. Due to terrain and travel difficulties, the helicopter also became indispensable in transporting the 20,000 injured from the battlefields to the MASH units. Korea set the scenario for Vietnam where 94,000 injured were evacuated from 1962–1967. The Vietnam experience truly demonstrated the value of the helicopter and its role in medical evacuation.

Civilian air medical transport lagged behind the military experience. In fact, at the time the White Paper was published in 1966, calling for improved Emergency Medical Services (EMS), 50 percent of the ground ambulances were morticians' vehicles that could accommodate a litter. Fire, police, and volunteers with minimal training provided the other 50 percent of ground ambulance transport in the 1960s.

In the U.S., helicopter medical transport began as a statewide, public service model in 1969 in the state of Maryland and also in Illinois in 1972. Organized, private service models of air medical transport were first seen in the 1960s using fixed-wing transport. The first organized hospital-based fixed-wing service began in 1969 in Phoenix, Arizona. In 1972, the first hospital-based rotor-wing service began in Denver, Colorado. The public sector did not experience the same rapid growth; in fact even today there are only a handful of statewide helicopter air medical systems with some county and local sheriff departments providing air medical transport sporadically throughout the U.S.

The private sector, however, experienced a rapid growth of hospital-based helicopter services in the mid 1980s. Many of these new services were an adjunct to trauma centers, which were also growing in number. Other designated centers of excellence created additional need to transport patients from further distances.

By 1986, there were approximately 140 hospital-based rotor-wing services transporting approximately 600,000 patients that year. The growth spurt during the mid 1980s leveled off as managed care and Health Care Financing Administration (HCFA) began to influence the way hospitals did business in the 1990s. Typical hospital-based rotor-wing programs that contracted with an aviation operator for aircraft, pilots, and maintenance are no longer the norm. Air medical services today offer several types of transport (rotor-wing, fixed-wing, and ground) and have many variations of business models such as hospital-vendor contracts, stand-alone vendor sponsored, private, airport-based, hospital consortium sponsored, etc. Many programs began to outsource support services such as billing and communications. By January 2000, the number of air medical transport services had doubled from approximately 140 programs in 1986 to approximately 300.

TIMELINE

Nonmilitary Origins

Although Leonardo Da Vinci is credited with inventing the concept of vertical lift centuries before the first airplane flew, it took 30 years after the development of airplanes to build the first helicopter. The need for higher powered engines and the complexity of stability and control are offered as some of the reasons for the helicopter's prolonged development phase.

Military Origins

Since the advent of war, man has needed to deal with casualties. The time period, culture, available resources, current medical practices, and treatments as well as the conveyance chosen to move those casualties have remained limiting factors in the availability and provision of medical care.

- **Napoleonic Wars 1786–1815**

  Dominque-Jean Larrey further developed the concept of the mobile ambulance, based on the original *ambulancias* provided by Ferdinand and Isabella of Spain to their troops during the crusade against the Moors in the late 15th century. Larrey, a French surgeon, was outraged by the care provided to the wounded and the lack of supplies that he saw in 1792 during the war between France, the Prussians, and the Austrians. His two-wheeled vehicle provided a place at the front line for the surgeon to work before moving the wounded soldier to the rear of the battle. He refined his invention for later use in the Napoleonic Wars.

- **U.S. War Between the States (Civil War) 1861–1865**

Jonathan Letterman, Medical Director for the Army of the Potomac during the Civil War, demonstrated the first organized approach to outfitting horse drawn ambulances using three-wheeled and four-wheeled carts to remove the injured from the battlefields to the field hospitals for surgical intervention. From the field hospitals, the patients were then transported to regiment hospitals for further care and surgical intervention. Once the patient conditions were stabilized, special railroad cars or hospital ships transported survivors to large general hospitals in major cities for recuperation and rehabilitation. Because the original ambulance services were disorganized, unpredictable and often driven by irresponsible attendants, Congress passed an Act in 1864 identifying the roles and responsibilities of personnel within the military ambulance services.

During the 1864 Convention in Geneva, several European countries reached an agreement, establishing the neutrality of hospitals, personnel, patients, and services connected with war relief. The U.S. joined in this agreement with the establishment of the Sanitary Commission, later re-named the Red Cross.

The first known air medical transport occurred in 1870 during the Franco-Prussian War. A hot-air balloon was used to transport the wounded to safety on the friendly side of enemy lines.

- **World War I 1914–1918**

Gossman and Rhoades developed a mechanism for air medical transport of WWI casualties. They demonstrated how to wedge a patient litter into the narrow cockpit of an open fixed-wing aircraft, thus allowing air medical evacuation of critical casualties. However, the war department refused to fund their concept. Instead, motorized ambulances were put into service. Several other Army conversions were developed for patient transport on fixed-wing aircraft, but the war department disapproved them in 1921. An airplane crash occurred May 28, 1921 during an electrical storm. Seven passengers were killed causing further delay in the development of air transport.

It took many years and many attempts to launch and fly the first rotor driven aircrafts. In 1923, Juan de la Cierva flew his C-4 design, the first practical autogiro, in Madrid, Spain. The first “working” helicopter was the German FW-61, flown by a female pilot, Hanna Reitsch on October 25, 1937. In 1938, Reitsch demonstrated a fully controllable helicopter, the Focke 61, in a Berlin sports stadium filled with 20,000 people.

Igor Sikorsky flew his VS-300 in 1939 and started production in 1942 of the R-4 Models for the U.S. Army. In 1947, Sikorsky said, "If you are in trouble anywhere in the world, an airplane can drop flowers, but a helicopter can land and save your life." This was the turning point in aviation history that led to the development of air medical transport, as we know it.

- **World War II 1941–1945**

  - ***Fixed-wing Transport***

    In November 1942, the War Department initiated programs to train flight surgeons, flight nurses, and enlisted medical personnel for air evacuation. Typically, the wounded waited at least 8 hours to get definitive medical treatment. Various fixed-wing aircraft were utilized to transport the wounded, with smaller single engine aircraft used to transport within a 30 mile range and larger aircraft used to transport patients from an evacuation hospital to larger hospitals for more definitive care.

    This experience demonstrated that patients had positive outcomes with air transport if the aircraft stayed below 3500 feet, there was oxygen on board, and there were medically trained personnel providing care.

  - ***Helicopter Transport***

    There was limited use of rotor-wing aircraft for medical evacuation during WWII, but within the decade of the 1940s, the helicopter evolved from a handful of developmental models to hundreds of production line Bell 47s and Hiller 360s that were sold worldwide for commercial use.

- **Korean War 1950–1953**

  The Korean War initiated the helicopter as a rescue and air medical evacuation vehicle. Initially used to pick up downed pilots, the helicopter was quickly adopted as an alternative method to move injured soldiers from the battlefields to the MASH hospitals. At this time, the wounded waited about 3 hours for definitive medical treatment.

When the Korean War ended in July 1953, after 37 months and costing 50,000 American lives, 20,000 injured personnel had been transported by helicopter mainly in the Bell 47. The mortality rate decreased from 4.5 deaths per 100 casualties in World War II to 2.5 deaths per 100 casualties in Korea. This impressive change in mortality rates provided the basis for further development and expansion of military and nonmilitary helicopter evacuation and transport programs.

- **Vietnam War 1964–1975**

  The impetus to use helicopters for evacuating the ill and injured started in the 1960s with the increased reliability of helicopters and the dense and rugged terrain encountered in Southeast Asia. During the Vietnam War, 94,000 injured personnel were evacuated by helicopter. The model most utilized was the Bell UH-1. Utilization of rotor-wing aircraft decreased the time from initial injury to arrival at definitive treatment to less than 2 hours. In turn, this improved the mortality rate during the Vietnam War to less than 1 per 100.

  In response to the success of air medical helicopter missions and the greatly improved transport time and mortality rate, the Department of Defense issued Air Force Regulation 164-1. This dictated that the movement of patients during war and in peacetime be conducted by aeromedical evacuation whenever available and appropriate.

  Because of this increase in helicopter utilization, the demand for more aircraft was quite high. To meet the military needs, the Bell Corporation received the largest government contract ever awarded to a helicopter company. This 1967 contract was issued for 250 million dollars to produce two 115 Bell U-1B and UH-1D models.

Civilian Air medical Transport 1960–2000

Until the success of the military helicopter and fixed-wing air medical evacuation services, the civilian EMS agencies concentrated their efforts on improving ground transport units and the aircraft industry focused on the development of corporate and commercial services.

- **1960–1970—Legislation for Improving EMS**

  In 1966, a document known as the EMS White Paper was published. The White Paper, or "*Accidental Death and Disability:*

The Neglected Disease of Modern Society", called for improving EMS and providing guidelines for highway accident care. These guidelines were published by the National Academy of Science and triggered the legislation, Highway Safety Standard 11, which was issued on June 27, 1967. This legislation specifically addressed EMS and suggested the use of helicopters because of their success in the military. At the time the White Paper was published, formalized medical transport by helicopter did not exist in the nonmilitary setting.

During the 1960s, morticians' vehicles were used for about 50 percent of the ground ambulance transports, because only these vehicles could accommodate a patient stretcher or litter. Fire, police and volunteer groups having minimal, or no, formal medical training provided the other 50 percent of ground ambulance transports. In the same time frame, several European countries were already using helicopters to transport critically injured patients from the scene of motor vehicle crashes.

- **1970–1980—Public Service Models**

Beginning in 1969, the state of Maryland developed an air medical helicopter system using the Maryland State Police Aviation Division. Shortly thereafter, in 1971, Dr. David Boyd developed a state helicopter system for the state of Illinois.

The Departments of Defense, Transportation, and Health, Education and Welfare developed Military Assistance to Safety and Traffic (MAST), in 1969. The goal of MAST was to assist civilian EMS agencies by providing military helicopters and medical personnel (active and reserve duty status) to provide air ambulance services to the civilian population.

- **1970–1980—Private Service Models**

The 1970s saw a period of accelerated growth in the private air medical sector. There were many "firsts" during this era including the establishment of the first hospital-based fixed-wing program in 1969, by Samaritan AirEvac in Phoenix, Arizona; the first hospital-controlled helicopter program started in 1972 at Loma Linda, California; and the first hospital-based helicopter program also established in 1972 at St Anthony's Hospital in Denver, Colorado. The first known hospital/aviation/vendor contractual arrangement was formed with Rocky Mountain Helicopters during this same time period.

- **<u>1980–1990—Hospital-Based Program Growth</u>**

  The growth of hospital-based helicopter programs from the late 1970s through the late 1980s was a direct result of hospitals finding reasons to justify the considerable operational expense. The primary justification for rapid transport of trauma patients from an accident scene to a trauma center began with the theory of the "Golden Hour", developed in the late 1960s by Dr. R. Adams Cowley, Director of the Shock Trauma Unit in Baltimore, Maryland. The "Golden Hour" for critical trauma patients refers to the maximum time lapse recommended from the time of injury to definitive surgical intervention in a hospital operating room

  Many hospitals wanted to replicate the decrease in mortality rate that had been experienced during the Vietnam War. This decrease resulted from the use of helicopters to move critically injured patients to definitive care and surgical intervention. The number of hospitals becoming designated as "trauma centers" or centers of excellence in other clinical areas such as cardiology, neonatal intensive care, pediatric intensive care, and high-risk obstetrics increased significantly in the 1980s, further justifying the cost of operating a hospital-based air medical program. Competition between hospitals increased dramatically, with the helicopter service being viewed as a visible marketing tool.

  It is a reflection of this competition that during the first 10 years of hospital-based helicopter programs, it is estimated that more than 95,000 patients were flown a total of 8 million miles. In addition, hospital helipads in 1965 numbered 34, but by 1982, there were more than 900 hospital helipads.

  A typical hospital-based helicopter program in the early to mid 1980s consisted of a nonstandardized, medically configured helicopter. Configurations ranged from a temporary patient litter to a fully mounted and customized patient litter. The helicopter was usually staffed by two pilots sharing the on-duty time, 24 hours a day, 7 days a week. At that time, there was no standard for the maximum number of consecutive on-duty hours worked. It was customary to count pilot duty-time retrospectively rather than prospectively, and in some cases salaries were based on the number of completed flights within the time period rather than total hours on-duty. The medical flight crews generally consisted of RNs and/or paramedics with little or no formal air medical training and a varying amount of on-the-job training.

Fixed-wing services were typically offered by independent charter companies that were based at local airports. Due to the small and variable patient flight volume, flight crews were often on-duty to respond to the first incoming call, whether it was for rotor-wing or fixed-wing. This “double” coverage sometimes led to staffing difficulties, delayed departure times, and missed flights.

- **1980–1990—Increased Focus on Safety**

  With the rapid rise in the number of air medical programs in the mid 1980s, the number of air medical crashes also increased. The air medical related professional organizations responded by creating safety guidelines and standards to address operational issues not covered by the Federal Aviation Administration (FAA) or by medical policies addressing patient care issues. The FAA also published flight and duty-time regulations for helicopter hospital emergency medical evacuation services (HEMES—Part 135.271), which required a pilot to have at least 8 consecutive hours of rest during any 24 consecutive hours of duty-time.

  In the late 1980s, an emphasis on safety awareness, a maturing profession, and initiation of standards and guidelines influenced many aspects of the air medical industry including improved pilot staffing; formal orientation, and education for medical personnel, utilizing the First Edition of the Air medical Crew National Standard Curriculum, published in 1988 by the National Highway Traffic Safety Administration (NHTSA); operational policies that addressed patient care in the transport environment; and standardized medical configurations for helicopters and fixed-wing aircraft.

- **1990–2000—Accreditation, Funding, and Managed Care**

  A voluntary accreditation process for air medical services was developed in the late 1980s and was made available in 1991 by the Commission on Accreditation of Air Medical Services. This effort was a multidisciplinary process that took into consideration all aspects of a well-run air medical program. This standardized accreditation process was instrumental in establishing consistency in patient care, safety, and other air medical mission components across state lines and within geographic regions.

  Many air medical services that began as rotor-wing only, started to expand in the late 1980s and early 1990s, adding fixed-wing and ground transport components. Many independent fixed-wing services continued to operate at local airports throughout the U.S.

In the mid 1990s, hospital-based programs came under heavy scrutiny from hospital administrators who were being tasked with cutting programs and services that were not profitable. Traditionally, helicopter program transport fees were set below the actual cost because the hospitals thought of these programs as loss leaders. It was assumed that revenue would be made through the increase in patient admissions brought in by the helicopter service. The helicopter also provided an additional benefit to the hospital by serving as a visible billboard for marketing the institution.

Gradually, with managed care and the balanced budget act pressing changes in health care delivery, air medical programs had to re-evaluate their services. They were challenged to function as a bottom line department by adjusting their fees and outsourcing services or face closure. In the late 1990s, typical hospital-based programs began outsourcing parts of their services such as the communications and billing functions. Other programs moved out from under the hospital sponsorship and budget, continuing to operate as a stand-alone service or, in some cases, merging with other flight programs to provide a more cost-effective service to work within the new budgetary constraints.

The Balanced Budget Act of 1997 stipulated that the medical transport profession (ground and air), through a regulations negotiation process, design and implement a fee schedule consisting of a base rate and mileage add-on. The fee schedule was published by HCFA in 2002.

TYPES OF AIR MEDICAL SERVICES

Law Enforcement Agencies

Local, state, and Federal police, sheriff, and public safety agencies very often provide an aviation component in addition to their primary law enforcement mission. In addition to law enforcement, traffic control, search and rescue (SAR), and scene response, these public service agencies may also do inter-facility transports when civilian air transport is not available.

The law enforcement agencies and their aviation components are not required to comply with certain Federal regulations. However, all aircraft operating in the National Airspace System must comply with general operating rules of part 91 of the CFR. Individual programs often choose to follow the CFR as well as other Federal, state, and local restrictions.

Hospital-based Services

Rotor-wing, fixed-wing, ground ambulance or any combination can be found in the following business arrangements:

- Single hospital sponsorship.
- Two-hospital merger providing dual sponsorship.
- A consortium with several hospitals sponsoring the service.

Shared ownership or a division of responsibilities within an air medical program may be managed in a number of ways:

- The air medical service can be owned and operated entirely by the hospital(s) with its own FAA Part 135 Certificate.
- The program can be owned by the hospital(s), but aviation services may be contracted out to an aviation vendor.

Nonhospital-based Services

- A stand-alone service may be owned and operated by an aviation vendor and not sponsored by a local hospital. In these cases, contracts or letters of agreement with a local hospital may specify collaborative staffing, education, and/or clinical practice opportunities as well as medical director oversight.
- Aviation-operator owned services might be based at local airports, with the operator funding positions for the medical director, medical crew, and aviation personnel, in addition to providing the aircraft and service components.
- Selected program services such as the communications center or patient billing can also be outsourced to improve cost-effectiveness.

MISSION TYPES

BLS (Basic Life Support) Service

BLS services transport patients receiving care commensurate with the scope of practice of an Emergency Medical Technician-Basic (EMT-B). These missions may include nonemergent patient transfers for procedures and services or medical escort onboard a medical or commercial aircraft.

ALS (Advanced Life Support) Service

ALS involves the transport of a patient who receives care commensurate with the scope of practice of an EMT-Intermediate (EMT-I) or EMT-

Paramedic (EMT-P). These missions may include scene response, search and rescue (SAR), or emergent medical response.

Critical Care

Critical care transport involves a patient whose condition warrants care commensurate with the scope of practice of a physician, registered nurse, or EMT-P with advanced critical care education and experience. These missions may include emergent ED transfers, inter-facility critical care, device-dependent patients, and those patients requiring a center of excellence or prompt surgical or medical intervention.

Specialty Care Teams

Some transport teams specialize in the care of specific types of patients. They are considered a critical care team and may be added to a regularly scheduled medical team or may transport as a dedicated medical transport team. Types of specialty teams include high-risk neonatal teams, critical care pediatric teams, high-risk perinatal teams, teams specializing in device-dependant cardio-thoracic patients (patients requiring intra-aortic balloon pumps, left or right ventricular assist devices, etc.), or teams trained in extra-corporeal membrane oxygenation (ECMO).

Dedicated specialty teams are not usually assigned to a critical care unit, but are assigned only to transport. Like their primary medical crew counterparts, they may have other flight related duties assigned between flights and are expected to meet all program requirements. Crew configuration would remain constant with an RN/RN, RN/paramedic, or RN/respiratory therapist as the designated team.

A nondedicated specialty team would be primarily assigned to a patient care unit such as the neonatal ICU, pediatric ICU, cardio-thoracic ICU, or high-risk labor and delivery area and would respond to accompany a medical flight team when needed for specific transports. Crew configuration may vary to include an RN, RN practitioner, respiratory therapist, or physician.

Commercial Escorts

The escort of stable patients on a contracted aircraft or on a commercial airliner is a recognized service within the air medical profession. Generally only one attendant is required and the qualifications may vary depending on the patient diagnosis or injuries. Any of the following EMS providers can be utilized in this capacity: EMT-B, EMT-P, RN, or MD.

MISSION PROFILE

Inter-facility

Inter-facility transports occur between two healthcare facilities, usually from a lower to higher level of care such as a Level I Trauma Center or other center of clinical excellence.

Laws affecting inter-facility transport took effect in 1986 and were updated in 1994, as part of the Consolidated Omnibus Budget Reconciliation Act (COBRA) legislation. COBRA laws state that any individual who comes to an ED for treatment is entitled to a medical screening examination regardless of their ability to pay. This medical screening exam must occur before the patient is transferred to another unit or facility, and the transfer must meet all COBRA requirements for an appropriate transfer. Typically 75 percent of all rotor-wing missions are inter-facility and approximately 95 percent of fixed-wing missions are pre-arranged inter-facility transports.

Scene Response

Scene calls originate at the site of an injury or onset of an illness. These locations are outside of a healthcare facility and the patient destination is the closest and most appropriate healthcare facility. This may include responses to automobile crashes, farm, industrial, and recreational sites. Typically 25 percent of nonpublic service/law enforcement rotor-wing missions are scene responses. This percentage increases for those services with a primary mission of law enforcement, trauma response and SAR. In very remote areas, fixed-wing services may also respond to scene calls, utilizing private, dirt, and forest service maintained airstrips.

Search and Rescue (SAR)

The majority of SAR missions are completed by public service or military aircraft. These larger services are more likely to have the heavy-duty hoist equipment and trained personnel to adequately assist in rescue operations. Many times there is a network of these highly specialized programs that can be contacted for response throughout an entire region or state.

Some private helicopter services have the capability to aid in SAR activities by providing nighttime searchlights and/or aerial inspection of rough terrain. Some programs also assist in ferrying rescue personnel into remote areas for detailed ground searches. Once victims are found or rescued, the private helicopter services are usually called upon to transport the patient to the most appropriate facility.

Other

There are other, less common missions that are also provided by rotor-wing and fixed-wing EMS services. These services are based on local or regional need, affiliated hospital services and clinical specialties as well as the geography and access to the area served. Organ retrieval missions involve either transporting an organ harvest team to remove and retrieve an organ or the transport of an already harvested organ. Transplant recipients may also be transported to the center receiving the donor organ. However, this often requires the services of a specialty care team trained in cardio-thoracic assist devices, pediatric, or neonatal intensive care. In some instances, medical teams may also be transported to a referring facility to stabilize and care for a patient who is critically unstable for transport.

ROLES OF AIR MEDICAL TEAM MEMBERS

Communications Specialists

Referred to as dispatchers in some systems, these individuals are trained in radio communications of various kinds. Their role is to answer, process, and facilitate incoming requests for air medical transport. They are responsible for the coordination of all aspects of the mission, including notification of the pilot and medical crew, facilitating the initial patient report to the crew, notification of estimated time of arrival (ETA) at the referring facility, coordination of ground transport services, confirmation of landing zone (LZ) security and flight following with the pilot while en route.

Lead Mechanic

The lead mechanic is responsible for the airworthiness of all program aircraft. If a program provides both fixed- and rotor-wing services, two lead mechanics may work collaboratively, each with responsibility for the aircraft that they are certified to maintain. This position also provides oversight and supervision for any additional maintenance personnel permanently or temporarily assigned to the program. To assure continuity and consistency in safety practices, the in-house safety program and regular safety briefings are often coordinated by the lead mechanic and lead pilot.

Lead Pilot

The lead pilot is responsible for the overall success of each mission. He/she also provides oversight and periodic training for the other pilots under his/her command. This includes aircraft specific operations, program specific policies and procedures, local and regional weather, topography, overall briefing on the program mission, and medical crew scope of practice.

Medical Director

The medical director is a licensed physician responsible for supervising and evaluating the quality of medical care provided by the air medical personnel. Many programs utilize the services and expertise of board-certified emergency medicine physicians. These physicians may also be double-boarded in other specialties such as pediatric emergency medicine or toxicology, while others may specialize in transport medicine, EMS education, or trauma systems. The medical director through his/her level of participation and commitment often sets the personality and tone of each individual air medical program. A participative medical director is often seen as a mentor to flight personnel, a situation that in turn generates employee and overall customer satisfaction.

Program Personnel

All personnel involved with a medical transport service, including pilots, ambulance attendants, mechanics, communications specialists, medical personnel, educators, administrators, and support staff, are referred to as program personnel. All of these individuals have a duty to represent the program in a professional manner at all times, but especially when dealing with outside personnel, agencies, patients, and other flight services.

Flight Team

The on-duty or responding crew, inclusive of the pilot, primary medical personnel, and any specialty team members involved in the air medical transport, are referred to as the flight team.

Air medical Personnel

The individuals involved with the actual patient assessment and care are referred to as medical personnel, regardless of their title or level of certification.

Pilot in Command

A pilot in command is identified for each mission flown. This pilot is responsible for the operation and safety of the aircraft on any given mission.

SUMMARY

Modern air medical services are the result of centuries of medical care advances, technology development, a perceived need for quicker emergency response, and access to definitive medical care. Many professional disciplines have collaborated to build a safe and standardized air medical industry. Because of these efforts, the EMS system –and more specifically, the air medical component of the EMS system—has grown and matured in its ability to provide emergent medical response and care to all parts of the world.

A. **Bibliography:**

Accreditation Standards of the Commission on Accreditation of Medical Transport Systems. 4th ed. South Carolina: 1999.

Air Medical Crew National Standard Curriculum. 1st ed. California: ASHBEAMS, 1988.

Beller, Susan Provost. *Medical Practices in the Civil War*. Cincinnati: Betterway Books, 1992.

Collett, Howard. *Aeromed Week*. 15 July 1989, Vol 3, Number 14.

DOD Dictionary of Military and Associated Terms. Joint Publication 1-02, U.S. Government.

Helicopters 1948–1998—A Contemporary History. Virginia: Helicopter Association International, 1998.

Lee, Genelle. *Flight Nursing Principles and Practice*. Mosby, 1991.

Marasco, Ed et al. “Washington Watch.” *AirMed* March/April 1998:19.

McCleary, Nancy. “Air Medical Transfers: Are you COBRA Compliant?” *AirMed* Oct–Dec, 1997: 113.

McKenney, Sharmin. “Aeromedical Evolution.” *Aeromedical Journal.* May/June 1986: 22.

Oates, Stephen B. *A Woman of Valor-Clara Barton and the Civil War.* New York: Free Press, 1994.

Schneider, Connie. “Forum.” *AirMed* Nov/Dec 1998:31.

Segerstrom, Jim “Search and Rescue: A Primer Part II”, *Emergency Medical Services Magazine.*

B. **Definitions of Keywords**:

Fixed-wing—Engine driven aircraft with stationary wings; can be propeller or jet engine driven

Rotor-wing—An aircraft with a main rotor acting as a spinning "wing" to provide lift

MAST—Military Assistance to Safety and Traffic (MAST) was developed in 1969 by the Department of Defense; some units of the regular Army, the Army Reserve and active-duty units of the National Guard provide air ambulance services to the civilian population through this program

Accreditation—A process of recognizing a program or agency as maintaining standards established for professional practice; to be provided with credentials that acknowledge practice in accordance with prevailing standards

Mission Profile—A broad statement that defines the roles and purpose of an air medical program; defines type of mission, patient populations served, aircraft types, markets served, and environment in which the program will operate

C. **Test Questions**:

1. Flight surgeons and nurses were *first* trained for fixed-wing medical evacuation during:

   a. World War I
   b. World War II
   c. Korean War
   d. Vietnam

2. The FAA HEMES regulations specifically address:

   a. Pilot qualifications and training for EMS
   b. Weather reporting practices
   c. Flight and duty time
   d. Required helicopter communications in controlled air space

3. The Commission on Accreditation of Medical Transport Systems (CAMTS) is:

    a. A voluntary accreditation process for medical transport systems (air and ground)
    b. Limited to medical transport systems in the U.S.
    c. Controlled by the Association of Air medical Services (AAMS)
    d. An accreditation process that addresses patient care issues only

4. The Balanced Budget Act of 1997 stipulated:

    a. Air medical transports receive the same reimbursement as ground transports
    b. Fixed-wing transports are uninsured by Medicare and Medicaid
    c. Medical transport professions (air and ground) develop a schedule consisting of a base rate and mileage add-on
    d. Helicopter services outsource patient billing.

5. The "White Paper" published in 1966 by the National Academy of Science:

    a. Reported on motorcycle accident statistics
    b. Suggested the use of helicopters since they had been so successful in the military
    c. Developed a coding system for trauma patients
    d. Reported on the number of auto accidents at certain speed limits

D. **Didactic Hours**: 2

E. **Skills Hours**: N/A

F. **Patient Care Hours**: N/A

MODULE 2: INDUSTRY STANDARDS

Author: Mr. Scott James, RN/CEP, Life Star, Hartford, CT

Reviewer: Ms. Norma Battaglia, RN, BSN, Star Mountain, Inc.

KEYWORDS

Regulation
Guideline
Standard
Certification
License
Scope-of-practice
Accreditation
Code of Federal Regulations (CFR)

OBJECTIVES

Upon completion of this module, the student should be able to:

- Define accreditation
- List 5 national professional organizations involved in air medical standard setting
- Identify at least 3 topics covered by the CFR
- Name 5 Federal regulatory agencies that have responsibilities directly associated with the air medical industry
- List 3 organizations involved with accreditation

INTRODUCTION

Air medical Services (AMS) are affected by multiple levels of governmental influence. Federal, state, and local governing bodies play pivotal roles in the daily performance and decision-making in AMS agencies. These influences may affect the aviation or patient care aspects of a service. In addition, accreditations, certifications, and professional organization guidelines impact the quality and operations of an air medical service. Therefore, it is important that air medical crew members understand the influence of governing bodies that regulate and voluntary standards that guide the practice of air medical services.

FEDERAL REGULATORY AND OVERSIGHT AGENCIES

Federal Aviation Administration (FAA)

http://www.faa.gov

The FAA is a branch of the Department of Transportation (DOT), and is responsible for the regulatory action of aviation. The Code of Federal Regulations (CFR), formerly known as the Federal Aviation Regulations (FARs) establishes minimum operating standards for pilots, flight operations, airspace, and maintenance of aircraft.

Air medical services operate predominately under two distinct parts of the CFR: Part 91 and Part 135. Part 91 regulates flight operations for aircraft flying within U.S. airspace. Part 135 provides specific regulations for air carriers, including air ambulances.

TABLE 1: EXAMPLES OF THE CODE OF FEDERAL REGULATIONS (CFR)

14 CFR Part-91.3	The pilot in command of an aircraft is directly responsible for, and is the final authority, as to the operation of that aircraft.
91.107	Use of safety belts, shoulder harnesses, and child restraint systems. Restraints should be used during all phases of flight. Restraints should not be routinely loosened or removed to provide patient care.
91.17 91.19	Personnel may not function as a crew member: a. <8 hours after consumption of an alcoholic beverage b. with blood alcohol level >.04 percent by weight c. while using any drug that affects the person's ability to react contrary to safety d. while appearing intoxicated or under the influence of drugs. e. while carrying narcotic, depressant, or stimulant drugs except those authorized by Federal and state statutes. Such drugs must be under direct supervision of an air medical crew member.

Federal Communications Commission (FCC)

http://www.fcc.gov

The FCC was established by the Communications Act of 1934, as an independent U.S. government agency that is directly responsible to Congress. The Act, which has been amended over the years, charges the Commission with establishing policies to govern interstate and international communications by television, radio, wire, satellite, and cable. Bandwidth for wireless devices such as cellular telephones and Internet capable microcomputers is also controlled by this agency. The FCC is responsible for allocating frequency bands for specific uses. This is achieved in title 47, Chapter I, Part 2 of the Code of Federal Regulations.

National Transportation Safety Board (NTSB)

http://www.ntsb.gov

NTSB is an independent, nonregulatory Federal agency that investigates every civil aviation accident in the U.S. and significant accidents involving other modes of transportation. The NTSB maintains a comprehensive aviation-accident database that is available to the public. It conducts special investigations and safety studies, and issues safety recommendations to prevent future incidents and accidents. Safety Board investigators are on-call 24 hours a day, 365 days a year.

Centers for Medicare & Medicaid Services (CMS, Formerly HCFA)

http://www.hcfa.gov/default.htm

CMS, formerly HCFA, is a Federal agency within the U.S. Department of Health and Human Services. CMS manages Medicare and Medicaid programs and sets policies regarding reimbursement. They strive to facilitate equal access to affordable and quality health care services, regardless of location, income, or other circumstances.

Occupational Safety and Health Administration (OSHA)

http://www.osha.gov

OSHA sets safety and health protection policies for air medical transport of patients with blood or airborne pathogens and regulates ergonomics in the workplace. OSHA also regulates job safety for mechanics and pilots in their work environment.

National Highway Traffic Safety Administration (NHTSA)

http://www.nhtsa.dot.gov/people/injury/ems

NHTSA, under the U.S. Department of Transportation, was established by the Highway Safety Act of 1970, as the successor to the National Highway Safety Bureau, to carry out safety programs under the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966, now under Title 48 of the U.S. Code on Motor Vehicle Safety. NHTSA also carries out consumer programs established by the Motor Vehicle Information and Cost Savings Act of 1972, now under Title 49.

NHTSA is responsible for reducing deaths, injuries, and economic losses resulting from motor vehicle crashes. This is accomplished by setting and enforcing safety performance standards for motor vehicles and motor vehicle equipment, and through grants to state and local governments. NHTSA also investigates safety defects in motor vehicles, sets and enforces fuel economy standards, helps states and local communities reduce the threat of drunk drivers, promotes the use of safety belts, child safety seats and air bags, investigates odometer fraud, establishes and enforces vehicle anti-theft regulations, and provides consumer information on motor vehicle safety topics.

NHTSA also conducts research on driver behavior and traffic safety to develop the most efficient and effective means of bringing about safety improvements. The NHTSA EMS Division serves as a coordinator of Federal EMS initiatives, including curriculum guidelines for the following courses: First Responder, Emergency Vehicle Operator Course, EMT-Basic, EMT-Intermediate, EMT-Paramedic, EMS Dispatcher, Pre-hospital Management of Traumatic Brain Injury, and the U.S. DOT Guidelines for Air medical Crew Education.

STATE REGULATORY AGENCIES

Department of Health Services (DHS)

The DHS provides oversight for health promotion and disease prevention, health care regulation, and health care delivery services. In addition, the agency regulates professional licensure for physicians, nursing and nursing related sub-specialties such as nurse practitioner, nurse anesthetist, pre-hospital RN, etc. They also regulate the professional certification of EMT-B, EMT-I, EMT-P and other certified health care providers. The state health departments also define the scope-of-practice for each practitioner. Some states also have specific minimum standards for air medical crew configuration, aircraft equipment, and levels of care.

Various bureaus and offices within the state departments of health also regulate Medicaid and health care cost reimbursements, oversee helipad operations, regulate ground and air ambulance vehicles, equipment, and policies as well as provide health care consumer protection through state sponsored Patient Rights Acts. Those most commonly involved with air medical services are:

- Bureau of EMS
- Bureau of Emergency Management
- Bureau of Maternal Child Health

Department of Transportation (DOT)

The DOT is a state-based counterpart to the Federal agency that provides oversight for all highway and traffic related services. They are responsible for the development and operation of the transportation infrastructure and for system improvements. In addition, the DOT provides a means for revenue collection and licensing of motor vehicles for that state.

Department of Public Safety (DPS)

The DPS is comprised of a network of state law enforcement and public safety services that uphold Federal, state, and local laws and provisions.

NATIONAL PROFESSIONAL/ACCREDITATION ORGANIZATIONS

Many organizations have collaborated to develop standards, position papers, job performance guidelines, and minimal competencies required of personnel functioning in air medical and advanced practice roles. Some of the issues addressed are:

- Air medical crew staffing and training
- Aircraft equipment and configuration
- Community/outreach education
- Continuity of care
- Hazardous materials management
- Infection control
- Management of flight operations
- Medical direction
- Quality management
- Safety

Accreditation Bodies

- **CAAS: (http://www.caas.org)**
- **CAMTS: (http://www.camts.org)**
- **JCAHO: (www.jcaho.org)**

National and Professional Organizations

- AACN: (http://www.aacn.org)
- AAMS: (http://www.aams.org)
- AAP: (http://www.aap.org)
- AARC: (http://www.aarc.org)
- ACEP: (http://www.acep.org)

- ACOG: (http://www.acog.org)
- ACS: (http://www.facs.org)
- ALEA: (http://www.alea.org)
- AMPA: (http://www.ampa.org)
- AsMA: (http://www.asma.org)
- ASTM: (http://www.astm.org)
- ASTNA: (http://www.astna.org)
- Angel Flight for Veterans: (http://www.angelflightveterans.org/)
- AWHONN: (http://www.awhonn.org)
- CAMI: (http://www.mmac.jccbi.gov/mmac/research.html)
- ENA: (http://www.ena.org)
- FAR: (http://www.nemspa.org/FAR.htm)
- HAI: (http://www.rotor.com)
- NAACS: (http://www.naacs.org)
- NAEMSP: (http://www.naemsp.org)
- NANN: (http://www.nann.org)
- NASEMSD: (http://www.nasemsd.org)
- NEMSPA: (http://www.nemspa.org)
- NFPA: (http://www.nfpa.rotor.org)
- START: (http://www.start4cism.org)
- USAFSAM: (http://www.sam.brooks.af.mil)

NATIONAL ACCREDITATION ORGANIZATIONS

Accreditation is a validation of achieving specific standards for rotor-wing, fixed-wing, and ground transport services.

Commission on Accreditation of Medical Transport (CAMTS)

CAMTS was originally founded in 1990 as the Commission on Accreditation of Air Medical Services (CAAMS). There is a Board of Directors composed of medical transport professionals representing all major emergency medicine, air medical, ground inter-facility and emergency sub-specialty organizations, who strive to provide the highest possible quality of care and service to their constituents. CAMTS offers a program of voluntary evaluation of compliance with accreditation standards that demonstrates the ability to deliver service of a specific quality. The process involves both the completion of an in-depth program survey and an onsite review by outside air medical professionals trained as CAMTS surveyors. CAMTS believes that the two highest priorities of an air medical or ground inter-facility transport service are patient care and safety of the transport environment. By participating in the voluntary accreditation process, services can verify their adherence to quality accreditation standards to themselves, their peers, medical professionals, and to the general public. These organizations collaborate to publish the

Accreditation Standards every two years to meet the dynamic needs of air medical and ground transport systems worldwide.

Commission on Accreditation of Ambulance Services (CAAS)

CAAS was established to encourage and promote quality patient care in America's medical transportation system. Based initially on the efforts of the American Ambulance Association, the independent commission established a comprehensive series of standards for the ambulance service industry. These standards often exceed those established by state or local regulation. The process includes a comprehensive self-assessment and an independent outside review of the EMS organization.

Joint Commission on Accreditation of Health Care Organizations (JCAHO)

There are no specific JCAHO standards for air medical programs or crew members, however, hospital-based or affiliated services may be affected. These services may be evaluated under the department of nursing or allied health, with the documentation of expanded role skills and competencies being reviewed for currency and training content. Revisions to the JCAHO 2001 standards establish competency levels for telemedicine practitioners that will impact those AMS agencies utilizing such technology. Compliance is voluntary, however accreditation is necessary for Medicare and Medicaid reimbursement.

NATIONAL PROFESSIONAL ORGANIZATIONS

American Association of Critical-Care Nurses (AACN)

AACN has 270 chapters representing every state in the nation as well as Germany and Japan. The association is dedicated to providing critical care registered nurses with the knowledge and background necessary to provide optimal care to the critically ill patient. Many critical care nurses also perform in the flight environment, and for this reason, the education and standards set forth by AACN are considered an exemplary resource for air medical programs. In addition to publishing a monthly newsletter, AACN publishes a scientific research journal, a clinical magazine for the practicing nurse, a quarterly hardbound series, and a scan publication.

AACN, originally known as the American Association of Cardiovascular Nurses, was established in 1969 to help educate nurses working in the newly developed intensive care units (ICU). The first ICUs were developed in the early 1950s when special areas were needed in hospitals to manage critically ill patients such as polio victims and patients with cardiac disease.

<u>Association of Air Medical Services</u> (AAMS)

AAMS is an international membership association for the providers of air and ground medical transport services. A voluntary, nonprofit organization originally established in 1980 as the American Society for Hospital-Based Emergency Air Medical Services (ASHBEAMS), its purpose is to encourage networking among its members and support its members in maintaining a standard of performance reflecting safe operations and efficient, high-quality patient care.

AAMS currently represents a membership base of over 400, including medical transport services in 46 states in the U.S. and in numerous other countries. Other members include aircraft manufacturers, aircraft operators, industry suppliers, and professionals committed to their involvement in the air ambulance industry, such as pilots, mechanics, Part 135 operators, physicians, nurses, paramedics, respiratory care practitioners, program directors, financial officers, hospital administrators, public relations professionals, and communication specialists. Together, all these individuals work through AAMS to implement uniform safety standards, to maintain and improve reimbursement procedures, and to stimulate industry research and education, all in pursuit of improving and advancing EMS transport and patient care.

<u>American Academy of Pediatrics</u> (AAP)

AAP was founded in June 1930 by 35 pediatricians who met in Detroit in response to the need for an independent pediatric forum to address children's needs. When the AAP was established, the idea that children have special developmental and health needs was a new one. Current preventive health practices associated with childcare—such as immunizations and regular health exams—were initiated by AAP to change the custom of treating children as "miniature adults."

The American Academy of Pediatrics Section on Transport Medicine (SOTM) was founded in 1990. SOTM facilitates interactions between members involved in pediatric inter-facility transport for the purpose of improving care of infants, children, and adolescents who require inter-facility transport. Issues of clinical care, service delivery, access to care, education, research, and administration are all included in the mission of SOTM.

<u>American Association for Respiratory Care</u> (AARC)

AARC was initially founded as the Inhalation Therapy Association (ITA), which was legally chartered as a not-for-profit entity in the State of Illinois on April 15, 1947. It has now grown into a 50-state network of chartered affiliates, with representation from all aspects of pulmonary science, respiratory care, education, and administration. AARC is sponsored by the American Thoracic Society, the American College of Chest Physicians, and the American Society of Anesthesiologists. There are a broad range of other specialty physicians serving on the board and various committees.

American College of Emergency Physicians (ACEP)

ACEP exists to support quality emergency medical care and to promote the interests of emergency physicians. ACEP represents more than 22,000 members.

The Board of Directors has identified values that serve as the guiding principles for the specialty of emergency medicine. These values are the foundation of ACEP's planning processes and actions and include the philosophy that quality emergency care is a fundamental right; that the knowledge unique to emergency medicine requires continuing refinement and development; that physicians entering the practice of emergency medicine should be residency trained in emergency medicine; that quality emergency medicine is best practiced by qualified, credentialed emergency physicians; that patients are best served when emergency physicians practice in a fair, equitable, and supportive environment; and that emergency physicians have the responsibility to play the lead roles in the definition, management, evaluation, and improvement of quality emergency care.

ACEP has 23 sections of membership or special interest groups representing the broad range of interests of emergency physicians. This includes the Section of Air Medical Transport.

American College of Obstetricians and Gynecologists (ACOG)

ACOG was founded in 1951 in Chicago, Illinois, and is now the nation's leading group of professionals providing health care for women. Now based in Washington, DC, it is a private, voluntary, nonprofit membership organization. The organization works primarily in four areas:

- Serving as a strong advocate for quality health care for women
- Maintaining the highest standards of clinical practice and continuing education for its members
- Promoting patient education and stimulating patient understanding of and involvement in medical care
- Increasing awareness among its members and the public of the changing issues facing women's health care

ACOG has collaborated with other professional organizations such as the AAP to develop guidelines for practice within the perinatal and neonatal care arenas. Guidelines for levels of perinatal and neonatal care and transport have long been references for the transport industry.

American College of Surgeons (ACS)

ACS is dedicated to promoting the highest standards of surgical care through the education of, and advocacy for its fellows and their patients. It provides a cohesive voice addressing societal issues relating to surgery. The ACS supports programs and policies that ensure patients access to high-quality, effective care provided by appropriately prepared and well-qualified surgical specialists of their choosing. Such care is to be delivered in a system that provides maximum safeguards for patient safety.

Airborne Law Enforcement Association (ALEA)

ALEA is a nonprofit educational, individual membership organization, founded in 1968 to support and encourage the use of aircraft in law enforcement. There are over 3500 members from the international to the local level, creating an invaluable networking system for sharing ideas and expertise. ALEA offers regional, national, and international continuing education seminars, and conferences specific to law enforcement aviation, both fixed and rotary. The courses are taught by professionals and reflect years of experience. The latest technology, equipment and services for law enforcement aviation are often displayed, presenting an excellent opportunity for the decision-makers in law enforcement and EMS to see what is available and compare services and equipment.

Air Medical Physicians Association (AMPA)

AMPA was organized in 1992 by a group of 50 medical directors of air transport programs and other physicians involved in air medical transport. Currently, there is an international membership of over 400 members.

“The Air Medical Physicians Association is a unique association comprised of physicians and professionals involved in medical transport who are committed to promoting safe and efficacious patient transportation through quality medical direction, research, education, leadership, and collaboration.”

The *Air Medical Physician Handbook* was authored by AMPA members to provide guidance to medical director colleagues functioning as medical directors for air medical transport services. The organization also partners with the Air Medical Journal Associates to publish the *Air Medical Journal.*

Aerospace Medical Association (AsMA)

AsMA was founded in 1929 under the guidance of Louis H. Bauer, M.D., the first medical director of the Aeronautics Branch of the Department of Commerce (which later became the FAA). Dr. Bauer and his associates dedicated themselves and the new Association to "dissemination of information as will enhance the accuracy of their specialized art, thereby affording a greater guarantee of safety to the public and the pilot, alike; and to cooperate…in furthering the progress of aeronautics in the United States." From the 1929 organizational meeting of 29 "aeromedical examiners," the Association has grown to its present strength of more than 3,500 members from about 76 countries.

AsMA is the largest most-representative professional organization in the fields of aviation, space, and environmental medicine. AsMA's membership includes aerospace medicine specialists, scientists, flight nurses, physiologists, and researchers in this field. Most are with industry, FAA, NASA, Department of Defense, and universities. Approximately 25 percent of the membership is international. AsMA has provided its expertise to a multitude of Federal and international agencies on a broad range of issues including aviation and space medical standards, the aging pilot, and physiological stresses of flight. Through the efforts of the AsMA members, safety in flight, and man's overall adaptation to adverse environments has been greatly improved. AsMA's official journal is *Aviation, Space and Environmental Medicine.*

American Society for Testing Materials (ASTM)

ASTM is a nonprofit association dedicated to voluntary standards development. Standards cover test specifications, guides, practices, classifications, and terminology. More than 10,000 standards are published each year. A number of these are pertinent to EMS. The following apply to air medical transport: F 1118, F1119, F1124, F1145, F1187, F1274, and F1283.

Air and Surface Transport Nurses Association (ASTNA)

ASTNA, formerly known as the National Flight Nurses Association (NFNA), was organized in 1980 as a nonprofit organization to represent professional flight nurses. The membership has risen steadily to include over 1800 members and 10 regional chapters, with a mission to represent, promote, and provide guidance to professional nurses who practice the unique and distinct specialty of transport nursing. Membership is primarily helicopter, ground, and fixed-wing EMS registered nurses. Opportunities for communication and collaboration among transport nurses are facilitated by Special Interest Groups (SIG).

ASTNA supports and promotes scientific research and education that enhances transport nursing knowledge and air medical patient care practice.

Angel Flight for Veterans

The mission and purpose is to ensure that no financially-needy veteran/ active duty military person or their family member(s) are denied access to distant specialized medical evaluation, diagnosis, treatment, or rehabilitation for lack of a means of long-distance medical air transportation.

Association of Women's Health, Obstetric, and Neonatal Nurses (AWHONN)

AWHONN has worked collaboratively with many perinatal and pediatric organizations to ensure quality care in the hospital, the birthing center environment, and during maternal and newborn transports. Organization activities are focused in three areas: Childbearing and the Newborn, Women's Health Across the Lifespan, and Professional Issues. The association provides nurses, and the women and families they care for, with health promotion and prevention programs and resources that enhance health care practices and address the wide range of health care issues unique to women. AWHONN develops nursing guidelines and position statements on crucial and emerging women's health, obstetric, and neonatal nursing practice issues. AWHONN works with Federal, state and local legislators, regulatory bodies and key decision makers to ensure that women and newborns receive the best possible health care.

Civil Aero Medical Institute (CAMI)

CAMI, under the direction of the Federal Air Surgeon, conducts medical research applicable to the FAA mission. CAMI supports research on the human factors of aviation safety. Scientists study the causes of aircraft accidents, how to prevent them, and how to make accidents more survivable. Specialists in pathology, chemistry, engineering, psychology, human factors, aviation, survival, and environmental health investigate the medical factors that contribute to incidents and accidents.

Emergency Nurses Association (ENA)

ENA is a national association for professional nurses dedicated to the advancement of emergency nursing practice. The membership encompasses staff nurses, managers, administrators, pre-hospital, flight, pediatric and trauma emergency nurses, emergency clinical nurse specialists, nurse practitioners, students, and educators. Founded in 1968 as two separate entities, ENA was combined into one organization in

1970. The current organization provides a peer-reviewed journal, newsletter, emergency core curriculum, specialty courses in trauma, pediatrics, and leadership, scientific assemblies, continuing education units, and standards for nursing practice.

Foundation for Air Medical Research (FAR)

FAR was founded in 1987 with support of the AAMS, ASTNA (formerly NFNA), and NFPA. FAR's purpose is to support original research and education in the air medical industry. The goals are to: 1) promote research and education that enhances patient care; 2) provide funding for research and education; 3) encourage development of medical technologies that improve patient outcomes; and 4) promote safety by encouraging scientific investigation of transport procedures.

Helicopter Association International (HAI)

The Helicopter Association International (HAI) is a nonprofit, professional trade association of over 1,400 member organizations from 70 nations. Since 1948, HAI has been dedicated to promoting the helicopter as a safe and efficient method of transportation, and to the advancement of the civil helicopter industry. The organization provides programs to enhance safety, encourage professionalism, and promote the unique societal contributions made by the rotary flight industry. The organizational structure enables HAI to provide ongoing interchange between the manufacturers, operators of civil helicopters, peripheral industry supporters, and the Federal government. Members' interests are presented in a constructive manner to legislative bodies, regulatory agencies, commerce and industry, the news media, and the public.

The National Association of Air Medical Communication Specialists (NAACS)

NAACS is the professional organization representing communications professionals. This body is responsible for providing a voice for communications specialists at the national level, and serves as a liaison to the other organizations. It also provides training material for the initial training of communications personnel. Their mission is to provide representation of the air medical communications specialists on a national level.

National Association for EMS Physicians (NAEMSP)

Founded in 1984, NAEMSP is an organization of physicians and other professionals who provide leadership and foster excellence in out-of-hospital emergency medical services. Their vision is to create a peer group organization that serves as a resource and advocate for EMS physicians and other EMS personnel. NAEMSP views its role as an EMS advocate, to coordinate and focus on advances in medical care, research, and training.

National Association of Neonatal Nurses (NANN)

NANN can be traced to the chartering of the Neonatal Nurses of Northern California, formed in the Stanford University area in 1976, and the Neonatal Nurses Association established in 1980 in Stockton, California. In June of 1984, NANN was founded as a national organization for nurses and expanded the role of clinicians involved in the care of high-risk newborns. Since its inception, NANN has contributed greatly to the education and professionalism of the specialty of neonatal nursing. Guidelines for the care of sick and premature infants both in the neonatal intensive care unit (NICU) and while on transport are published to assist nurses, physicians, practitioners, perinatal care centers, and transport services.

National Association of State EMS Directors (NASEMSD)

NASEMSD is committed to the development of effective, integrated, community-based, universal, and consistent EMS systems. NASEMSD is a key industry leader in developing and disseminating evidence-based decisions and national EMS policy. NASEMSD's focus is on developing coordinated EMS systems across the nation, facilitating interstate cooperation in the areas of patient transfer, communications, and reciprocity of EMS personnel, and on maintaining ongoing and effective liaison with state and national governments, professional organizations, and other appropriate public and private entities. As a permanent national advocacy group for EMS, NASEMSD encourages knowledge and skills enhancement, research, and evaluation in all areas of EMS.

National EMS Pilots Association (NEMSPA)

NEMSPA was organized in 1985 as a not-for-profit organization, administered by active helicopter and fixed-wing EMS pilots who are elected by NEMSPA membership. The organization provides representation to working groups that impact changes in the Federal Aviation Regulations and in the insurance industry. NAMSPA is dedicated to the establishment of operational and safety standards, while providing a network for the dissemination of knowledge and the guidance to formulate positive change in the EMS pilot profession.

National Flight Paramedics Association (NFPA)

NFPA was organized in 1986 as a nonprofit organization to represent flight paramedics. It is the largest independent paramedic association in the U.S. Its members are involved in transporting critical care patients by airplane, helicopter, and ground ambulance. The organizational mission is to promote professionalism, education, and recognition of the role of the flight paramedic in advanced pre-hospital care, and to serve as advocates for the profession on a national basis.

Surface To Air Response Team (START) for Critical Incidence Stress Management (CISM)

The START team is a nationwide response team dedicated to providing CISM interventions to those associated with air medical transport teams and airborne law enforcement.

The team is made up of trained peers and mental health professionals. The peers are comprised of flight nurses, flight paramedics, pilots, airborne law enforcement officers, communication specialists, and mechanics. In addition to the peer team members, all of the mental health professionals have participated in air medical training and experiences.

START for CISM is registered with the International Critical Incident Stress Foundation (ICISF). There are currently over 350 CISM teams worldwide registered with ICISF. In addition to training thousands of individuals both nationally and internationally, ICISF has trained CISM teams for the U.S. Coast Guard, U.S. Navy, U.S. Air Force, the FBI, the Bureau of Alcohol, Tobacco and Firearms, and the FAA’s Air Traffic Controllers and Association of Flight Attendants. ICISF has also trained CISM teams for multiple commercial airlines. In August 1997 ICISF was granted full consultative status with the United Nations Economic and Social Council.

USAF School of Aerospace Medicine (USAFSAM)

USAFSAM provides training, education, and consultation in direct support of USAF, other Department of Defense agencies, and allied nations aerospace operations, both peacetime and contingency, in areas of military medical operations, human performance enhancement, occupational health, diseases prevention, environmental quality, and aero-medical evacuation.

SUMMARY

There are many professional organizations and associations involved in standard setting for air medical and ground EMS services. Even though there is some overlap in the standards and guidelines, considerable effort by these organizations has gone toward building a collaborative practice. This cooperative effort has facilitated the improvement of aircraft operations and patient care both in the military and civilian sectors. The air medical industry involves many disciplines, priorities and goals, and without this joint effort, there would be little consistency in operations, administration, or patient care.

A. **Bibliography**:

American Academy of Pediatrics. *Guidelines for Pediatric Emergency Care Facilities*. 6 Sept. 2000. <http:www.aap.org/policy/00964.html>

American College of Emergency Physicians. *Appropriate Utilization of Air Medical Transport in the Out-of-Hospital Setting*. 6 Sept. 2000. <http:www.acep.org/library/index.cfm/id/375> <http://www.acep.org/library/index.cfm/id/619>

ASHBEAMS. *Air Medical Crew National Standard Curriculum—Advanced Student Manual.* Pasadena: ASHBEAMS, 1988.

Association of Air Medical Services. Home page. 6 Sept. 2000. <http://www.aams.org/mission.html>

Commission on Accreditation of Ambulance Services. Home page. 6 Sept. 2000. <http://www.caas.org/mast.html>

Commission on Accreditation of Medical Transport Systems. Home page. 6 Sept. 2000. <http://www.camts.org/>

Federal Aviation Administration. Regulations. 6 Sept. 2000. <http://www.faa.gov/aviation.html>

Holleran, Renee Semonin. *Mosby's Emergency and Flight Nursing Review*. 2nd ed. St. Louis: Mosby, 1996.

Holleran, Renee Semonin, ed. *Flight Nursing Principles and Practice.* 2nd ed. St. Louis: Mosby, 1997

Joint Commission on Accreditation of Health Care Organizations. *Telemedicine*. 6 Sept. 2000. <http://www.jcaho.org/standard/medical staff_rev.html>

Marquis, Bessie L. and Huston, Carol J*. Leadership Roles and Management Functions in Nursing.* Philadelphia: J.B. Lippincott, 1992.

National Flight Nurses Association. *Flight Nurses Core Curriculum*. Park Ridge: NFNA, 1997.

Occupational Safety and Health Administration. *Ergonomics*. 6 Sept. 2000. <http://www.osha-slc.gov/ergonomics-standard/index.html>

B. **Definitions of Keywords**:

Regulation—A law or statute designed to control or govern specific conduct

Guideline—A statement or policy designed to guide a course of action

Standard—A minimally acceptable action or level of quality

Certification—Acknowledgement of achieving a particular qualification or standard

License—The legal permission to practice within a particular profession

Scope-of-practice—A range of duties and activities set forth by the state Nurse Practice Act or EMS Rules and Regulations that delineates a practitioner's rights and privileges while maintaining valid licensure or certification

Code of Federal Regulations (CFR)—Established by the Federal Aviation Administration to address all aspects of aviation operation. Formerly known as Federal Aviation Regulations (FARs)

- **14 CFR Part 91**—Establishes specific regulations pertaining to the general operation of aircraft and aircraft flying within U.S. airspace
- **14 CFR Part 135**—Establishes specific regulations for air carriers and commercial aviation operators

Accreditation—A voluntary process through which a service is certified as substantially meeting nationally accepted standards

C. **Test Questions**

1. A "Regulation" is best described as:

   a. A law or statute designed to control or govern specific conduct
   b. A voluntary process through which a service is approved
   c. A minimally acceptable action or level of quality
   d. A statement or policy designed to determine a course of action

2. Which of the following organizations provide voluntary certification processes?

   a. CAMTS, FAA, NHTSA
   b. NHTSA, JCAHO, CAMTS
   c. CAAS, CAMTS, JCAHO
   d. FAA, NHTSA, CAAS

3. Which of the following is **not** a Federal regulatory agency with responsibilities directly associated with the air medical industry?

   a. CMS
   b. OSHA
   c. CAAS
   d. NTSB

4. Which of the following topics are covered by the Code of Federal Regulations (CFR) minimum operating standards for pilots?
   a. Flight operations and maintenance
   b. Airspace and air-taxi operations
   c. All of the above

5. Scope-of-practice can be defined as a range of duties and activities set forth by the state Nurse Practice Act or EMS Rules and Regulations, that delineates a practitioner's rights and privileges while maintaining valid licensure or certification.

   a. **True**
   b. False

D. **Didactic Hours:** 2. Include discussion of local program accreditations, regulations, and professional memberships.

E. **Skills Hours:** N/A

F. **Patient Care Hours:** N/A

CHAPTER 2:
FAMILY AND COMMUNITY INTERFACE

Module 3: Public Relations

Module 4: Diversity and Cultural Issues

MODULE 3: PUBLIC RELATIONS

Author: Dr. Kenneth Williams, University of Massachusetts, Boston, MA

Reviewer: Ms. Becky Sue Hanson, RN, Wyoming Life Flight,
Wyoming Medical Center, Casper, WY

KEYWORDS

Public relations
Community
Marketing
Mission
Transfer agreement

OBJECTIVES

Upon completion of this module, the student should be able to:

- Discuss their program mission statement
- Identify and contrast internal and external public relations and whom they involve
- Discuss community education and injury prevention activities appropriate for air medical program involvement
- Identify at least 4 items that should be included in transfer agreements
- Contrast the different local/regional methods of activating the air medical component of the EMS system

INTRODUCTION

Public relations is the art and science of building and maintaining a desired impression or relationship with the public. This relationship was traditionally based upon reputation, much like when a craftsman builds an object; the fit and finish of the parts are an indication of overall quality. Another analogy describes this association of appearances and substance; when a mansion's grounds are meticulously trimmed and adorned with ornamental gardens, we assume that the inside of the building is a showplace. Sometimes, however, external appearance does not reflect internal reality. Beauty is often only skin deep, and in some cases, a public relations program is used to hide the truth, the truth that under the shiny finish, the quality just isn't there.

There is no room in air medical care for programs that lack quality. For, without quality, patients are not safe and the crew is not safe. But, even with excellent program quality and services, there will occasionally be things that please one group but upset another. There will be people or groups who do not understand the program, its purpose, or its procedures. For these reasons, a good public relations program is essential for an air medical program.

Your flight program needs to exhibit quality, safety, and care throughout. Doing a good job every time is the best way to maintain good public relations. A public relations program that is “skin deep” won’t make up for errors within. Concentrate first on doing things right, then on telling others about your success. However, aspects of your program that are confusing or upsetting, despite your overall quality, will need explanations. For example, noise, changes in patient referral patterns, and transport distances that separate families are all by-products of good air medical care that may need explanation. The groups who can benefit from your public relations program may be divided into those internal to your institution and those external, such as government regulators, the general public, or referring medical professionals.

INTERNAL PUBLIC RELATIONS—THE PROGRAM, THE INSTITUTION

Understand the Program Mission

Let’s assume that excellent patient care and an exemplary safety record are key features of your air medical program mission. There may be other important aspects to your mission, including research, education, and financial viability. However, your mission may not mesh with the mission of your institution, the mission of particular sub-groups within your institution, or the mission of certain individuals within the institution. The first goal of an air medical program’s public relations effort is understanding and acceptance within its sponsoring institution, be it a hospital, consortium health care system, private entity, or government agency.

Understand the Institutional Mission

Every air medical program exists within a broader institution or community structure. In most cases, a hospital, medical network, or other health care institution supports the air medical program. Sometimes the program exists within a private company or government agency. Members of the air medical crew typically understand and are supportive of that program, although the same may not be true of all institutional employees. In fact, some may see the program in a negative light. Their perception may be that the program is an expensive method of advertising, a “glamorous” job within the institution, or an irritation that delivers unstable patients to their already overburdened patient care units. The missions of the various departments and programs as well as the priorities of individual employees must be understood in order for your program to operate effectively within that environment.

In order to deliver excellent patient care and transport services, your program must operate cooperatively with your institution. Shared patient care, equipment maintenance and procurement, funding, billing, training, staff support, and a variety of other issues may depend upon excellent internal public relations. In other words, if your air medical program is seen as a center of institutional excellence and your crew as skilled and professional, then your program is likely to receive necessary support and cooperation.

How the Air medical Program Helps Fulfill the Institutional Mission

One way to build a good image within your institution is to emphasize similarities between your program mission and your institutional mission. If your institution is a hospital, then good patient care is a common goal. Optimal patient volume is also a common goal, as is financial viability. Your program may be instrumental in allowing the hospital to offer certain specialty care. For example, trauma, cardio-thoracic surgery, pediatric or neonatal intensive care, and other specialty units often require patient referrals from a broad geographic area. Your program may be the means by which many of these patients arrive. Understanding this bigger picture and having institution and transport program specific statistics ready to use as a reference can help build positive relationships.

Building Clinical Leadership Skills

Clinical leadership is another area where your program can be helpful. If your staff is seen as the best in their particular area, and if they are willing to share their knowledge, your program becomes a center of excellence within the institution. For example, are your flight nurses known as the best source of knowledge about critical care medications, or for their procedural skill in starting IVs or other patient care procedures? Does everyone in the hospital think of calling your communications center with questions about unusual patient transport needs? If not, work toward that goal. Helpful and competent assistance from the flight team will impress the hospital staff. On the other hand, condescension or otherwise negative flight crew attitudes can destroy institutional good will in seconds. Never allow your flight crew to be negative, critical, or mean-spirited. Resolve problems and complaints to the satisfaction of all parties and within a reasonable time frame.

Helping the Institution Meet Its Public Relations Goals

Administrative support and assistance with institutional public relations and fund raising efforts are also important. If your flight program understands the institution's mission and goals, and responds positively to requests for meeting presentations and public events, the hospital will see the flight program as an integral partner. Offers to provide aircraft tours, flight crew interviews, educational speakers, or conference displays will go a long way toward solidifying the relationship between institution and air medical program. Brief hospital and program administrators on your activities. Keep track of complements and positive patient outcomes, particularly involving newsworthy events in your community. Be willing to speak at fund raising events, board meetings, and staff functions. Ask to present information about your program at internal meetings with medical staff, unit managers, case managers, social workers, billing staff, support staff, facilities staff, and anyone else who will listen to a brief presentation. Focus on the collaborative partnership between the institution and the air medical program. Spend time educating people on how the transport program supports and complements in-patient services.

Teaching Institutional Staff About the Air medical Program

All of these efforts also teach the institutional staff about your air medical program. If your program is good, then all of these people become your supporters. The future of your program may depend on one of these people arguing a point in your favor at a meeting, defending your care at a conference, or justifying your budget requests. Tell them about your aircraft, your staff, your communications capabilities, and typical patient missions. Present transport cases at specialty rounds, and be present to explain the transport aspects of patient care whenever possible. Have ready answers to typical questions. Be friendly, and invite people to tour your program facilities. If financial and safety concerns are manageable, some programs even arrange for institution staff to ride on the aircraft during special events. The more that's understood about the air medical program, the more positive the relationship becomes. Internal public relations efforts are not just worthwhile, they are essential. The best external public relations efforts can be negated by a poor attitude, misunderstandings, and negative comments by your own institutional staff. Imagine how damaging it would be, for example, for the accepting resident in the coronary care unit to tell a referring physician inquiring about using your flight service, "We don't use that flight service unless we have to!"

EXTERNAL PUBLIC RELATIONS—THE PROFESSIONAL, REGULATORY, AND PUBLIC COMMUNITIES

External Groups—A Variety of Interests

Public relations outside of your institution may involve a variety of interests, including those other members of your profession, government regulators and officials, the general public, and other special groups. Some may be supportive but lack understanding, and others may be openly hostile. While your focus and vocabulary may differ, your message to these varied audiences should be similar. Your program should pride itself on excellent patient care, and on being the regional leader in its chosen area of specialty. If you are not comfortable sharing that message, spend time making your program better, safer, and more professional. Again, a public relations effort that is only skin deep will hurt more than help.

Problem Solving

Problem solving must be approached with objectivity and creativity. When working with groups that express concern about negative issues or who are openly hostile, express sensitivity to their needs and genuinely explore options that solve their problems while maintaining safe and excellent patient care operations. For example, the neighborhood surrounding the hospital may be upset about noise or concerned about the risk of a “helicopter falling on my children’s playground”. They might respond to a thorough, objective explanation of your aviation operations and flight paths and plans to reduce risk. If there is a particular concern that you can address, solve the problem. For example, if neighbors are willing to accept takeoff and landing noise because they now understand that every flight potentially helps a patient, but are not tolerant of maintenance engine testing at night or on weekends, perhaps they will agree to a schedule when such noise is tolerable, an agreement to perform scheduled maintenance at an airport, or the use of fences to deflect the sound.

Participation in Community Events

All air medical programs face difficult decisions regarding their participation in community events. These decisions directly impact the public relations efforts of the program and the community perception of that program. Your aircraft cannot attend every bake sale in the county, but may be an important component of a disaster drill. Financial, safety, and patient care concerns should guide your aircraft participation in these public events. Staff participation should be frequent. All of your staff should be comfortable speaking in public. If they need training and practice, provide it by sponsoring sessions on education, slide-making skills, and adult learning. Then have them practice at staff meetings or internal educational events. Every member of your staff is an ambassador for the program, and should be able to speak clearly and positively about it. Pre-packaged program presentations, in the form of videotapes or slides, may assist with scheduled event presentations. Handouts, fact sheets, brochures, directions to your facility, and other printed materials may be helpful during these events.

In-flight Observers

Many programs have an aircraft large enough to allow an additional passenger for training or observation purposes. This capability may allow you to better orient new employees, display your program to news media or public officials, or provide regional EMS and medical professionals with a chance to “walk a mile in your shoes”. Again, if your program provides quality service, this experience will be positive for the observer, and your program will have enlisted another ambassador.

COMMUNITY EDUCATION AND INJURY PREVENTION

The Public Health Role of EMS

EMS and air medical programs are often considered reactive assets. That is, they are ready and available to react when there is an emergency. Currently, there is an emphasis on expanding the role of air medical services, and EMS in general, to include preventive services. Examples in similar areas, such as the fire service and the U.S. Coast Guard, suggest that energy invested in prevention and safety can reduce the need for emergency medical care.

Serving as a Role Model

The first way that air medical services can be involved in preventive aspects of public health is as a role model. Physical fitness, healthy lifestyles, and risk-reducing personal behaviors set good examples for others. Programs should emphasize these public health roles, if only because they will reduce injury and illness among their own crew. Smoking cessation, regular exercise, seatbelt and helmet use, and other healthy attitudes will help the flight crew and set a good example for others. Whether at a public event or driving to the grocery store wearing a program t-shirt, members of the flight crew represent the program and the health care system in general. Safe habits demonstrated during daily living as well as during missions, promote public health. Obviously, credibility is difficult to maintain if the flight crew exhibits risky behavior but lectures about the dangers of such behavior to others.

Safety Awareness and Interventions

A second way that air medical services can be active in injury prevention and community education is through active work to raise safety awareness and specifically intervene in risk areas. For example, consider the top few reasons why your program is called to transport injured children. Are they gunshot wounds, vehicle crashes, falls, near-drownings, or sporting injuries? For each of these injury mechanisms, there is awareness and intervention activities that can help reduce the risk of injury. Consider mechanisms prevalent in your community, and become involved in preventing these injuries.

If your community has an injury prevention agency or office, ask how you can participate in their activities. If not, consider collaborating with others to start such an effort. Speakers at community safety events, lectures at local schools, and meetings with community leaders can all be effective if there is good rapport, respect for your program, and a reasonable message. If there is no organized effort in your community, at least consider adding safety messages to your program's printed materials and public messages. Speak with your institution's public affairs office and consider providing safety messages for distribution by the local media. A small effort can prevent significant problems.

As an example, children who wear protective helmets are less likely to suffer head injuries while bicycling or participating in other wheeled sports. Many states have programs to donate helmets to needy youngsters, so access to helmets is not a big challenge in most areas. Compliance with use, however, is a problem. If your flight crew wears helmets, they can become role models in promotional materials and in person at educational events. If the flight crew is "cool" and wears helmets, then maybe more children will overcome peer pressure and wear helmets during their own "at-risk" activities.

Professional Injury Prevention

An often unrecognized but important aspect of air medical care is patient safety through example, within the program service area. If the flight crew exhibits and teaches best medical practices, they become professional role models for other EMS and hospital health care providers. Spinal immobilization, intravenous access, airway management, pain management and sedation, and other aspects of routine air medical care can be exhibited in their best form by the flight crew, thus providing an example for the region. In some cases, this role modeling will improve local EMS and hospital care, with providers wanting to "do it like the flight crew". If this improves patient safety and reduces medical errors, it is a positive aspect of the program's presence, and should be acknowledged and encouraged. While formal training programs and ride-along observational activities can provide this education, the best forum is through daily example of excellent patient care and technical skill.

Community Involvement and Commitment

For injury prevention activities to succeed, the program has to be committed. Efforts that appear superficial, forced, or are not supported by the crew's public lifestyle are likely to fail. Mere involvement isn't enough. The flight crew needs to live fit and healthy lives, use protective equipment properly, and exhibit injury prevention as a committed lifestyle before they will be accepted, particularly by children, as effective role models and spokespersons for injury prevention. However, the benefits of this commitment are significant, to the flight crew personally and to the community as a whole.

TRANSPORT AGREEMENTS WITH REFERRING FACILITIES, AGENCIES, AND PROVIDERS

Agreements and Mutual Understanding

Transport agreements are documents that specify conditions for transport of patients between entities and/or facilities. They may be as simple as a telephone number and the location of a helipad, or as complex as a lengthy contract specifying conditions for patient transfer between government agencies or military services and public providers. In all cases, they should capture clearly in writing the mutual understanding that the parties have about such transfers. Written transfer agreements are not necessary in all situations, but are preferred in some areas of the country or by some government agencies or regulatory bodies. If there is not a written transfer agreement between two parties, then the mutual understanding should be clear, simple, and repeated with each transfer to assure the safest possible operation. Local regulations, state, and Federal laws may influence the transfer of patients, and should be locally researched in every case.

Protocols and Procedures

At a minimum, any transfer agreement should specify the protocols and procedures to be followed in the event of a transfer request. These minimum specifications should include:

- Contact numbers at both institutions
- The names of the referring and accepting physicians
- Assurance that proper patient care will occur and records will be transferred with the patient

- Assurance that the receiving facility can care for the patient
- If possible, patient or guardian consent for the transfer
- If the patient is unstable, physician certification that the transfer is in the patient's best interest
- The logistics of the transfer, including helipad location and hazards, contact radio frequencies, LZ security arrangements, ground transport needs, etc.

In many cases, the medical aspects of the transfer are contained within a hospital's patient transfer form, generated in compliance with Federal law and regulations. The Consolidated Omnibus Budget Reconciliation Act (COBRA), has a section called the Emergency Medical Treatment and Labor Act (EMTALA) that controls some aspects of emergency patient care and transfer. More complex transfer agreements may specify types of patients that a receiving institution is generally capable of caring for, such as complex cardiac disease, ill neonates, renal dialysis patients, etc. Times and methods of transfer, payment agreements, and other complex issues specific to local situations should also be addressed. In many cases, the facilities involved have other affiliations or agreements, and the transfer of patients is part of a broader agreement.

Benefits and Risks of Agreements

Transfer agreements can benefit a flight program by specifying mutually agreeable and safe ways to transfer patients upon request. By specifying a procedure for transfer, risks are minimized and both parties are involved in designing the protocols and procedures used. The flight program may also benefit if the agreement provides a steady or even predictable flow of patient referrals, with clinical, research, educational, and financial benefit to the flight program and its sponsoring institution. Patients may benefit if specialty care is available by agreement, urging referring staff to "follow the protocol" for certain types of patients who may best be cared for through transfer.

With these benefits comes the risk of written agreements. No written agreement can anticipate all circumstances, and rigid reliance on the protocol may be unsafe in unusual or special circumstances. Written agreements that "promise" service can be risky, since no transport program is available 100 percent of the time. It is better to agree to service when safely available, and to avoid language that implies aircraft availability regardless of weather, maintenance, or other missions. If provider training, and level or certification of the flight crew is specified, then the program should be confident of meeting or exceeding this standard on every flight. Promises of transfer time or ETA can also place a program at risk if the promises are not met. Weather, maintenance, and other factors can reasonably delay a mission, and therefore must be an allowable exception to any written agreement.

ACTIVATION PROCEDURES WITHIN THE LOCAL EMS RESPONSE SYSTEM

General Activation Procedures

In almost all situations, an air medical service must be requested before responding. Exceptions might include public service aircraft that perform a dual role of law enforcement/SAR along with a medical role, or other services that note a medical emergency while performing other missions. In most cases, someone calls by telephone, radio, or occasionally FAX or electronic message. Service is requested and preparation made so that the aircraft does not land at the scene unannounced and uninvited. Regional regulations and protocols dictate local program activation procedures. They should provide for rapid and logical activation of air medical services in situations where they may be of assistance. If this is not the case, then the air medical service should seek to change local practice in favor of better system utilization.

Public Requests

In some cases, the general public may call requesting air medical care. While unusual in most parts of the country, rural or isolated areas where other EMS services are not readily available may be best served by allowing or encouraging the general public to call for air medical care when indicated. In these places, education about proper use of air medical care is important and may have to be creative. For example, town meetings, school or civic center events, or business sessions may be the venue for these sessions rather than the typical hospital or EMS lecture. In other situations, people with special medical needs occasionally wish to have “special permission” to activate the air medical program. For example, rural parents of a child with a complex cardiac condition may be told that they can only get care at the medical center 150 miles from their home and to “just call the helicopter if the child gets sick”. These arrangements must be considered locally and individually, but in most cases, activation of the local EMS system and involvement of the local hospital in any special plan is prudent. While definitive care may be needed at a remote site, local stabilization may be possible, and education about special needs patients in a local area will help local providers plan for emergency requests.

First Responder Requests

The first responder, or the first public safety official at the scene of an accident or illness, should be aware of regional air medical services and the criteria for requesting their activation. In some cases, this request will be simultaneous with a request for ground EMS care. If the region has a communications network that includes the air medical programs, a system of standby or launch-on-standby can be established to reduce response times in situations where air medical activation is likely. When the responding service reaches the scene and evaluates the probable medical needs, a decision can be made to confirm the flight team's arrival or to cancel them en route. Landing should not occur until a safe and secure LZ is established, but the ETA is reduced if the aircraft is already on the way when need is confirmed. First responders can be trained during existing educational sessions coordinated by the air medical program. This can occur during their initial training, or as continuing education through onsite lectures, literature, or videotape. Their training should include local protocols and practices for activating the air medical system, LZ requirements, hazard reporting, and scene security.

EMS Requests

EMS providers should be experts in the proper use of air medical care as a medical asset. Their understanding of the EMS system, location of air medical programs and receiving facilities, transport times and patient condition places them in the best position to judge proper use of air medical services. When an EMS professional is also the first responder, the situation is ideal. In other cases, local protocol and radio communication can provide EMS consultation for the first responder at the scene. EMS professionals should receive significant training from air medical services in safety, protocols for activation and patient care, and LZ requirements. In many areas of the country, pre-designated LZs within the response area are established in cooperation with local EMS and other officials. These LZs, often in parking lots, athletic fields, or other open areas, are cataloged by the air medical program with exact location, photographs, and hazards. Response time may be reduced and safety enhanced through the use of these “pre-determined” LZs in a particular town or area.

Medical Facility Requests

Medical facilities, such as offices, clinics, and hospitals, that anticipate the need for air medical services should plan for such a request and train their staff to assist with air medical operations. A site visit by aviation and medical personnel from the flight program can assist in selecting a safe and convenient LZ. Security at facility LZs is very important, as they are often in or near heavily used parking or pedestrian areas. Damage or injury from rotor wash can be significant, and should be considered in LZ or helipad selection. Protocols should be drafted to outline the use and availability of special equipment, supplies, and personnel needed at the LZ or referring facility. This will reduce the need to repeat instructions with every mission, and, therefore will decrease the on-scene time.

Disaster Agency Requests

Every state and region of the country has a disaster management plan and designated participating agencies. These agency personnel should consider the air medical programs an asset in their planning and response. Protocols for air medical activation should be an integral part of the disaster management plan. The IC should consider the following factors that may influence the use of an air medical provider: site access, weather, terrain, type of incident, and benefit of air medical or aviation support. Use of helicopters and occasionally fixed-wing aircraft to ferry medical personnel and supplies, provide scene reconnaissance, and augment communications should be considered along with the ability to transport patients. Since EMS personnel will be involved in all disaster operations, emphasis on LZ operations is not as critical for disaster managers, but a basic understanding of aircraft operations and requirements is important to safe and proper utilization within the disaster plan.

SUMMARY

Positive internal and external relationships between air medical team members, their sponsoring institutions, professional colleagues, and their community play a vital role in the success of an air medical program. A collaborative attitude and approach is necessary for the air medical program to be viewed as a role model and integral part of the EMS community. It is only through this collaboration that the local, regional, state, and national guidelines for air medical practice can be improved upon, ultimately resulting in improved patient care.

A. **Bibliography**:

Delbridge T, Anderson P, Aufderheide T, et al. *EMS Agenda for the Future*: *Implementation Guide*, U.S. Department of Transportation, National Highway Traffic Safety Administration, DOT HS 808 711, 1998.

Marcum L, The Not-So-Scientific Value of EMS, *Annals of Emergency Medicine*, Volume 32, Number 5, November 1998.

U.S. Department of Transportation, National Highway Traffic Safety Administration. *EMS Agenda for the Future*. DOT HS 808 441, NTS-42, 1996.

B. **Definitions of Keywords**:

Public relations—The art and science of building and maintaining a desired impression or relationship with the public

Community—Persons living in a particular locality or having the same interests or goals

Marketing—The advertisement or promotion of a company or organization

Mission—The performance of a particular job or task; the guidelines by which an organization or program conducts business

Transfer agreement—A verbal or written contract specifying mutually agreeable and safe ways to transfer patients upon request

C. **Test Questions**:

1. What is likely to be the best approach to a complaint about aircraft noise?

   a. Cite FAA regulations to the complainant
   b. Have the hospital administrator write a letter
   c. Convene a community meeting to discuss noise complaints and necessary aircraft operations
   d. Have flight crew go door-to-door with program marketing materials

2. EMS has traditionally been considered proactive.

   a. True
   b. False

3. Flight crews are role models for children when they

   a. Properly use safety equipment
   b. Maintain physical fitness
   c. Carefully consider risk-taking activities, such as sports
   d. All of the above

4. Written transfer agreements:

   a. Require arrival at the referring hospital within a specific ETA
   b. **Document a mutual understanding between parties**
   c. Provide immunity from COBRA claims
   d. Guarantee payment for transfers

5. First responders should be trained to:

    a. Activate air medical services when indicated
    b. Work with EMS to best use air medical assets
    c. Assist with LZ operations
    d. All of the above

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

1. Have participants stand in front of the group and briefly explain
    - The program mission
    - A technical medical procedure
    - A safety briefing overview for referring EMS providers
    - A program overview for community leaders

2. Distribute and discuss examples of public relations materials. Design similar materials for your program.
    - Handouts and brochures
    - Educational or safety materials
    - Standardized lectures
    - Injury prevention materials

3. Brainstorm a way to reduce particular injury patterns in your community

4. Design a safety message for public distribution via radio, TV, billboard, or written brochure

5. Make a list of the risks and benefits of transfer agreements in your service area

6. Discuss your most challenging referral source, and suggest how a written agreement could smooth patient transfers with that source

F. **Patient Care Hours**: N/A

MODULE 4: DIVERSITY AND CULTURAL ISSUES

Author: Ms. Jean Moody-Williams, RN, MPP, EMSC National Resource Center, Washington, DC

Reviewer: Angela Golden, RN, MNEd, MS, FNP-C, CNS/CFRN, Verde Valley Medical Center, Emergency Department, Cottonwood, Arizona; Northern Arizona University, Department of Nursing, Assistant Clinical Professor, Flagstaff, Arizona

KEYWORDS

Acculturation
Assimilation
Culture
Cultural competency
Cultural pre-competence
Cultural destructiveness
Cultural incapacity
Cultural blindness
Cultural proficiency
Linguistically appropriate

OBJECTIVES

By the end of this module the student should be able to:

- Define cultural competency
- Discuss the cultural makeup of their local/regional community
- Identify the essential elements in cultural competency
- Compare their personal cultural beliefs and practices to those of the local populations/cultures
- Discuss rituals, home-remedies, and coping strategies that might be seen within groups in their response area

INTRODUCTION: A CHANGING NATION

The cultural composition and demographics of the U.S. are continually changing. While the U.S. has always had great diversity, population trends indicate that the number of African Americans, Asians, Native Americans, Hispanics, and others is expected to increase as a proportion of the total population. By the year 2010, Hispanics will comprise 14.6 percent of the population, African Americans 12.6 percent, and Asians 4.8 percent. By 2050 Hispanics will make up almost one fourth of the population (U.S. Bureau of the Census, 2000).

More important than having knowledge of national statistics is knowing the makeup of your community and the people that may require your air medical services. Information about your community can be gathered from the U.S. Census Bureau at www.census.gov, from your local city hall or county commissioner's office, or by surveys, research, and conversations with local leaders.

Air medical providers must be able to provide culturally appropriate services with consideration of varying health care needs that result because of race, ethnicity, geography, age, gender, sexual orientation, socioeconomic status, or disability. It is a mistake to believe that the same medical treatment will be effective for everyone.

Beginning the Dialogue

Cultural competency efforts are often bogged down by discussions regarding appropriate terminology and definitions. While it is important to use terms that are not offensive to individuals and their families, finding the appropriate terms should not serve as a barrier to moving forward with cultural competency efforts.

Cultural competency may be referred to as cultural proficiency, diversity, multiculturalism, or transcultural services. Each term is subtly different from others, reflecting the discipline that introduced the term. More important than the term is grasping the concept of providing care that meets the needs of the population receiving services. Open and honest discussion helps to address misconceptions about cultures and provides a common ground for continuing dialogue.

WHAT IS CULTURAL COMPETENCY?

Definition of Cultural Competency

Cultural competency is defined as a set of values, behaviors, attitudes and practices within a system, organization, program, or among individuals that enables them to work effectively across cultures. Further, it refers to the ability to honor and respect the beliefs, language, interpersonal styles, and behaviors of individuals and families receiving services, as well as staff who are providing such services. Cultural competency is a dynamic, ongoing, developmental process that requires a long-term commitment and is achieved over time (Cross, et al. 1989, Denboba 1993, Moody-Williams 2000).

The term competency is associated with the word culture to emphasize that it is not enough to be aware of or sensitive to the differences that exist between cultures. Instead, service providers must have the knowledge and skills to provide the necessary support and care required by different populations.

Assessing Competence

It is often useful to have a model that helps health care providers assess their current level of competency and describe levels that they may aspire to achieve. Terry Cross et al. developed a useful tool in 1989 for mental health professionals. Since that time the model has been widely adapted by other health care and community-based providers. Cross' cultural competency continuum assumes that cultural competence is a dynamic process with multiple levels of achievement. These levels include cultural destructiveness, cultural incapacity, cultural blindness, cultural pre-competence, cultural competence, and cultural proficiency.

Cultural Destructiveness

The negative end of the continuum is characterized by cultural destructiveness. Organizations or individuals in this stage view culture as a problem and participate in activities that purposefully destroy a culture. Cross notes that some agencies have historically been involved in services that have denied people of color access to their natural helpers or healers, removed children of color from their families on the basis of race, or purposely risked the well-being of minority individuals in social or medical experiments without their knowledge or consent. Organizations at this extreme assume that one race is superior and should eradicate "lesser" cultures.

Cultural Incapacity

The next stage of the continuum is cultural incapacity. Organizations in this phase do not intentionally seek to be culturally destructive but rather lack the capacity to help different cultures from diverse communities. They remain extremely biased, believe in the racial superiority of their racial/ethnic group, and assume a paternal posture toward "lesser" groups. They may act as agents of oppression by enforcing racist policies and maintaining stereotypes. People of color are not made to feel valued or welcomed and hiring practices are discriminatory.

Cultural Blindness

Cultural blindness is at the midpoint of the continuum. Organizations in this stage of the continuum function with the belief that color or culture makes no difference, and that all people are the same. They often view themselves as unbiased and meeting cultural needs when in fact such beliefs ignore the valuable differences of diverse groups and make services so ethnocentric that they are rendered virtually useless to all but the most assimilated people of culture. Outcome is usually measured by how closely the patient approximates a middle class, nonminority status.

Cultural Pre-Competence

Organizations that are culturally pre-competent are beginning to move toward the positive end of the continuum. They realize weaknesses in serving various cultures and attempt to improve some aspects of their services to a specific population. Pre-competent agencies are characterized by the desire to deliver quality services. They hire staff from the cultures they service, involve people of different cultures on the boards of directors or advisory committee, and begin to have some type of training. Organizations in this phase are cautioned against becoming complacent by believing that the accomplishment of one goal or activity fulfills the obligation to the community. Tokenism is another danger. Organizations sometime hire one or more diverse worker and feel that they have done their job.

Cultural Competence

Culturally competent organizations accept and respect differences and participate in continuing self-assessment regarding culture, continuous expansion of cultural knowledge and resources, and a variety of adaptation to service models in order to better meet the needs of minority populations. Culturally competent organizations work to hire unbiased employees, seek advice and consultation from the cultures served, and actively decide what they are and are not capable of providing to the client. Culturally competent agencies provide support for staff to become comfortable working in cross-cultural situations and understand the interplay between policy and practice.

Cultural Proficiency

Culturally proficient organizations are at the most positive end of the continuum and are characterized by holding culture in high esteem. They seek to add to the knowledge base of culturally competent practice by conducting research, developing new therapeutic approaches based on culture, and publishing and disseminating the results of demonstration projects. Culturally proficient organizations hire staff who are specialists in culturally competent practice.

PROVIDING CULTURALLY COMPETENT SERVICES

Providing culturally competent air medical care requires a continuous process of learning and interacting with the population in the community.

Cultural competency does not occur by simply taking a training course or reading a scientific journal. Providing culturally competent air medical services require conscious attention and sustained activity. In the absence of such planning, emergency care efforts can appear disorganized, confusing, and inefficient.

The following steps are essential considerations for air medical services:

- Develop an understanding of your own culture
- Determine the cultural makeup of the community that utilizes your air medical services
- Recognize differences between and within cultures
- Provide culturally and linguistically appropriate air medical services
- Ensure that air medical services are accessible, appropriate, and equitable

Developing an Understanding of Your Own Culture

In order to work effectively with other people, you must first gain an understanding of your own culture, values, perceptions, biases, and coping strategies. Once you have developed this self-awareness, it is easier to understand and acknowledge why you may react to a situation in a particular manner and the interpersonal dynamics that occur when you interact with someone from another culture. Begin by thinking of your own family traditions, folk remedies that you frequently use, your family's comments about other cultures as you were growing up, and your own experiences with other cultures.

Determining the Cultural Makeup of the Community

You must attempt to develop an understanding of the culture with which you are interacting, realizing that it is impossible to fully understand everything there is to know about any one culture. It is always helpful to have an understanding of the community that you serve before the occurrence of an emergency. Quite often, the best knowledge can be obtained by interacting with the community.

You may consider attending community meetings, religious events, clinics, and other settings that offer a diverse look at the community. You may also be able to obtain information about the community make-up from the public relations or community affairs office of your institution.

Many ethnic groups have established cultural websites that are useful learning tools. The U.S. Office of Minority Health (www.omhrc.gov) and the Indian Health Services (www.ihs.gov) offer valuable information on their websites. You must be careful to avoid stereotyping your customers based on their culture since there are many differences among members of the same culture, as discussed in more detail below.

Recognizing Differences Between and Within Cultures

No group will respond to illness in exactly the same manner. There are often as many differences within a culture as there are between cultures. Broad groupings are often used to describe an entire culture without consideration of the subgrouping that may be present. For example, Asians are a very diverse group that may have origins from Korea, India, Vietnam, Cambodia, and Laos. Latinos may come from such locations as El Salvador, Puerto Rico, Chile, Brazil, Argentina, Mexico, Cuba, and other Latin American nations. Even members from the same subgroup have different beliefs and customs.

Differences in cultures will also vary depending on the level of acculturation or assimilation. Acculturation refers to the modification of the culture of a group or individual as a result of contact with a different culture. The group or individual does not completely give up his or her culture in the process. Assimilation is the process by which an individual or group completely adopts the identity, customs, and values of another culture.

PROVIDING CULTURALLY AND LINGUISTICALLY APPROPRIATE AIR MEDICAL SERVICES

Customs and Traditions

A person’s culture may shape their perceptions regarding illness, the seriousness of a condition, and the appropriate treatment and follow-up. Cultures vary in the use of rituals, home remedies, and religion during a traumatic event.

Western interventions frequently focus on the individual, whereas in many cultures, the individual cannot be separated from families and communities. In the time of a crisis, it may be necessary to make a quick assessment regarding family relevance and decision-making. You may have to determine who is significant in making health care decisions by observing family interactions and asking relevant questions. You may be able to save valuable time during an emergent situation by making this assessment early during the interaction with the patient and family.

Communications and Linguistics

Communications issues must be considered when attempting to treat or assess the patient. Differences in language often lead to frustration, a breakdown in credibility, and an atmosphere of contempt. Interpreters should be used when the language barrier is so great that it impedes service provision.

Avoid using children, relatives, or friends as interpreters since the patient may not feel comfortable expressing concerns of a personal nature to these individuals. In an emergency, family members may be the only source available to translate. An understanding of cultural difference is particularly important in this instance, since it may influence the information you receive and the decisions that you make. Pay particular attention to body language, facial expressions, and tone.

Cultural Assessment and Intervention

Giger and Davidhizer developed a transcultural assessment model in 1999 that identifies six issues that can affect interactions of a provider and patient. They include communications, both verbal and nonverbal; personal space requirements that may vary from culture to culture; and, social organizations, such as family, kinship and tribes, politics, economics, and religion.

Other issues include time, which may be measured differently by various groups, and environmental control or the belief that events occur because of some external factor—luck, chance, fate, or the will of God. Lastly, biological variations may impact such things as drug dosing, therapeutic response, and side effects.

Ensure That Air medical Services are Accessible, Appropriate, and Equitable

Ensuring accessibility, appropriateness, and equality requires an institutional approach to cultural competence. It is not sufficient to have one person skilled in interacting with different cultures. Competency should be expected of everyone on the air medical staff. It often takes a champion to introduce the concepts embodied in cultural competence.

Ask if your facility has a plan to address cultural competence or whether you may be able to assist in developing a plan. The planning and implementation process should include completing an organizational needs assessment to determine the organizational culture and level of competency, completing a community assessment to determine the predominant cultures in your community; conducting a review of treatment protocols to integrate cultural consideration in treatment plans; providing ongoing training opportunities to keep abreast of information related to health care disparities and treatment outcomes, and conducting ongoing research and evaluation.

Finally, the most effective plan includes a strategy for recruiting and hiring air medical providers that represent the community served. People from the community can help to train others on the staff.

SUMMARY

Air medical providers must be able to meet the health care needs of an increasingly diverse patient population. Health care requirements may vary based on race, ethnicity, geography, age, gender, sexual orientation, socioeconomic status, or disability. There must be an understanding that culture factors can have an impact on the effectiveness of the patient's treatment and air medical experience. Ensuring accessibility, appropriateness, and equality in air medical services requires an institutional approach with an expectation that everyone on the air medical staff strive for some level of competency.

A. **Bibliography**:

Athey, J & Moody-Williams, J. *Serving Disaster Survivors Better: Achieving Cultural Competence in Crisis Counseling.* Produced by the Emergency Services and Disaster Relief Branch, Center for Mental Health Services (CMHS), Substance Abuse and Mental Health Services Administration. Washington DC. 2001.

Giger, J. & Davidhizar, R. *Transcultural Nursing: Assessment and Intervention*. 3rd ed. St Louis: Mosby Year Book, 1982.

Cross, T.L., et al. *Towards a Culturally Competent System of Care*. Vol 1: A Monograph of effective services for children who are severely emotionally disturbed. Washington, DC: Georgetown University Child Development Center. 1989.

Denboba, L., et al. Reducing Health Disparities through Cultural Competence. *Journal of Health Education*, September/October Supplement. 29(5): 47–53. 1998.

U.S. Bureau of the Census, *Projection of the Resident Population by Race, Hispanic Origin, and Nativity: Middle Series*, 1999 through 2100. Washington, DC: Population Division, U.S. Bureau of the Census, 2000.

B. **Definitions of Keywords**:

Acculturation—The modification of the group culture as a result of contact with a different culture, without completely giving up the original culture in the process

Assimilation—To completely take in or incorporate the identity, customs, and values of another culture

Culture—The makeup of a community, including customs, practices and beliefs specific to that group

Cultural competency—A set of values, behaviors, attitudes and practices within a system, organization, program, or among individuals that enables them to work effectively across cultures

Cultural pre-competence—The point at which organizations realize their weaknesses in serving various cultures and attempt to improve some aspects of their services to a specific population

Cultural destructiveness—The stage at which organizations or individuals view culture as a problem and participate in activities that purposefully destroy a culture

Cultural incapacity—The point when organizations do not intentionally seek to be culturally destructive but rather lack the capacity to help different cultures from diverse communities

Cultural blindness—The point at which organizations function with the belief that color or culture makes no difference and that all people are the same, while sometimes ignoring the valuable differences of diverse groups

Cultural proficiency—Characterized by holding culture in high esteem

Linguistically appropriate—Communicating in a manner that recognizes cultural differences and how they may influence the information received and the decisions made, including, body language, facial expressions, and tone of voice

C. **Test Questions**:

1. Cultural competency efforts should be:

    a. Abandoned in an emergency situation
    b. Abandoned when terminology cannot be agreed upon
    c. **Integrated into all areas of air medical services and made an expectation of all providers**
    d. Assigned to one individual in the air medical services organization to ensure accountability

2. Which of the following is a true statement?

    a. Cultural competency involves treating all people the same
    b. Cultural competency can be obtained by completing a training course
    c. Cultural competency can be obtained by reading a good peer reviewed journal article
    d. **Achieving cultural competency requires a continuous process of learning and interacting with people from various cultures**

3. Assimilation involves

    a. Completely adopting the identity, customs and values of another culture
    b. Studying another person's culture, values, and customs
    c. Moving from one country to another to identify other cultures
    d. Maintaining your own cultural identity, values and customs

4. An organizational cultural competency plan

    a. Should be tailored to the nation as a whole
    b. Should be developed by one person on the staff to save time
    c. Should include a plan to recruit and hire people from the community served
    d. Should include a review of referral patterns so the program can choose their response areas

5. Acculturation refers to

    a. The process of completely changing one's own culture
    b. Modification of a culture as a result of contact with a different culture
    c. The process of becoming culturally proficient
    d. Accepting the cultural belief that color or culture makes no difference and that all people are the same

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Discuss local population demographics
- Have participants discuss folk remedies used by their families and how they may be incorporated into more traditional approaches to medicine
- Have participants complete a cultural self-assessment
- Role-play questions that an air medical provider may ask to assess a patient’s cultural preferences for treatment
- Invite community members from different cultures to share their perspectives and insight into their particular culture as it relates to health care

F. **Patient Care Hours**: N/A

CHAPTER 3: MISSION SAFETY

Module 5: Personnel and Aircraft Standards

Module 6: Aircraft Safety Training

Module 7: Air Medical Resource Management

Module 8: Hazardous Materials

Module 9: Environmental Factors and Survival

MODULE 5: PERSONNEL AND AIRCRAFT STANDARDS

Author: Dr. Carol Gilbert, Lifeguard 10, Roanoke, VA

Reviewer: Mr. Paul Roman, New Jersey EMT Registry, Shrewsbury, NJ

KEYWORDS

Crashworthy
Survivability
Head strike envelope
Limb flail
Mission profile
Air medical resource management
Flight following

OBJECTIVES

Upon completion of this module, the student should be able to:

- Define the terms crashworthy and survivability
- Describe the mission profile for the program and how the aircraft and safety policies reflect the profile
- Demonstrate the use of personal safety equipment
- Describe and demonstrate proper use of aircraft safety features
- Demonstrate the proper means of securing the patient and any heavy equipment routinely stored

INTRODUCTION AND HISTORY

On September 21, 1908, U.S. Army Lt. Frank Selfridge was the first aircraft occupant to be killed in a crash. In spite of this, focus on air safety was slow to develop until World War I and immediately afterward. Ten years later the Air Service manual published by the U.S. Army mentioned safety belts and goggles for protection, and pictured most aviators with leather helmets. Emphasis was also placed on rest, stress reduction, and nutrition for accident prevention. Early aviation safety efforts focused on fixed-wing military aircraft, and included development of helmets and other protective clothing, improvement of communications and navigation, and enhancement of crashworthiness in aircraft.

The development and extensive use of rotorcraft created new safety issues in the aviation environment. Occupants of helicopters are exposed to different forces and velocities than occupants of fixed-wing aircraft. Helicopters function in a different aviation environment, landing in makeshift areas, and participating in rescue and off shore operations.

Civilian use of helicopters for EMS was associated with similar risks. In 1986 the civilian EMS sector experienced a high crash and fatality rate. Nine per cent of the entire fleet was lost during that year. This resulted in an investigation and special report by the National Transportation and Safety Board (NTSB), which was published in 1988. This report, the NTSB/SS-88/01, although outdated in some areas, makes excellent reading for those interested in aviation safety for EMS.

The NTSB investigates and makes recommendations regarding transportation incidents. It is not responsible for promulgating regulations. NTSB recommendations and FAA response to these recommendations are included in one of the databases listed on the FAA aviation safety section of its web page. Not all of the NTSB recommendations in its EMS report went into regulation. For example, the use of helmets and flame retardant clothing by air medical crew members remained a recommendation only. Because of this, there may be a tendency by some programs to ignore some of the NTSB results.

AIR MEDICAL ENVIRONMENT

Aircrew members are exposed to risk in three distinct areas: the medical environment, rescue environment, and the aviation environment. Prior training in the pre-hospital and hospital settings prepares air medical crew members for the first two but not for the aviation environment. While there is a natural tendency of air medical programs to focus on aviation safety, the combination of all three environments is unique and demands attention.

SOURCES OF REGULATIONS AND STANDARDS

It is important to have access to sources for the various standards used in the development of a safety program. Regulations are established by federal, local, or state jurisdictions and reflect implementation of corresponding laws. Violation usually results in a penalty. Regulation covers a broad spectrum of agencies, and necessarily reflects the MINIMUM required compliance. In addition to regulations criteria are developed by a number of organizations with an interest in air medical or EMS operations. The list below is not comprehensive, but consists of several of the more commonly involved agencies and organizations.

Federal Regulations/Guidelines

- Federal Aviation Administration (FAA)
- Occupational Safety and Health Administration (OSHA)
- Federal Communications Commission (FCC)
- Centers for Medicare & Medicaid Services (CMS, formerly HCFA)
- National Transportation Safety Board (NTSB)
- National Highway Traffic Safety Administration (NHTSA)

State Regulations

Each agency functions under a set of state regulations as well as federal regulations. The name of the department or office promulgating the regulations pertaining to air ambulances varies from state to state. Some of the more commonly involved state agencies are:

- **Department of Health Services**

  Bureau of EMS
  Bureau of Emergency Management
  Bureau of Maternal Child Health

- **Department of Transportation**

Professional and Accreditation Organizations

- **AAMS: (www.aams.org)**
- **CAMTS: (www.camts.org)**
- **CAAS: (www.caas.org)**
- **AMPA: (www.ampa.org)**
- **JCAHO: (www.jcaho.org)**
- **ASTM: (www.astm.org)**
- **NFPA: (www.nfpa.rotor.org)**
- **ASTNA: (www.astna.org)**
- **HAI: (www.rotor.com)**
- **NEMSPA: (www.nemspa.org)**
- **NASEMSD: (www.nasemsd.org)**
- **ACS: (www.facs.org)**
- **AAP: (www.aap.org)**
- **NAEMSP: (www.naemsp.org)**
- **AARC: (www.aarc.org)**
- **NANN: (www.nann.org)**
- **START: (www.start4cism.org)**
- **ALEA: (www.alea.org)**
- **CAMI: (www.mmac.jccbi.gov/mmac/research.html)**
- **NAACS: (www.naacs.org)**
- **USAFSAM: (wwwsam.brooks.af.mil)**

See Module 2, Industry Standards, for detailed organization descriptions.

PROGRAM PHILOSOPHY

Safety and standards are integral and complimentary parameters that must drive all policies, procedures, practices, and the overall philosophy of each air medical program. Every safety program operates under several important principles.

Safety as a Program Priority

Safety takes priority over every other aspect of the program, including patient status and economy.

Comprehensive Participation of All Members

All program members are responsible for safety. This includes air medical crew of course, but also pilots, mechanics, program administrators, and medical direction.

Comprehensive Inclusion of All Components and Activities

While most programs emphasize the aviation environment, a safety program should address all areas that present potential hazards to crew or patient safety.

Management of All Phases

Each potential problem should be addressed with regard to prevention, response at the time of an incident, and post-incident management.

HADDON'S MATRIX MODEL OF PREVENTION

Haddon's matrix was originally described as a model for use in disease prevention, but may be modified for use in air medical program safety management. The matrix may be adapted to address a variety of situations such as exposure to blood-borne pathogens, or tactical rescue situations. In the illustration below, it is used to address crash of an aircraft.

	Host		Physical Environment	Socio-economic
	Pilot/ Crew/Patient	Aircraft	Geography /Climate	EMS System Program
Pre-Exposure (Pre-Crash)	• Uniforms • Protective Equipment • Training	• Selection • Maintenance	• Flight following • Weather and updates • Terrain • Air traffic environment and control • Time of day	• Flight Acceptance protocols • Mission profile • Flight following • Pilot/crew fatigue and stress • Mission urgency • Radios—dispatch communications
Exposure (Crash)	• Correct use	• Crash-worthiness • Equipment secured	• Terrain • Weather	• Notification • Functional communication system
Post-Exposure (Post Crash)	• Physical condition • Evacuation procedures • Injuries	• Access to emergency exits • Fuel leaks • Survival equipment	• Terrain • Weather	• Search and rescue • Post incident plan • Debriefing • CISM

PILOT, CREW AND PATIENT PROTECTION

Personal Equipment

Air medical crews must be equipped for protection from the rescue, medical and aviation environments. Hazards pertaining to each of these environments must be identified and addressed. Protective equipment of any kind must be used appropriately if it is to be effective. Program policies and procedures should include the requirements and use of all such equipment.

Medical Environment

Transport of medical patients involves risk of exposure to agents of infectious disease, hazardous materials, and physical injury from exposure to violent or agitated patients. The Occupational Health and Safety Administration (OSHA) requires training in management of blood-borne and respiratory pathogens. Information on up to date standards may be obtained from the OSHA web page.

While any pathogen presents a potential risk to staff, blood-borne pathogens are certainly the most frequently encountered. The small space of the aircraft cabin exacerbates difficulty in taking precautions. In situations where contact with blood is a possibility, crew should use protective gloves. Those usually provided by hospitals are fragile for scene work. Several companies provide thicker latex gloves more suitable for this purpose. Helmet visors provide eye protection in the lowered position. Masks should also be available. Although the general public is most concerned about exposure to HIV, hepatitis B and C present a greater risk to the health care provider. Immunization for hepatitis B should be provided for all crew members.

Following transport of a patient, the aircraft must be returned to a state of readiness as quickly as possible. Clean-up equipment should be provided in a location close to the helipad. There should be on-site capability to launder soiled uniforms and exchange contaminated linens. The medical equipment associated with air medical transports as well as the aircraft itself are expensive and complex. Whenever necessary, the program should have a policy describing the best means of episodic and routine decontamination.

Any transportation agency, ground or air, needs an exposure plan to address occurrence of exposure of crew to a known or suspected infectious agent. This is not as straightforward as it would seem. Sending facilities do not always know the nature of a patient's illness. Receiving facilities are occasionally reluctant to release information about patients. While the latter is rarely a problem for the host hospital for an agency, it is a good idea to establish agreements ahead of time with other receiving hospitals. One or more members of the air medical crew act as contact points for gathering information about the exposure and nature of patient illness, as well as any follow up tests and treatments required.

Rescue Environment

Rescue activities may be within the mission profile of the program. If so, this should be reflected in training activities. The program should maintain and use its own equipment rather than borrowing equipment from agencies on the ground, as the history and maintenance of borrowed equipment are unclear. Even if a crew member has been trained in specific areas such as vehicle extrication, it is important to remember that flight suits do not always provide sufficient protection for the activity.

A special problem encountered in the rescue environment is the hazardous materials (hazmat) incident. Within the small space of a cabin, fumes can affect crew profoundly, and with disastrous consequences. Additionally, decontamination for some substances is very difficult. Occasionally, the only effective decontamination is to discard the equipment, including the aircraft. The program should have a policy describing the approach to hazmat incidents. While air transport of a patient slightly contaminated with gas or diesel fuel may be appropriate, more toxic or unknown substances necessitate a ground transport from the scene. Inter-hospital transport following decontamination and evaluation should be initiated only with input from on line medical direction.

The public has high, and sometimes unreasonable, expectations of air medical programs. Public education regarding the program mission may help to avoid pressure to perform beyond training and equipment levels.

- **Aviation**

  Chances of surviving a crash are enhanced with adequate personal protection for the crew. The NTSB report of 1988 recommended that crew members be equipped with helmets, appropriate footwear, and flame retardant clothing. Although these recommendations are not reflected in regulations, research and experience with crash investigations strongly support use of protective equipment.

- **Personal Protective Equipment (PPE)**

  - ***Uniforms***

    Flameproof materials suitable for uniforms are not practical. However, uniforms are available in flame resistant materials such as Nomex®. Flame retardant materials do not protect from prolonged exposure to fire, but may provide sufficient time for rapid egress and escape from burning wreckage. Synthetic materials melt when heated, causing burns. Only natural fibers should be worn beneath (or on top) of flame retardant uniforms. The fit should be loose in order to allow a layer of air between the skin and the uniform. The sleeves must be long for arm protection, and should not be worn rolled up during flight. Although impractical for law enforcement and military operations, reflective uniform markings are invaluable for programs with a primary EMS function, since crews frequently work on scene at night.

  - ***Helmets***

    Helmets provide protection against head injury, the most frequent cause of death and disability in aircraft crashes. Military studies show that pilots not wearing helmets were six times more likely to sustain a fatal head injury than those pilots protected by helmets. Rear occupants of aircraft were over seven times more likely to experience a fatal head injury than if they were wearing a helmet (Crowley, et al). Air medical crew members function primarily in the rear of the aircraft and may benefit substantially from use of head protection during a crash. Helmets provide some hearing protection as well as protection for the brain. Most crew prefer to continue wearing the helmet while working in the vicinity of the aircraft rather than switching to an alternate form of ear protection. All of the helmets mentioned above have integrated visors. These provide eye protection from dust and debris. Examination of military equipment worn during helicopter crashes suggests strongly that visors worn in the lowered position may provide substantial protection from severe facial injuries and further reduction in fatality (Rash, et al). Clearly, simply having access to a helmet is not enough. Proper use is essential. Aviation helmets come in different sizes, with liners that allow further adjustment to fit the individual crew member. Several civilian helmets have been based upon military designs and are appropriate for use in rotorcraft. At present these are the SPH-5, HGU-56, SP-5, HGU-6, and the HGU-84.

- ***Footwear***

  Rescue and aviation environments present similar requirements in term of footwear. Ankle high boots with steel shanks and toes prevent injury to feet from glass and metal debris whether from a damaged aircraft or crushed motor vehicle. Leather is flame retardant. In cold environments, insulation prevents conduction through the sole of the boot.

- ***Separate Hearing Protection***

  The aviation environment is noisy. Over time, hearing loss occurs in unprotected exposed individuals. The program is responsible for providing education and assuring that appropriate equipment is available. As mentioned previously, helmets provide hearing protection. For those not wearing helmets and frequently exposed, the “ear muff” type protectors worn over the head and covering each ear afford the best protection and are economical. Occasional users benefit from ear insert protection. The foam ear inserts provide less hearing protection than helmets or muffs, but are extremely inexpensive and easy to carry around.

AIRCRAFT SELECTION

Selection of an aircraft is one of the first decisions made by program administrators. No single aircraft is ideal for all air medical programs. The aircraft should be selected based upon the mission of the program. Factors such as transport time, terrain, patient type, and additional activities such as law enforcement or rescue must be weighed against each other in considering the aircraft. Clearly, a program flying trans-continental missions will require a fixed-wing aircraft. In contrast, a program flying short missions at higher altitudes needs to consider rotary-wing aircraft capable of functioning effectively at altitude.

Cabin Configuration

The configuration of the aircraft is the arrangement of the interior. This is individualized and should reflect the mission profile for the program. Seats are located in a manner to allow easy access to the patient for airway management, treatments, procedures, and possible delivery of a newborn. Whenever possible, the air medical crew should remain restrained during flight. Drawers and cabinets should latch shut and be accessible by restrained crew. The cabin should have sufficient lighting to permit patient care, yet allow isolation of the pilot at night in order to avoid loss of night vision.

Flight Crew Restraints

Four point adjustable restraints should be provided for each occupant. Four point restraints control the position of the torso during a crash or hard landing, but do not protect from head strike and limb flail. For this reason, it is important to maintain a clear area within the area of head and limb excursion. This is referred to as the head and limb strike envelope.

Securing of Equipment/Gurney

Equipment must be secured during the flight. Large equipment such as stretchers or incubators is secured using frame attachments. The “Type Certificate” issued by the FAA pertains to the basic design of the aircraft. ANY significant modification of the design or airframe structure requires a “Supplemental Type Certificate”. This certificate follows an engineering study of the changes involved. An appropriate mechanic must make any actual aircraft modifications. The location of an anchoring point may seem irrelevant to aircraft operations but it is not. Performance and integrity of the aircraft are at risk.

Air medical crew should arrange portable equipment within the cabin in a manner that allows easy access and continued use of restraints for the patient.

O2 Systems, Tanks, Air Compressors

Oxygen, almost always in use during a medical transport, is also an essential component for maintaining a fire. Medical oxygen supply systems on board aircraft must have cut off valves readily accessible to the occupants rather than being located in isolated cargo compartments. Liquid oxygen supply systems may provide an additional margin of safety and weigh less than oxygen supplied in the form of gas.

Avionics equipment designed to assist with navigation and storm identification is essential for the pre-incident or prevention phase of crash management.

AIRCRAFT FACTORS DETERMINING EVENT OUTCOME

Crashworthiness

The term crashworthiness applies to features of the aircraft designed to withstand forces or hazards generated during a crash. Examples include energy attenuating seats, puncture resistant fuel tanks, and protection of occupant space. The presence of a design feature does not assure that it will be effective. Much depends upon actions of the occupants. For example, reinforcement of the occupant compartment may be completely ineffective if heavy items are not properly stowed.

Survivability

Survivability of a crash pertains to the forces incurred during the incident. A crash is said to be survivable if forces on the human body are not incompatible with life. Not all survivable crashes have survivors. Much depends upon crew actions. Even a survivable crash may be fatal if the air medical crew is unrestrained or not wearing helmets.

Status at Time of Incident

Outcome of a crash also depends on the status at the time of the incident. Air medical crews are responsible for the appropriate use of restraints and protective equipment. The cabin must be checked for loose equipment, and heavy items must be properly stowed. The head strike zones and areas of possible limb flail should be as clear as possible.

ENVIRONMENT AND GEOGRAPHY

The geography and climate in which a program operates are integral factors in pre-incident, incident, and post-incident phases of management. Agencies operating in areas of high air traffic face different hazards than those operating in remote rural areas. Geography and climate also affect selection of the aircraft.

Survival training for post-incident situations should be compatible with the operating environment of the program. In the planning of such training, it is important to estimate the time required for emergency response to an aircraft incident. For a program operating strictly within an urban area, prolonged unassisted survival is not an expectation. By contrast, survivors of a crash in a wilderness area may need to survive for days prior to the arrival of help.

Physical geography and climate play a direct role in planning and equipping for survival. In the event of a crash, a program operating in an oceanfront area must accentuate water landings and egress, while one operating in a desert may need additional water supplies and familiarity with thermal injuries.

All programs should address hard landing training and rapid egress of the aircraft. It is very important to undergo hands-on drills. Since vision will often be impaired by smoke or darkness, this confounding factor must be included in the drill for aircraft egress. The air medical crew members should practice exiting an aircraft quickly, in the presence of a simulated patient and substantial amounts of medical equipment. It’s easy to get tangled up in IV tubing and monitor wires, and hard to step over a patient on the way out. It is important to remember that air crew who can escape unimpaired have a better chance of going back for the patient than if they remain with the patient and are further injured themselves.

LZ training is essential for those programs that rely on rescue agencies to establish LZs. As part of the quality assurance process, the program should keep track of how effectively LZs are set up and any problems that arise. This allows retraining as necessary. Not all aircraft load in the same way. When several different aircraft are operating in the same area, it is important to emphasize any differences during LZ training.

SYSTEM AND PROGRAM

Mission Profile

Every program has a mission, and not all missions are the same. It is imperative that air medical crew understand the mission and operate within that definition. Deviation from the mission, such as attempting rescue operations by a program not designed, equipped, or trained for rescue, is a recipe for disaster.

Communications

- **Electronics Specifications**

  The communications equipment, its availability, reliability, range, and compatibility with other local and regional communications systems, are vital components to a successful communications network.

  All electronic devices carried on board must be compatible with the avionics equipment and aircraft radios.

- **Dispatch/Communications**

  Each air medical program is associated with a communications center. The center and the communications specialists are an essential part of every program. They are usually responsible for gathering information on patients from receiving facilities, and for maintaining contact with missions in progress. Air communications specialists must have an understanding of the aviation environment and response area. This requires orientation and training beyond the usual public safety dispatch course.

  The communication center should be sufficiently isolated to allow the specialist to focus on the flight. While the specialist may have other duties, these must not overwhelm or distract them from flights in progress. Contact should be made with the aircraft every 10 minutes and progress plotted so that if an aircraft disappears, location and assistance will be as expeditious as possible.

  If an emergency occurs, the communications specialist is responsible for initiating contact with other program members, administrative personnel, and SAR operations. Every program should have a post accident/incident plan. This plan describes who should call whom, and which actions should be taken. The plan should be designed to minimize call-in to the communication center itself, since unnecessary calls will distract the focus of attention from the aircraft and its crew.

- **Within the Crew**

  Earlier models of communication for air medical crews emphasized isolation of medical and aviation decision-making. It is true that program policies should be designed in a manner not to place excessive pressure on pilots to accept a risky flight. However, it is also true that the air medical crews are more than passive occupants of a flight in progress.

Commercial airlines have discovered that open, nonjudgmental communications between cockpit crew assist in identifying potentially risky situations. In several major incidents, one or more members of the cockpit crew perceived a problem, but failed to communicate it because they either felt the captain knew much more than they did, had the situation under control, or would respond in a derogatory manner. Airlines instituted cockpit resource training to address the problem. Shortly after this, it became apparent that all air medical crew members should participate, and the term was changed to reflect this: "air medical resource management". During medical transports, air medical crew members are responsible for watching for and identifying potential risks and reporting them to the pilot. These include, but are not restricted to, presence of spectators around the rear of the aircraft, wires in or immediately adjacent to flight paths, and other air traffic in proximity to the aircraft. Air medical resource training is an invaluable contribution to the overall safety of a program and will assist in areas other than aviation.

While communication is essential, air medical crew members must also maintain silence during times when the pilot is in communication with air traffic control and in aircraft-related emergencies. Isolation of the patient compartment intercom may be used to achieve this, since the patient's condition may require communication between medical crew.

SUMMARY

The air medical environment presents a unique combination of rescue, medical, and aviation factors. Each of these presents potential hazards to the crew involved in patient transport. All program members are responsible for mission safety, and safety must always take priority over patient care.

A. **Bibliography**:

Adams. R.J., and McConkey, E.D., *Aeronautical Decision Making for Air Ambulance Program Administrators*, DOT/FAA/DS-88/8. Feb 1990.

Adams, R. and Thompson. J., *Risk Management for Air Ambulance Helicopter Operators* DOT/FAA/DS-88/7. June 1989.

Allen, R.F. et al ed. *ASTM Standards on Emergency Medical Services*. 2nd ed. 1998; F1119-91, F1124-91, F1146-91, F1187-91, F1274-91, F1283-91.

Bagian, J.P. and Allen, R.C.. "Aeromedical Transport". *Wilderness Medicine*. Auerbach, P. 4th ed. 2001: (640–672).

CAAMS. *Accreditation Standards on Air Medical Services.*

Crowley. J. “Should Helicopter Frequent Fliers Wear Head Protection? A Study of Helmet Effectiveness.” *J Occupational Medicine*. July 1991. 33(7): 766–769.

Gibbons, H.L. and Snyder, R.G. “Aircraft Accidents: Prevention, Survival, and Rescue” *Fundamentals of Aerospace Medicine.* DeHart, R.L. ed. 2nd ed. 1996: 977–999.

Gilbert. C.M. “Aviation Safety for the Air Medical Physician.” *Air Medical Physician’s Handbook*. 1996; IV(3).

Hawkins. M. R. “Personal Protective Equipment in Helicopter EMS”, *Air Medical Journal.* April 1994. 13(4). 123–126.

Mc Meekin, R.R. “Aircraft Accident Investigation” *Fundamentals of Aerospace Medicine*. DeHart, R.L. ed. 2nd ed. 1996. 845–895.

Mitchell, G.W., Chase, N.B., and Kreutzman, R.J. “Army Aviation Medicine” *Fundamentals of Aerospace Medicine.* DeHart, R.L. ed. 2nd ed. 1996. 707–730.

National Transportation Safety Board. *Safety Study-Commercial Emergency Medical Service Helicopter Operations* NTSB/SS-88/01. January 1988.

Rhee, K.J., Holmes, E.M., O’Malley, R.J. “Helicopter Safety and Medical Transport,” *Problems in Critical Care.* December 1990. 4(4). 528–533.

Shanahan, D. and Shanahan, M. “Injury in US Army Helicopter Crashes: October 1979–September 1985”. *J Trauma*. April 1989. 29(4): 415–423.

B. **Definitions of Keywords**:

Crashworthy—The design and structural aspects of an aircraft that decrease risk of injury or death in a survivable crash

Survivability—The degree to which forces generated on the body during a crash are compatible with life

Head strike envelope—The area immediately around the usual position of the head (approximately 10 inches in all directions) of a restrained occupant, representing the area into which the head may be thrust during the a crash

Limb flail—The movement of extremities of a restrained occupant during a crash. Limb flail may result in fractured extremities if the space around the occupant is not clear. This may further hinder egress.

Flight following—The process in which the communications center contacts an aircraft in flight at regular predetermined intervals in order to track its position and status

Mission profile—The role of the air medical program and the environment within which it operates

Air medical resource management—A program designed to enhance clear verbal and nonverbal communications between pilots and air medical crew members in order to optimize decision-making and response to critical situations.

C. **Test Questions**:

1. All of the following are true of helmets developed for use in helicopters EXCEPT:

    a. The helmet may enhance hearing protection
    b. When the visor is in the lowered position, head protection provided by the helmet is increased
    c. **The helmet improves crashworthiness**
    d. The survivability of the crash is not increased

2. At the time of approach for landing on a scene call, you notice an electrical wire close to the left border of the landing area. The pilot has not commented upon this. Which of the following is correct?

    a. You should maintain silence since the pilot is engaged in landing operations
    b. You should wait until the landing is complete and then inform the pilot
    c. This is an aviation issue. You should take no action.
    d. **You should point the wire out to the pilot when you notice it**

3. Air medical resource management is:

    a. The process of scheduling crew members for sufficient rest periods
    b. Identification of strengths and weaknesses of each crew member
    c. **Understanding and facilitation of communication processes between crew members**
    d. Provision of sufficient crew members to do the job at hand

4. The top priority on all flights involving the transport of critically ill or injured patients is:

    a. Proper equipment
    b. Crew safety
    c. Informed consent
    d. Patient safety

5. All but one of the following organizations have set forth guidelines regarding equipment use in the air medical environment:

    a. ASTM
    b. FCC
    c. NHTSA
    d. FAA

D. **<u>Didactic Hours</u>**: 1

E. **<u>Skills Hours</u>**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours

Examples:

- Be fitted for, select, and practice proper use of personal protective gear
- Become familiar with the placement and securing of equipment and supplies and preparation of the cabin for flight
- Identify a potential risk to your program. Develop a Haddon's matrix to identify means to decrease the risk or respond to an incident involving the risk

- Participate in at least one rapid egress drill. The drill should be carried out from within the aircraft used by the program. Participating crew members should be in uniform. Masking or hoods should be used to simulate visual impairment due to smoke. Spotters should be available to minimize injury during egress. The drill is first tried without a patient or equipment. Following this, the drill should be repeated with a simulated patient and equipment

F. **Patient Care Hours**: None. However, adherence to safety policies should be observed at all times, and a separate rating for safety provided for each megacode and actual patient transport during orientation and training.

MODULE 6: AIRCRAFT SAFETY TRAINING

Author: Mr. Chuck Prudhomme, RMH, Provo UT

Reviewer: Mr. John Fisher, RN/CEP, LIFESTAR, Hartford, CT

KEYWORDS

Pilot in command (PIC)
Emergency Locator Transmitter (ELT)
Landing zone (LZ)
Reconnaissance (Recon)
Cold load
Crew member
Engine cool-down time
Egress
Hot load
Inter-facility
Multiengine
Reference point
Rotor disc
Scene

OBJECTIVES

Upon completion of this module the student should be able to:

- Demonstrate safe load/unload technique
- Demonstrate aircraft egress from all positions in the aircraft
- List important factors involved in over-water operations
- Discuss approach and departure to/from aircraft
- List 5 factors affecting patient access and loading

INTRODUCTION

Recurrent aircraft safety training will have a positive impact on flight crew emergency preparedness. Aircraft loading and unloading competency is vital to safe operations on scene, at helipads, and at airports. Mission profile, patient acuity, and aircraft performance all impact the decision to perform hot or cold loads and unloads. The flight crew members must work collaboratively with other air medical services, ground EMS providers, and law enforcement to assure that all actions in and around the aircraft, ground unit, and incident scene are safely carried out. In addition to aircraft safety, crew and patient safety must be considered. Once the patient and equipment have been secured on-board the aircraft, the air medical crew must ensure access to the patient for any interventions that may be required at altitude.

SPECIAL MISSIONS

Although every patient transport is different some situations demand particular expertise from the PIC and/or medical crew. Because of this specialization, not all programs accept the responsibility of all transport requests. Municipal, military, and law enforcement programs are most often involved in SAR, and special procedures such as long-line rescue, white-water rescue, and confined space rescue. Hospital affiliated programs most often provide the highly specialized transport services required for high-risk maternal patients, high-risk neonatal patients, critical-care pediatric patients, and device-dependent cardiothoracic patients. Each of these special missions requires equipment, stretchers, incubators, or assist devices that are not routine on-board equipment. For this reason, air medical crews must become familiar with the missions and equipment that they work with on a periodic basis, since they may pose particular safety challenges.

LANDING CONSIDERATIONS

Both the PIC and the air medical crew have a responsibility to assure a controlled and safe LZ. This is best accomplished proactively by providing outreach education on LZ safety to the referring ground personnel responsible for LZ set up prior to patient transports. In addition to providing recurrent training on LZ security, the air medical crew must always be prepared to assist the PIC in scene reconnaissance on initial approach. Once landing has been accomplished, the medical crew may also be required to exit the aircraft prior to shutdown, and post to maintain scene security.

PATIENT ACCESS CONSIDERATIONS

Having adequate access to the patient for the purpose of in-flight stabilization and intervention is of utmost importance. Several factors may impact this access:

- Patient/medical compartment size
- Crew configuration
- Seating arrangement
- Number, type, and location of patient adjuncts (airway, IV lines, monitor cables, etc.)
- Patient diagnosis, anticipated interventions, and area of body requiring access (airway, extremities, perineum, etc.)

The position of the patient must allow, at minimum, simultaneous access to the airway, ports or lines for medication, and fluid administration and in the case of a pregnant woman, the perineum.

LOAD/UNLOAD: HOT/COLD

In general, the use of hot load/unload should be evaluated based on mission type, patient acuity or complexity, and time considerations. Because of the inherent dangers associated with this type of patient loading and unloading, it should be avoided unless patient acuity is an issue. Hot load/unload should only be performed by flight crew members who are properly and recurrently trained.

Decision Making

Many factors must be considered before choosing to perform a hot load or unload. First and foremost, patient acuity and medical situation must be determined. Complicated patient care activities, such as a number of IVs, ventilator use, and special equipment, may take crew focus away from safe operations and create a loss of situational awareness. In turn, this may have a detrimental affect on the safety of the crew, patient, and any bystanders.

Timing of activities during each mission may also validate or negate the landing choice. Engine cool-down times must be known by the pilot and crew, since short cool-down times of approximately 1 minute may not warrant the danger associated with a hot off load.

Hot loads at the facility or scene should be considered only when the patient is already packaged and ready for loading, or if the anticipated ground time will be minimal. Aircraft running time on-scene should generally not exceed 5 minutes. Exceptions may be considered for things such as a suspected weak aircraft battery that might not be adequate for a subsequent start. Patient acuity and mission profile should also be taken into consideration.

Approach to and Departure from the Aircraft

The PIC is responsible for providing security of the main and tail rotors during all hot load/unload operations. He/she may designate one of the crew members to assist, but only if that person is thoroughly trained and familiar with aircraft operations. If there is any doubt about the safety of the operation, the aircraft should be shut down.

All personnel must approach and depart the aircraft from the front of the aircraft, except during slope operations, and only after receiving approval from the PIC. During slope operations, all personnel should approach and depart the aircraft to and from the down slope side. All personnel must remain clear of the tail rotor, and must remove hats or any other items that may blow into the turning main or tail rotor.

The areas of greatest risk while working in and around the helicopter are the areas within range of both rotors. The diameter of the main aircraft rotor creates an area known as the “rotor disc”. The rotor disc diameter and height vary from aircraft to aircraft. This information must be known by all crew members in order to educate and assist other personnel who may not be as familiar with that particular aircraft. IV poles and other equipment must not extend higher than crew shoulder height, and only personnel absolutely necessary for loading and offloading should be allowed under the rotor disc.

Ground ambulance or other vehicles should remain at least 10 feet outside this rotor disk diameter.

SECURING AIRCRAFT PRIOR TO TAKEOFF

In addition to assuring the safe load and unload of all patients, the aircraft must be visually inspected prior to each flight. Before lift off, a “walk-around” inspection is usually performed by the PIC. The remaining flight crew members may be responsible for conducting their own overview of the aircraft exterior, but their priority is to ensure safety of the medical cabin, with all equipment and supplies being stowed properly and secured for take-off. The PIC or designee must also make sure that all doors are visually checked for security prior to lift-off.

EMERGENCY CONSIDERATIONS

Emergency Egress

Safe crew egress from the aircraft must be accomplished efficiently and without hesitancy regardless of the environment or weather. To assure this, all pilots and crew members should receive annual blindfold egress training. This training should be performed from all positions and through all exits within the aircraft, and should reflect operations that closely resemble those of that particular air medical program. If the response area includes bodies of water, mountainous regions, desert areas, dense foliage, or other areas that require special considerations, training must be tailored to those environments. Evacuation of a downed aircraft must be orderly and well planned with the PIC, medical crew members, and ambulatory passengers exiting the aircraft and convening at a pre-determined location. Once this has been accomplished and the crew is accounted for, nonambulatory patient off-load can be attempted. This exit plan provides the greatest benefit for the greatest number of passengers. Emergency egress training must also include fire-safety instruction and the use of extinguishers in and around the aircraft. In case of a post-crash fire, priority is on egress of all personnel who are not extinguishing the fire.

Water Operations

Egress procedures must be reviewed prior to all over-water operations. This review can be incorporated into the preflight briefing of known over-water operations or be a part of the reconnaissance or pre-landing briefing. Any flight operation over water, even in multiengine aircraft, exposes the flight crew to a potential untoward egress situation. Crew members should consider donning a personal flotation device (PFD) prior to the mission, as the PFD may not fit over the helmet. For those programs operating in areas with large bodies of water, the PFD may be a required part of the personal protection gear.

Egress should take place calmly and in the order that the steps are commonly drilled and performed: unfasten the seatbelt and then the helmet communication cord, open doors after the pressure is equalized, maintain a reference point, and complete hand-over-hand egress. This approach is imperative since the most common cause of injury and fatalities in egress situations is panic.

Aircraft Shutdown

Performing an emergency aircraft shutdown must only be done by trained flight crew members. In the event that the PIC is incapacitated and/or unable to provide instructions, the medical flight crew must be able to follow the process as outlined by program policies and procedures. This activity must be included within already planned safety drills, allowing plenty of opportunity for crew members to ask questions and simulate the shutdown process.

Once the aircraft has come to rest, ceased all movement, and the crew have reconvened, initial assessment of the situation and planning for rescue should begin with locating the ELT and other resources available.

SUMMARY

Safety considerations and aircraft operations are essential components in the initial training and continuing education of all personnel working in and around rotor-wing and fixed-wing aircraft. The perspective and knowledge of an experienced EMS pilot is a critical factor in the training of air medical crew members. Policies and procedures must reflect “best practice” in both safety and patient care. To assure competency in emergency procedures, return demonstration of skills must be conducted annually or more frequently if program or operator policies dictate. Safety can never be reviewed too often.

A. **Bibliography**:

Adams RJ, McConkey ED. *Aeronautical Decision Making for Air Ambulance Administrators*. National Technical Information Service. February 1990. PB90-190117: DOT/FAA/DS-88/8.

Commission on Accreditation of Medical Transport Systems. *Accreditation Standards,* 1999.

DeHert, R. Beers K. Aircraft Accidents Survival and Rescue. *Fundamentals of Aerospace Medicine*. DeHart R, ed. Lea and Feiberger pub. 1985; 862–887.

Department of the Air Force. *Aeromedical Evacuation* [AF Pamphlet 164-2]. Washington D.C., 1976.

Federal Aviation Administration. *Airman Information Manual Federal Aviation Regulations*, 2001.

Flight Safety Foundation. *Flight Safety Digest*, 2001.

Fox R. Crash Survivability. *Air Medical Safety Quarterly*. 1st Quarter, 1988; 23–25.

McFarland, R.A. *Human Factors in Air Transportation*. New York: McGraw-Hill Book Co., 1953.

NTSB. *Safety Study-Commercial Emergency Medical Services Helicopter Operations*. January, 1988; PB88-017001: NTSB/SS-88/01.

B. **Definitions of Keywords**:

PIC—Pilot in command, pilot responsible for an individual flight/mission; makes all decisions regarding safety, weather, weight-and-balance, and flight acceptance or denial

ELT—Emergency Locator Transmitter—Signal transmitter on board all aircraft that emits a distress signal after an aircraft has sustained a substantial impact or crash

LZ—Landing zone—The area defined by the air medical program and the aircraft manufacturer as appropriate for a safe rotor-wing landing. This area should be secured by ground personnel with prior training in LZ set-up.

Recon—Reconnaissance, the act of surveying an area from the air to assess for safety or landing hazards and previously unseen victims or undiscovered areas of the scene

Cold load—Loading the patient with the helicopter shut down

Crew member—Assigned aeronautical medical attendant

Engine cool-down time—Time required by the engine manufacturer to cool down the engine at idle speed. This time is normally 1 or 2 minutes.

Egress—Emergency escape from an aircraft

Hot load—Loading the patient while the engines and rotor blades are operating

Inter-facility—Flight between a sending and receiving hospital

Multiengine—More than one engine

Reference point—Known fixed point in the aircraft, used to maintain situational awareness during egress

Rotor disc—The diameter of a turning rotor system

Scene—LZ away from a hospital; normally an unprepared area such as a road or field

C. **Test Questions**:

1. Personnel should approach a running aircraft on flat terrain from which direction?

   a. Rear
   b. Left side
   c. Pilot's side
   d. Front

2. How close may an ambulance approach the aircraft with rotors turning?

   a. 50 feet
   b. To the loading door
   c. 10 feet from the aircraft
   d. 10 feet from the rotor disc

3. What is the most important step in emergency egress?

    a. Getting out before the aircraft sinks
    b. Removing your helmet or headset before exiting the aircraft
    c. Always keep your reference point
    d. Help other crew members

4. Hot loads should be considered only when

    a. Ground time is expected to be 10 minutes or more
    b. The patient is ambulatory
    c. The crew needs to complete an additional mission quickly
    d. The patient is ready and packaged for loading or ground time is minimal

5. What is the most common cause of injury during emergency egress?

    a. Getting out too fast
    b. Removing the seat belt
    c. Panic
    d. Loss of reference

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Demonstrate blindfolded egress proficiency from all doors
- Demonstrate proper cold and hot loading and offloading procedures
- Demonstrate load/unload of all special equipment (incubators, etc.)
- Demonstrate/simulate aircraft shutdown
- Describe LZ scene security and safety; practice provider LZ safety briefings
- Demonstrate use of all fire extinguishers required on-board, on helipad, or in hanger

F. **Patient Care Hours**: N/A

MODULE 7: AIR MEDICAL RESOURCE MANAGEMENT

Author: Captain Arthur J. French, MD, FACEP, Flight Surgeon, U.S. Coast Guard

Reviewer: Mr. Kevin Savidge, CEP, NREMT-P, FP-C, University MedEvac, Hahnemann University Hospital, Philadelphia, PA

KEYWORDS

Human factors
Air medical resource management
Situational awareness
Latent errors
Active errors
Stress

OBJECTIVES

Upon completion of this module, the student should be able to:

- Describe the potential effects of human factors on patient safety and flight safety
- Recognize the basic concepts and safety improvements of air medical resource management
- Identify human factors that can adversely affect situational awareness
- Understand the basic physiology of fatigue and the effects of fatigue on patient safety
- Differentiate between latent errors and active errors

INTRODUCTION

The air medical industry has benefited in the recent years from the increased understanding and awareness of those factors that impact mission safety, patient care, and interpersonal relations. Appropriate air medical resource management is dependant upon human factors involving many disciplines such as medicine, physiology, cognitive psychology, and engineering/bio-dynamics.

DEFINITION OF HUMAN FACTORS

There are two definitions commonly used in the discussion of human factors in flight or air medical environments.

Classic

The traditional definition of human factors involved the study of the interrelationship between humans, the tools they use, and the environment in which they live and work. This study originated in the flight and crew safety arena in an effort to minimize error and potential life-threatening events that may result from such errors.

Operational

An operational definition has been applied to better define the variables that can affect human beings in their work environment. The study of human factors involves the physical, physiological, psychosocial, psychological, pharmacological, and pathological limitations of human operators as they interface with the machine and the environment. It specifically addresses the aircraft and the flight environment, whether in a military, commercial, or air medical mission.

DEFINITION OF AIR MEDICAL RESOURCE MANAGEMENT

Air medical resource management (AMRM) is a method of making optimum use of the individuals and systems to achieve the safest and most efficient completion of a patient transport. AMRM often introduces practices at odds with the way aviation and medical crews are taught, with one person as the sole arbitrator of the tasks. Utilizing AMRM, assigned crew members are still fully responsible for flight safety and patient care, but they are encouraged to involve others in the system that may contribute to decisions affecting mission safety.

AMRM Principles

- Working as a team
- Supporting each other
- Monitoring other's actions and decisions
- Speaking up when a potential problem is noticed by utilizing a five-step process to maintain assertiveness while being respectful
    - Address person by name
    - State and own emotion
    - State perceived or real problem
    - Offer a solution
    - Obtain recommendation and agreement
- Maintaining team situational awareness
- Performing team contingency planning

Individual Responsibilities for Patient Safety

- Program director. Sets organizational climate, and allocates necessary resources and time for human factor-related initiatives
- Flight safety officer/lead pilot. Must maintain working proficiency in human factors and their effects on flight program, including scheduling and training; monitor human factors elements in flight crews.
- Chief flight nurse. Must understand principles of human factors and their effects on medical crews and patient safety, including crew coordination
- Medical director. Most often the program's life sciences subject matter specialist in human factor areas, i.e. pharmacology, physiology, psychology; must monitor human factors elements in crew members and support personnel; although not primary medical care provider for crew members, must be aware of physical, psychosocial, and psychological status and other human factor elements affecting them; must have confidence in crew members regarding "need to know" confidentiality issues.
- Crew members and maintenance personnel. All personnel associated with flight programs have a responsibility to always consider the "six Ps" of stressors on and off duty (defined on page f of this module) to ensure that their situational awareness and performance are optimal for flight safety and patient safety.

ROLE OF HUMAN FACTORS IN AIR MEDICAL TRANSPORT

Flight Safety

Knowledge of human factors is an essential component in improving and maintaining flight safety. Ninety per cent of mishaps are related to human factors. The FAA recognized this statistic while developing the National Plan for Civil Aviation Human Factors. Numerous studies of aviation mishaps and the data collected by the National Aviation and Space Administration (NASA) Aviation Safety Reporting System (ASRS) corroborate these statistics.

Patient Safety

Human factors are increasingly being recognized as significant contributors to medical errors and adverse events in clinical patient care. The 1999 Institute of Medicine (IOM) report on errors in medicine, *To Err is Human*, publicly identified the role of human error. The IOM report reviewed the Harvard medical practice study, which showed that:

- Four percent of patients suffered injury, 14 percent of those resulting in fatalities
- Up to 180,000 iatrogenic deaths per year occur in U.S. hospitals
- The estimated annual costs of adverse events is between $17 billion and $40 billion annually
- Losses are equivalent to a jumbo jet crash every day

While there have been responses to the report arguing the accuracy of the numbers and data, we know that we continue to make errors and we can and should do better. The IOM report also pointed out that the medical community in general has not implemented error-reducing systems learned from anesthesia and other high-risk occupations that have impressively improved their safety records. In response to the IOM report the President directed the Federal Quality Interagency Coordination (QuIC) Task Force to respond with a national strategy to reduce medical errors and to create a national focus of leadership, research, tools, and protocols to enhance patient safety. *Doing What Counts for Patient Safety: Federal Actions to Reduce Medical Errors and Their Impact*, the report of the QuIC Task Force to the President, was published in February 2000. The QuIC report again corroborated the importance of human factors in reducing medical errors.

Many new initiatives in medical error reduction have been initiated by Federal agencies that are members of the QuIC. The National Highway Traffic Safety Administration EMS Division is a member of the QuIC Task Force and is the Federal representative for the EMS community. Other federal agencies have started programs, such as the Department of Defense Med Team's project, which have relevance to EMS. The MED Team's project demonstrated that the aviation air medical resource management paradigm for improving coordination and flight safety was also effective in reducing errors in the emergency department setting.

HUMAN FACTORS ELEMENTS

Six Ps and Examples

There are many ways to classify human factors. The "Six Ps" approach is one of the more straightforward. The "Six Ps" follow:

- **Physical**: The condition, perception, stamina, and physical strength of the crew member
- **Physiological**: Factors that confuse, incapacitate, disorient, distract, or dull the crew member. These include fatigue, hypoxia, motion sickness, noise, vibration, temperature (heat and cold), dehydration, and hypoglycemia.

- **Psychological**: Cognitive factors such as skill, attention span, habit patterns, personality, judgment, focused attention, loss of situational awareness, procedure discipline, and supervision.
- **Psychosocial**: Factors affecting how a person gets along with others, including interpersonal relationships with peers and supervisors within the work unit; family stressors; occupational stressors; crew coordination/air medical resource management concerns involving ego and attitudes.
- **Pathological**: Acute or chronic diseases that affect performance, such as upper respiratory infections, renal stones, and musculo-skeletal injuries.
- **Pharmacological**: Any chemical or herbal treatment, including prescription medications and over-the-counter (OTC) medications. Performance related side-effects and misunderstandings regarding the effects of antihistamines and other medications; misconceptions regarding OTC remedies for minor illnesses; understanding that the underlying medical condition may affect performance more than the medications used; supplements such as vitamins, herbal remedies, tobacco, and caffeine may cause dehydration, withdrawal, sleep disturbances, and a false sense of alertness; FAA regulations regarding fitness to fly.

Situational Awareness

There are many definitions of situational awareness (SA). A formal definition from aviation psychologist Mica Endsley is "The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future." SA is also knowing what has gone on in the past and being able to use that information to anticipate future events.

Loss of SA has been identified as a casual factor in many mishaps. There is a direct relationship between stressors and loss of SA. Low levels of stressors or stimuli may lead to complacency and loss of SA. Excessive stressors or stimuli result in panic, task saturation, and loss of SA. It is essential that flight and medical crew members be able to recognize loss of SA in themselves as well as other crew members. Symptoms of loss of SA include:

- Fixation
- Ambiguity
- Complacency
- Euphoria
- Confusion
- Distraction

- Unresolved discrepancies
- Failure to meet deadlines
- Poor communications

Fatigue

Fatigue affects individual vigilance and performance. Fatigue performance decrements include:

- Decreased visual perception
- Delayed decision making
- Increased errors of omission
- Slower motor task performance
- Decreased communications
- Loss of SA

Fatigue has often been identified as the "common denominator" in human factors mishaps because it serves as the "catalyst" for other human factors to occur. Fatigue can be either acute or chronic.

Sleep and Fatigue

Fatigue can be caused by circadian rhythm disruption, sustained operations, or self-imposed sleep loss. Self-imposed sleep loss is the most common cause.

- **Sleep Physiology**

  To implement fatigue countermeasures, it is necessary to understand basic sleep physiology. Sleep is a highly complex process during which brain and body alternate between extreme activity and quiet but are never shut off. There are two basic stages of sleep, nonrapid eye movement (NREM) sleep and rapid eye movement (REM) sleep.

  NREM sleep has four stages, light sleep (stages 1 and 2) and deep sleep (stages 3 and 4). During NREM sleep, autonomic physiological functions (heart rate, breathing) and mental activity are slowed. NREM sleep is noted for sleep inertia, with a 10–15 minute disorientation if awakened during stages 3 or 4. It is required for physiological recovery. REM sleep is characterized by slowing of physiological and mental activity. It is an active brain (dreaming) state, essentially in a paralyzed body. REM sleep is needed to sustain cognitive performance. There is a normal sleep architecture with NREM/REM cycles. NREM and REM alternate throughout each sleep period. Typical night cycles are 90 minutes long with 60 minutes of NREM sleep and 30 minutes of REM. Most deep sleep occurs in the first third of the sleep period. REM periods are shorter early at night and become longer and more regular later in the sleep period. Overall, about 25 percent of sleep time is spent in REM and 50 percent in NREM stage 2.

- **Sleep Disorders**

  The amount and structure of sleep changes over the life span. Sleep becomes less deep and more disrupted, and total nocturnal sleep decreases. The ability to sleep decreases, but sleep requirements remain the same. Performance decrements begin after a 2-hour sleep loss. Two nights sleep may be required to recover from the loss of a single night's sleep. The quantity of sleep is as important as quality of sleep. Getting 8 hours of disrupted sleep can have effects similar to too little sleep. Hundreds of brief awakenings may occur during the sleep period. The sleeper can be completely unaware of these awakenings. The effects of alcohol (> two drinks) can have a profound effect on sleep cycles. Alcohol suppresses REM, leads to withdrawal effects, and causes more disrupted sleep. Medications may delay sleep onset, structure, or total sleep time. Environmental factors, such as noise, light, and temperature, also affect sleep. Sleep disorders can also disturb sleep and waking alertness. Sleep disorders can cause 300 to 400 awakenings during an 8-hour period. Sleep apnea affects 24 percent of males and 9 percent of females. Nocturnal myoclonus (leg twitching), a specific sleep disorder, can occur as many as 300 times per night. Sleeping pills, usually benzodiazepines, can affect sleep architecture. A new class of nonbenzodiazepines has less sleep disruption but may cause some residual cognitive problems.

- **Sleep Deficit**

  Sleep loss is additive and results in a cumulative sleep debt. Sleep is the first need that suffers when individuals are faced with everyday demands and pressures. Most people get 1 to 1 1/2 hours less sleep than they need, and accumulate 7 to 8 hours of sleep debt in a typical week. Sleep loss leads to increased sleepiness and degrades essentially every aspect of human performance. Sleep loss causes increased vulnerability to operational mishaps and errors as well as a reduced margin of safety.

- **Subjective versus Physiological Sleep and Alertness**

  Sleepiness is a physiological state initiated by brain signals indicating that the physiological sleep requirement has not been met. It is only reversed by sleep. Subjective sleepiness is how you feel and what you report. It can be concealed or altered by environmental stimulation, physical activity, caffeine, etc. It is very important to understand that self-reported ratings do not correlate with underlying physiological performance abilities. It can be difficult to reliably estimate your own sleep and alertness, especially if you are already sleepy. There is a tendency to overestimate the time required to fall asleep and underestimate total sleep time. There is also a tendency to report greater alertness than indicated by physiological measures. Factors affecting sleepiness include:

  - Prior sleep/wakefulness
  - Circadian phase
  - Age
  - Medical conditions/fitness
  - Medications/drugs (caffeine)
  - Alcohol
  - Environmental/work conditions

Circadian Rhythms

The term circadian comes from “circa” which means "day". The circadian clock in the brain (suprachiasmatic nucleus of the hypothalamus) coordinates daily physiological cycles, which include sleep/wake cycles, digestion, basal temperature, and hormone secretion. Without any timing information from the environment, the biological day is about 25 hours long, which is why it is easier to adjust westward travel than eastward when crossing time zones. The biological clock is hard-wired. It is incorrect to assume we can overcome these enforced cycles and function equally well any time of day or night. The circadian clock is synchronized (reset) daily by environmental cues called “zeitgebers”, meaning timegivers. Zeitgebers include bright light and sunlight greater than 2500 lux (normal indoor light is generally less than 500 lux). Morning light exposure advances circadian cycles, middle of the daylight has minimal effect, and evening light exposure delays subsequent circadian cycles. Other zeitgebers include work/rest schedules, regular social interaction, and entrainment. We are physiologically programmed for two periods of maximal sleepiness during the day. In a usual 24-hour day, the two periods of increased sleepiness are 0300–0500 and 1500–1700. Performance and alertness are often decreased during the 0200 to 0600 window. If operations permit, you should utilize these physiological "sleep windows" to schedule naps or anchor sleep periods.

- **De-synchrony**

  De-synchrony can occur with any schedule that requires someone to be awake and active when they would normally be asleep. It requires overriding the circadian clock, which pre-programs daytime activity and nighttime sleep and creates conflicts between environmental synchronizers (e.g., day-night/light-dark cycles). We are a day-oriented society, particularly with family and school schedules. Shift workers usually switch back to daytime activity on days off for social and family interaction. The circadian clock cannot adapt immediately to a new environmental time or to a duty/rest schedule change. It may take days to weeks for all physiological functions to synchronize, especially since individuals adapt at different rates. Symptoms of shift work include disturbed sleep (60 percent versus 20 percent of day workers), increased waking (work-time) sleepiness, decreased physical or mental performance, increased reports of fatigue, more negative mood, an increased incidence of sick leave and health care visits, increased gastrointestinal problems, and decreased crew interpersonal communications.

- **Factors Affecting Adaptation**

  Many different systems for shift work have been developed but there are two basic approaches for scheduling shift workers. The first is to schedule rapid rotations every few days. Circadian adaptation is faster with progressively later duty times because the biological day is usually longer than 24 hours. The second is to schedule longer rotations of 2 to 3 weeks to allow circadian adaptation. Evening types adapt faster than morning types, and the ability to adapt decreases with age. Common sleep misconceptions are that people know how tired they are and that motivation to "just push through it" compensates for sleep performance decrements. Scheduled rest periods do not guarantee sleep due to decreased sleep efficiency. Sleep efficiency is the total sleep time divided by the time in bed. Day sleep has decreased sleep efficiency. Sleep laboratory findings show it is very difficult to fall asleep earlier than usual except when sleep debt overcomes environmental factors. Workers cannot fall asleep earlier to compensate for early wake-up, except when cumulative sleep debt overcomes circadian factors.

NASA Fatigue Countermeasures Program

Congress mandated NASA in 1980 to address fatigue factors and its effects on aviation safety. The NASA Ames Research Center established a “Dream Team” to develop education and training modules on strategies for alertness management based upon scientific and operational data. Team members were tasked with explaining the current state of knowledge on physiological mechanisms underlying fatigue and applying that knowledge to improve crew sleep, performance, and alertness. They found that the best effects may result from combining multiple strategies rather than relying on a single strategy.

- **Prevention**

  Preventive strategies are used before and between duty periods. They may attenuate underlying physiological sleepiness. Workers should get the best possible sleep before duty and not start out with sleep debt, beginning operations as sleep-satiated as possible. Workers should try to get 8 hours sleep per 24-hour period. “Anchor sleep” during your usual sleep time should be maintained if possible. If you feel sleepy and circumstances permit, you should sleep. If you wake spontaneously and cannot go back to sleep within 15 to 30 minutes, you should get up and do something relaxing until you feel sleepy. Do not lie in bed awake. Limit naps before a duty period to less than 45 minutes to minimize chances of going into deep NREM sleep close to a duty period and suffering the effects of sleep inertia. Naps at other times should be longer than 2 hours to complete at least one NREM/REM cycle. Some sleep is better than none at all.

- **Good Sleep Habits**

  Good sleep habits are the second countermeasure strategy. Develop and practice a pre-sleep routine. If hungry, eat a light snack but do not eat or drink heavily before sleeping. Use physical or mental relaxation techniques and sleep in a room that is dark, quiet, and a comfortable temperature. If you don’t fall asleep in 30 minutes, get out of bed. The use of “white noise” can mask external sounds. Exercise regularly, but not too near sleep periods. People who exercise regularly usually have increased NREM sleep periods.

- **Maintain Alertness**

  Operational strategies to maintain alertness during duty periods include physical activity, conversation with others, and titrated caffeine consumption. Caffeine can be used to acutely increase alertness. The onset of action is 15 to 30 minutes with effectiveness of 3 to 4 hours. Use caffeine only when sleepy. If you use caffeine, do not use it when alert, at start of duty, or after a nap. Avoid caffeine near bedtime. Balanced nutrition is also necessary for alertness. The brain needs a steady fuel supply. Avoid simple carbohydrates that cause peaks of insulin release. Instead, consume complex carbohydrates and proteins. Stay well hydrated, since mental functions are the first to be affected by dehydration. Remember that caffeine is a diuretic; so if you use caffeine, stay well hydrated. Thirst is not a sensitive indicator of dehydration. Actually, urine output is the best indicator of hydration status.

- **Strategic Napping**

  Strategic napping during the duty period, the "NASA nap", is another operational strategy. Extensive NASA research clearly demonstrates the effectiveness of brief naps in improving performance. A planned and coordinated brief NASA nap up to 45 minutes in duration is helpful if operations permit.

STRESS EFFECTS ON PERFORMANCE

Definition

Stress is a nonspecific physiological and psychological response of the body to any demand made upon it. Stressors are events in our environment, both planned and unplanned, which cause these physiological responses. Stressors can be flight and nonflight related, and can be either acute or chronic. There can be family and social stressors in addition to occupational stressors. Crew members must be aware of the "emotional baggage" they consciously or subconsciously bring to work, and understand the effects this baggage can have on patient safety and flight safety.

Stress and Performance

Stress is often directly proportional to awareness and vigilance. At appropriate levels, stress increases performance and SA. Appropriate vigilance/stress levels with matching environmental stressors result in optimal performance. Low vigilance/stress in a low risk environment causes boredom. In a high-risk environment, boredom results in complacency and unrecognized loss of SA. Hyper-vigilance/high stress can result in panic and a severe loss of SA.

Self-imposed Stressors

Many stressors are self-imposed. These include dehydration, hypoglycemia, tobacco, alcohol, caffeine, and sleep deficits.

ROOT CAUSE ANALYSIS OF ERRORS

Root cause analysis is a systemic examination into what, why, and how an error occurred. The emphasis is on systems versus people and on the multifactorial nature of errors. The “mishap pyramid” describes the ratio of near-miss incidents to noninjury incidents and incidents causing injury. This ratio is approximately 300 “near miss” or hazardous incidents, which comprise the base of the mishap pyramid; to approximately 30 noninjury events, which make up the mid-section; to each single injury event, which makes up the top most section of the pyramid. It is important to identify root causes of near misses, since analyzing only injury events will cause the researcher to miss valuable data and trends in the more frequently occurring near misses. Identifying and understanding the near misses, the preceding chain of events, and the causal human factors is necessary to break the mishap chain.

HUMAN ERROR CLASSIFICATION TAXONOMY

SHELL Model

There are numerous systems and taxonomies for classifying human errors. The "SHELL" domain model is one used frequently in aviation. It examines five different domains:

- **Software:** operating policies and procedures
- **Hardware:** aircraft systems and patient care equipment
- **Environment:** external conditions in which the mission is operating
- **Live-ware (crew members):** human factors affecting crew members
- **Live-ware (others):** human factors affecting personnel who are supporting the mission, i.e., supervisors, maintenance crews, and dispatchers

HUMAN FACTORS ANALYSIS CLASSIFICATION SYSTEM

The Human Factors Analysis Classification System, developed by Shappell and Wiegmann, is one of several systems developed to meet the need for common taxonomy to classify root causes of mishaps. It classifies failure conditions as latent or active conditions.

- **Latent Conditions**

  Organizational factors
  Resource management
  Organizational climate
  Operational process
  Unsafe supervision
  Inadequate supervision
  Planned inappropriate operations
  Failure to correct problem
  Supervisory violations
  Preconditions for unsafe acts
  Substandard conditions of operators: Adverse mental states, adverse physiological states, physical limitations, mental limitations
  Substandard practices of operators: Air medical resource mismanagement, lack of personal readiness

- **Active Conditions (unsafe acts)**

  Errors
  Decision errors
  Skill-based errors
  Perceptual errors
  Procedural violations:
  Routine
  Exceptional

SUMMARY

Human factors impact and, in many cases, determine the success and safety of an air medical mission. Air medical resources must be managed in an objective and responsible manner, considering as many human factor variables as possible. All members of the air medical flight program must contribute to and share in the responsibility for the successful and safe completion of all missions.

A. Bibliography:

Federal Aviation Administration Human Factors.
http://www.hf.faa.gov

Institute of Medicine. *To Err Is Human: Building a Safer Health System*. Washington, DC: National Academy Press, 1999.

Quality Interagency Task Force. *Doing What Counts for Patient Safety: Federal Actions to Reduce Medical Errors and Their Impact*. Washington, DC: Agency for Healthcare Research and Quality, 2000.
http://www.ahrq.gov

School of Aviation Safety, Naval Postgraduate School.
http://web.nps.navy.mil/~avsafety/courses/overview.htm

Weiner EL, Nagel DC. *Human Factors in Aviation*. San Diego, CA: Academic Press, Inc., 1988.

B. Definitions of Keywords:

Human factors—The study of physical, physiological, psychosocial, psychological, pharmacological, and pathological limitations of human operators as they interface with the machine and the environment

Air medical resource management—A method of making optimum use of the individuals and systems to achieve the safest and most efficient completion of a patient transport

Situational awareness—The perception of the elements in the environment within time and space, the comprehension of their meaning, and the projection of their status in the near future

Latent errors—Errors occurring due to organizational policies, procedures, or resource allocations

Active errors—Errors occurring at the provider-patient interface or at the crew member-machine interface

Stress—A nonspecific physiological and psychological response of the body to any demand made upon it

C. **<u>Test Questions</u>**:

1. Most medical errors result in injury or death:

   a. True
   b. False

2. Fixation, complacency, and distraction are symptoms of:

   a. Spatial disorientation
   b. Fatigue
   c. Medical error
   d. Loss of situational awareness

3. Human factors which confuse, incapacitate, disorient, or distract are:

   a. Physical
   b. **Physiological**
   c. Psychological
   d. Psychosocial

4. NREM sleep is required for:

   a. Cognitive performance
   b. Increased autonomic functioning
   c. Sleep disorders
   d. Physiological recovery

5. Dehydration first affects:

   a. Coordination
   b. Thirst
   c. Mental function
   d. Appetite

D. **<u>Didactic Hours</u>**: 2

E. **<u>Skills Hours</u>**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Stress reduction exercises
- Personnel scheduling techniques to minimize fatigue and stress
- Team building exercises
- Personality inventory

F. **Patient Care Hours**: N/A

MODULE 8: HAZARDOUS MATERIALS

Author: Mr. John K Gaffney, BBA, CEM, TEMT-Flight Paramedic,
Director, University of New Mexico Health Sciences Center,
Emergency Management Division, Albuquerque, NM

Co-Author: Dr. Frank G. Walter, FACEP, FACMT, FAACT,
Associate Professor, Department of Emergency Medicine,
University of Arizona, College of Medicine, Tucson, AZ

KEYWORDS

Occupational Safety and Health Administration (OSHA)
Environmental Protection Agency (EPA)
Code of Federal Regulations (CFR)
Advanced Hazmat Life Support (AHLS)
Personal protective equipment (PPE)
Weapons of mass destruction (WMD)
Hot zone
Fixed locations
Placard
Material safety data sheet (MSDS)
Contamination
Toxidromes
Hazidromes
Poisoning treatment paradigm

OBJECTIVES

By the end of this module, the student should be able to:

- Describe the 4 key parts of a hazardous materials placard and the significance of each
- Describe the activities in and purpose of each hazardous materials "zone"
- Discuss the 4 concepts of initial contaminated patient management
- List and describe the 5 major hazmat toxidromes or hazidromes
- List the components of the poisoning treatment paradigm

INTRODUCTION

Because there are billions of tons of hazardous materials shipped in today's society, it should come as no surprise that one area of concern for air medical crews is the recognition and management of hazardous materials (hazmat) incidents. Every flight crew member should be able to recognize, and make informed clinical and flight-safety judgments involving, the hazmat-contaminated patient.

In addition to being prepared for responses to hazmat incidents, both OSHA and EPA have regulations that impact air medical programs. Primarily, they require employers to provide minimum training to personnel who “participate, or are expected to participate, in emergency response to a hazardous substance accidents.” This includes air medical crews.

A material is categorized as being hazardous if it poses a risk to people, property, or the environment when it is not properly controlled. This is obviously a broad definition, but it serves to illustrate that there are many hazardous materials, in many forms, posing many different risks.

PROVIDER LEVELS

The CFR establishes the minimum OSHA and EPA regulations. The OSHA regulations define who needs hazardous material training, as well as what the minimum training should be. It requires four levels of training: 1) awareness, 2) operations, 3) technician, and 4) specialist. These four levels can be considered as comprising Basic Hazmat Life Support (BHLS). The fifth level of training is AHLS. AHLS is an international training program for the medical management of hazmat victims.

The first two BHLS levels, awareness and operations, are courses designed to teach the responder the initial actions that can be taken at a hazardous materials scene. The technician-level provider is trained to take actions that are required to stop the spill. Another training level is the specialist, someone who has special training or experience pertinent to the event.

Awareness First Responder Level

The initial action is simply recognizing that the scene is a hazmat scene, so appropriate scene safety precautions can be taken while ensuring the proper response. The awareness first responder course introduces these responsibilities and is usually 8 to 16 hours in duration (Table 1).

Table 1: National Fire Protection Association (NFPA) 472 Competency Levels

Competency Levels	Typical Competency Course Duration (hours)
First Responder at the Awareness Level	8 to 16
First Responder at the Operational Level	24 to 40
Hazardous Materials Technician	160 to 180

(Reprinted with permission from the *Advanced Hazmat Life Support Provider Manual*, 2nd edition, copyright 2000, Arizona Board of Regents, Tucson, AZ.)

Operations First Responder Level

The next actions are the responsibility of operations level first responders and are considered defensive. They include attempting to identify the hazardous material(s) involved, while isolating the incident from access by nonessential persons. Operations level first responders also prevent the exodus of contaminated persons from the warm zone, which will be described later in this module, prior to decontamination. Operational level courses are usually 24 to 40 hours in duration (Table 1).

Hazardous Materials Technician Responder Level

This level allows the technician to operate in the hot zone, described later in this module, and requires that the provider wear appropriate PPE. There are different levels of PPE and different types of PPE (Table 2); therefore, simply deciding which to wear for a particular release is complex, technical, and critical. It is unlikely that any air medical team, without a significant investment in training and equipment, would ever be expected to enter the hot zone. The hazmat technician course is usually 160 to 180 hours in length (Table 1).

TABLE 2: PERSONAL PROTECTIVE EQUIPMENT (PPE*)*

Level:	Level A	Level B	Level C	Level D
Respiratory Equipment:	SCBA	SCBA or Positive pressure, supplied-air respirator (SAR) with escape SCBA	Air-purifying respirator (APR)	None
This Respiratory Equipment Safeguards Against the Following Hazards:	Gases Vapors Aerosols Oxygen-deficient atmospheres	Gases Vapors Aerosols Oxygen-deficient atmospheres	Some carefully selected vapors and aerosols	Nothing
Skin Protective Clothing:	Vapor-protective, fully encapsulated, chemical-resistant suit	Hooded, splash-protective, chemical-resistant suit	Hooded, splash-protective, chemical-resistant suit	None
This Protective Clothing Safeguards the Skin Against the Following Hazards:	Gases Vapors Liquids Solids	Liquids Solids	Liquids Solids	Nothing

(Reprinted with permission from the *Advanced Hazmat Life Support Provider Manual*, 2nd edition, copyright 2000, Arizona Board of Regents, Tucson, AZ.)

Specialist Responder Level

Another training level is the specialist. This may or may not be someone who actually enters the hot zone in PPE. In many cases, the specialist is someone thoroughly familiar with the hazardous material itself or with the type of container from which the material is escaping.

Advanced Hazmat Life Support (AHLS) Level

AHLS providers are paramedics, nurses, physicians, or other healthcare providers who have successfully completed the 16-hour AHLS Provider Course. AHLS providers are trained in the recognition of signs and symptoms caused by exposure to hazardous materials. AHLS providers are trained to deliver antidotal therapy to victims of hazmat poisonings, as approved by state and local protocols.

The inclusion of AHLS providers into a hazmat response team is necessary, not only for the needs of the public, but also to protect hazmat technicians who make entry into hazardous atmospheres. Protection of hazmat team members should be the primary responsibility of AHLS paramedics. Hazardous atmospheres should not be entered, unless an AHLS paramedic is on scene, with ALS and AHLS equipment in place, including a drug box containing approved antidotes for specific hazardous materials.

Medical Control

Obtaining medical control should begin early in the development of the hazmat team. Incidents involving hazardous materials can have far-reaching community implications. It is imperative to involve a physician with board preparation and/or board certification in medical toxicology. The ideal medical director for a hazmat team should be board certified in medical toxicology, and should be familiar with the operations and logistics of functioning in the pre-hospital environment. This physician should be consulted in all aspects of planning for a hazmat response. In addition to developing training curricula and treatment plans for toxic exposures, this physician can work with emergency responders and hospitals to help integrate emergency personnel into the incident command structure, and assist with the logistics of decontamination and hospital preparedness for victims of hazmat incidents.

On-line, direct medical control is important when caring for hazmat victims. Contact with medical control should be established as soon as possible after deciding that hot zone entry is necessary. Communication with the physician should include all pertinent information about the involved materials and any special medical conditions of the entry crew.

This notification prepares the physician and hospital staff to ready contingency plans for patients that may require transport to a receiving facility.

Medical control should also include consultation with a regional poison control center, if possible. Field personnel should be familiar with how to access information through the poison center. Clinical toxicologists should be available at the poison center. Similarly, the poison center should be familiar with the level of training of responding EMS personnel. This relationship will be valuable in the analysis of unknown substances, in choosing decontamination procedures, and for treating hazmat patients.

ZONE DESIGNATION

Hot Zone

The technician-level provider is trained to manage activities within the inner perimeter of what is known as the “hot” zone (Table 3 & Figure 1). The hot zone is established by the hazardous materials response team and is the area where there is imminent danger of exposure from the released hazardous material. Its size and shape depends upon the released material’s physical properties, the size of the release, the weather, and the geography of the incident. Inside the hot zone are victims who have not escaped the scene prior to its being contained; therefore, there is a natural tendency for health care providers to go to their aid. Doing so is hazardous at best, and potentially fatal; therefore, flight programs should have policies allowing for variance from triage and treatment protocols when flight crew safety is at high risk.

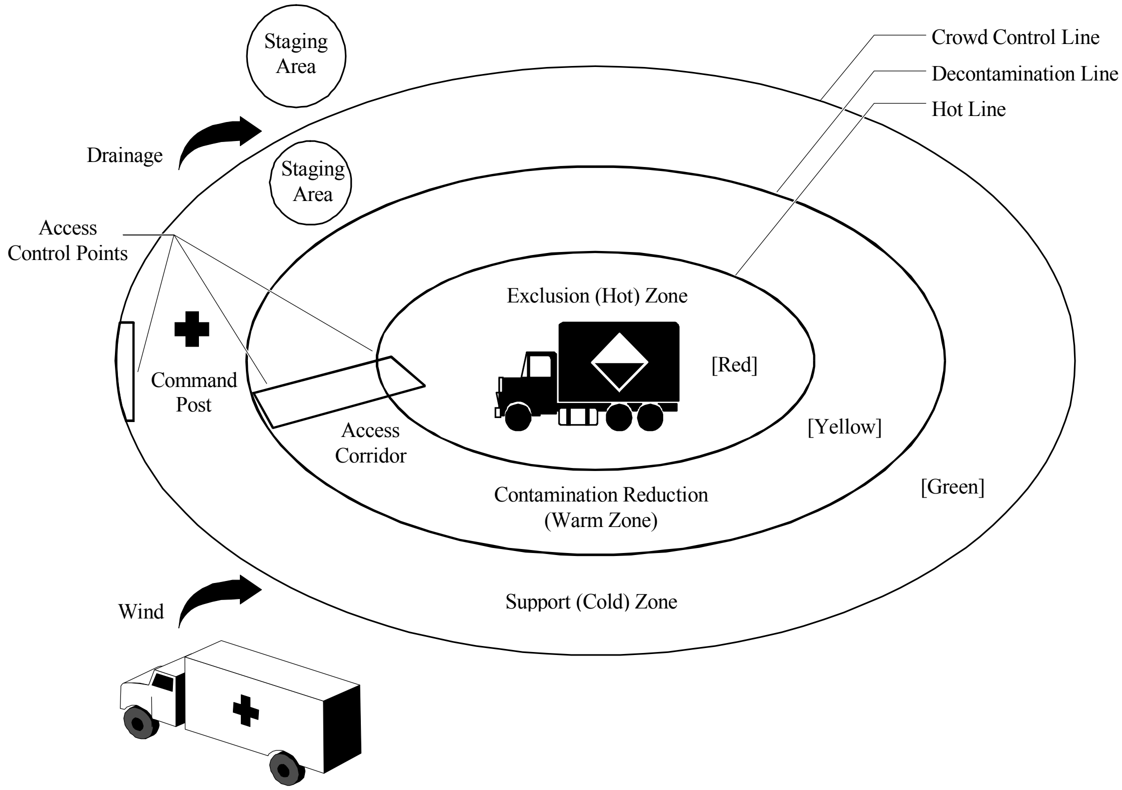
TABLE 3: THE THREE HAZMAT SCENE CONTROL ZONES WITH THEIR THREE EQUIVALENT NAMING SYSTEMS

Temperature Terminology System*	Color Terminology System	Explanatory Terminology System
Hot Zone	Red Zone	Exclusion or Restricted Zone
Warm Zone	Yellow Zone	Decontamination or Contamination Reduction Zone
Cold Zone	Green Zone	Support Zone

*NIOSH, EPA

(Reprinted with permission from the *Advanced Hazmat Life Support Provider Manual*, 2nd edition, copyright 2000, Arizona Board of Regents, Tucson, AZ.)

FIGURE 1: NIOSH/OSHA RECOMMENDED HAZMAT CONTROL ZONES



NIOSH/OSHA Recommended Hazmat Control Zones (from ATSDR guidelines, public domain)

Entry into the hot zone requires PPE, which requires that the rescuer undergo a physical assessment prior to donning the gear, and also requires that a decontamination corridor must be in place prior to entry. Per OSHA requirements, rescuers who don PPE and enter the hot zone must be trained to the hazmat technician level, fit tested for their equipment, and receive special annual physical exams. This obviously requires the response of a trained and equipped hazmat team and ensures that any ad hoc response would most likely be hazardous and could even subject the would-be rescuers to regulatory censure.

For every rescuer in PPE inside the hot zone, there must be another rescuer outside the hot zone who is prepared to effect a rescue of the first, if necessary. Performing on-scene pre-entry physical exams on hazmat technicians is a service an air medical crew could assist with; however, it is obviously a time-consuming process and most hazmat teams have their own specially trained paramedics to do this. Exhibit 8-1 at then end of this module, lists symptoms and conditions that should exclude hazmat workers from entering or re-entering the hot zone. Until the decontamination corridor is in place and a sufficient number of rescuers in PPE are available to enter the hot zone and perform extrication and decontamination of the victims, any nonambulatory victims inside the hot zone will stay there. Since some hot zones can be thousands of feet in size, the entire restricted area is potentially huge and will require tremendous resources of personnel to contain.

Warm Zone

Surrounding the hot zone is the warm zone (Table 3 & Figure 1). This is a buffer between the hot zone and the cold zone, and is where the decontamination corridor and other “dirty” duties are done. It is beyond the hazard of immediate exposure, but secondary contaminants could be present. Contaminated personnel and equipment must remain in the warm zone, prior to decontamination. The outer perimeter of the warm zone is the closest to the release that air medical personnel are allowed.

Cold Zone

Surrounding the warm zone perimeter is the cold zone, the buffer between the warm zone and the "rest of the world" (Table 3 & Figure 1). In this area, personnel are staged, ambulances prepared to receive patients for transport, and other official “clean” functions performed.

Incident Command System

Per OSHA, an incident command system (ICS) must be used at a hazmat scene, and the ICS must utilize a safety officer. One area for training and interface between the flight program and the local public safety community would be in ICS, if it is not already a part of their flight crew training.

RECOGNITION AND IDENTIFICATION

Immediately upon receiving a flight request, astute flight team members and communications personnel could recognize clues indicating a potential hazmat incident. Clues, such as the involvement of a hazardous material-carrying vehicle in the crash, location of the incident (such as a known chemical facility), or unexplained multiple casualties should alert the flight crew to be particularly cautious upon approaching the scene. Rotor-wing aircraft can generate sufficient down drafts to spread a released hazardous material, but the crew should not land that close to an incident.

When approaching the scene, the flight crew should look it over for clues. Among these would be the presence of facilities or containers where hazardous materials might be found, or the more obvious presence of actual spills or ongoing airborne releases. However, hazardous materials might be in a gaseous or aerosol form and thus might not be visible.

In general terms, a hazardous material should only be found in one of two settings, i.e., in transport or at fixed facilities. Only the first of these locations has specific regulations as to how the material must be packaged, shipped, and labeled. Under 49 CFR 172, the Department of Transportation (DOT) adopts the nine International Hazard Classification System (IHCS) that describes quantities of hazardous materials that must be labeled and placarded, and the specifics of the labels and placards themselves. Figure 2 shows both the DOT placards and the basic hazard classes.

The IHCS is limited in predicting the potential health hazards of a substance. Chemicals are assigned by their most dangerous physical characteristic, e.g., explosiveness or flammability. Other potential hazards of an agent, such as its ability to cause cancer or birth defects, are not considered. This system provides very little guidance in treating poisonings caused by hazardous materials.

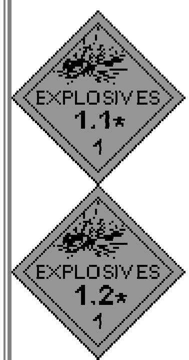
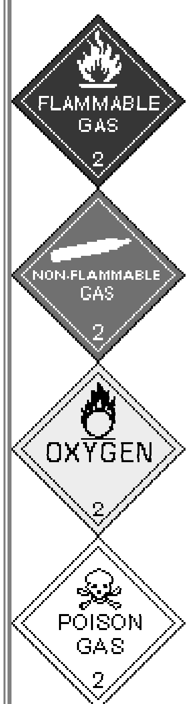
Transportation

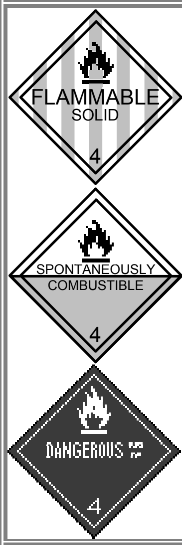
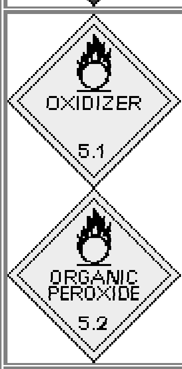
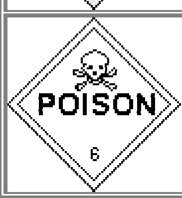
Transportation involves a vehicle, a transported container, or a trailer found at the scene of a hazmat incident. Although it is sometimes possible to identify specific hazardous materials based upon the setting, this is usually only a single clue. To obtain more information, based on the setting, requires training, experience, and reference materials; even so, this still can be misleading. Therefore, this chapter will not go into further detail, but will refer flight programs to more in-depth hazmat literature.

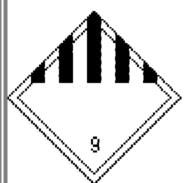
Fixed Facilities

Hazardous materials can also be found at fixed facilities. As the name implies, this is a location such as a chemical depot or manufacturing site where quantities of different chemicals are stored, either in preparation for transportation or for use in a manufacturing process, or as waste awaiting proper disposal. While Federal, state, and local regulations determine how these facilities are managed, these vary from locale to locale. Thus the only effective way to prepare for responses to fixed facilities is to do so well in advance. This is best accomplished by an on-going program of training as well as by maintaining a close relationship with the local fire department(s) with primary jurisdiction for hazmat responses.

FIGURE 2: DEPARTMENT OF TRANSPORTATION INTERNATIONAL HAZARD CLASSIFICATION SYSTEM (IHCS)

	Class 1—Explosives Division 1.1 Explosives with a mass explosion hazard 1.2 Explosives with a projection hazard 1.3 Explosives with predominantly a fire hazard 1.4 Explosives with no significant blast hazard 1.5 Very insensitive explosives; blasting agents 1.6 Extremely insensitive detonating articles
	Class 2—Gases Division 2.1 Flammable Gases 2.2 Nonflammable, nontoxic compressed gases 2.3 Gases toxic by inhalation 2.4 Corrosive gases (Canada)

<table>
<tr><td>
</td><td>Class 3—Flammable liquids (and Combustible liquids [U.S.])</td></tr>
<tr><td>
</td><td>Class 4—Flammable solids; Spontaneously combustible materials and Dangerous when Wet materials.
Division 4.1 Flammable Solids
4.2 Spontaneously combustible materials
4.3 Dangerous when wet materials</td></tr>
<tr><td>
</td><td>Class 5—Oxidizers and Organic Peroxides
Division 5.1 Oxidizers
5.2 Organic Peroxides</td></tr>
<tr><td>
</td><td>Class 6—Toxic materials and infectious substances
Division 6.1 Toxic materials
6.2 Infectious substances</td></tr>
</table>

	Class 7—Radioactive Materials
	Class 8—Corrosive Materials
	Class 9—Miscellaneous Dangerous Goods Division 9.1 Miscellaneous dangerous goods (Canada) 9.2 Environmentally hazardous substances (Canada) 9.3 Dangerous wastes (Canada)

Phone #'s for Chemical Emergencies
CHEMTREC **1-800-424-9300** Chemical Response Information
CHEM-TEL, INC **1-800-255-3924** Chemical Response Information
NRC **1-800-424-8802** National Response Center (Coast Guard)
Military **1-703-697-0218** Incidents involving explosives & ammunition
D.O.D. **1-800-851-8061** Incidents of dangerous goods other than above
Source: DOT website, public domain

Signage

While the DOT labeling requirement is complex, the labels and placards themselves are standardized and easily interpreted. A label is found directly on the package or container containing the hazardous material and gives information specific to the substance within. It is important to note that a vehicle could contain numerous different types and quantities of hazardous materials, so a high suspicion must be maintained. Even small delivery vehicles can pose significant and multiple hazmat risks.

Vehicular placards provide limited information. These are the large, color-coded, diamond-shaped signs on the outside of vehicles transporting hazardous materials. Some hazardous materials require placards for any quantity, while others have threshold amounts below which no placard is required. In addition, if the vehicle is transporting multiple hazardous materials, then the placard displayed could simply read “Dangerous.” Although this alerts rescue personnel to the presence of hazardous materials, it provides no clue as to what they might be.

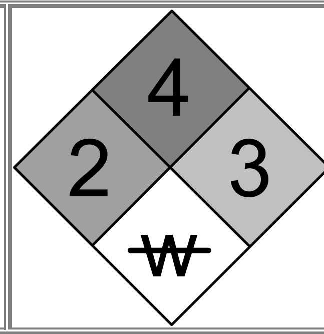
There are four key parts to a vehicular placard. First is the color, which is visible from a distance. In general, the colors alone can convey the type of hazard. Red, for example, always means that there is a combustibility or flammability hazard (combustible and flammable differ in the temperatures for ignition). In the center of the placard is a symbol of some type. These symbols indicate the general hazard; perhaps the best known is the purple “propeller” indicating radioactive materials. In the center of the bottom of the placard is a number between one and nine. In many cases this will be a single digit but could also include a numeral in the “tenths” column. This refers to the UN Hazard Class shown in Figure 2.

Vehicular placards contain a four-digit number known as United Nations (UN), North American (NA), or Product Identification Number (PIN) that is displayed on characteristic vehicular placards. This system is used by the U.S. Department of Transportation (U.S. DOT) in the *North American Emergency Response Guidebook*. This number indicates the hazardous material in question, to a certain level of specificity. 1203, for example, designates types of flammable liquids and is seen daily on tanker trailers hauling gasoline.

Fixed facilities such as hospitals or laboratories use a marking system that is different than the vehicular placarding system. If the local government has adopted it, there is one recognized national system for marking fixed facilities. Established by the National Fire Protection Agency (NFPA), Standard 704 requires the prominent display of a diamond shaped multicolored sign (Figure 3) outside the fixed facility where the hazardous materials are found. The diamond is divided into four color-coded quadrants. The left-most section is blue, and indicates health hazards, the top of the diamond is red and indicates flammability, and the right side is yellow and describes the reactivity of the building's hazardous materials. The remaining section is white and describes, by symbol and/or lettering, special precautions to be taken by emergency responders. Numbers in the red, blue, and yellow quadrants indicate the degree of hazard: Numbers range from 0 (minimal) to 4 (severe), and indicate specific levels of hazard. Like all placarding systems, this one also has limitations. It does not name the specific hazardous substances in the facility and no information is given about the quantities or locations of the materials.

FIGURE 3

National Fire Protection Association 704 M Hazard System: Placarding for Fixed Facilities



Health	Flammability / Flash Points	Reactivity
4—Deadly	**4—Below 73 deg.**	**4—May Detonate**
3—Extremely Hazardous	**3—Below 100 deg.**	**3—May Detonate with Heat and Shock**
2—Hazardous	**2—Below 200 deg.**	**2—Violent Chemical Change**
1—Slightly Hazardous	**1—Above 200 deg.**	**1—Not Stable if Heated**
0—Normal Material	**0—Will not burn**	**0—Stable**

Special Hazards
OXY—Oxidizer
ACID—Acid
ALK—Alkaline
COR—Corrosive
~~W~~—Use no Water
**—Radioactive**

Source: DOT website, public domain

SCENE RESPONSE

Based upon pre-dispatch information, clues noted while approaching the scene, the location of the incident, and various markings, flight crew members should anticipate the presence of a hazardous material release before approaching the incident. While some hazardous material courses teach the responder to observe the presence of odors or other 'physical' clues once on scene, any rescuer close enough to detect such clues is TOO CLOSE! If the crew suspects that they have arrived on a hazmat scene, they should immediately move to a safe location upwind, uphill, upstream, and at a distance that depends upon the type of material involved. In addition, the appropriate agencies and personnel must be notified prior to any patient contact.

Notification of Appropriate Agencies and Personnel

The agency(s) to be notified varies by jurisdiction and should be determined in advance. The local fire department is most commonly the hazardous material response agency, but other requirements may apply. For example, in New Mexico, the State Police have statutory authority over all hazmat material incidents and must also be notified.

To the highest degree possible, all notifications should include information about the material that is suspected of being released. In addition to the labels and placards described above, additional sources of information are available. In general, these start with the responsible party for the material. In the case of a fixed facility release, this may be a plant engineer or the leader of a corporate emergency response team. In the case of a transported material, it may be the truck's driver or train's conductor or engineer. Any of these individuals should have some knowledge on what materials are present in their facility or vehicle, and are also required to have access to specific paperwork. In the case of transported hazardous materials, the carrier has obligations and helpful resources, and should be notified promptly. The carrier may not only have a response team available, but is likely to be ultimately responsible for clean up and recovery at the scene and will require lead time to assemble the necessary resources. The plant engineer, safety officer, or shipping supervisor will also have access to the paperwork associated with a hazardous material. It will generally be a Material Safety Data Sheet (MSDS). Depending upon the type of vehicle, that paperwork may be known as a waybill, bill of lading, consist, or other form which will provide contact information for the shipper of the material. Both the MSDS and transportation paperwork provide general information on the material itself, its chemical and/or physical properties, the nature of risk posed by the material, and suggestions on the management of a release. While the latter may prove useful, it is questionable as to whether health care providers should follow the medical advice given on the form.

If the name of the substance is known before arrival at the scene, then research can begin en route, reviewing the physical, chemical, and toxicological properties of the material (Exhibit 8-2, at the end of this module). If the chemical is not known prior to arrival at the scene, then efforts to obtain this information should begin as soon as safely possible. Responder safety is, as always, the priority.

Even if the exact identity of the toxic material is not known, hazmat responders may be able to classify the hazardous material into one of several major toxicological classes by identifying a hazmat toxidrome (toxic syndrome) that allows them to reasonably treat the patient and protect themselves and others. For example, do patients have irritation of the mucous membranes and upper airway caused by a highly water-soluble irritant gas? Do the patients exhibit signs of asphyxia with major central nervous system and/or cardiopulmonary signs and symptoms? Do patients exhibit signs of cholinergic excess caused by organophosphate or carbamate poisoning? Do patients exhibit chemical burns compatible with corrosives? Do patients have the odor of solvents with signs of narcosis and cardiac irritability compatible with exposure to hydrocarbons or halogenated hydrocarbons?

Also, even when the exact identity of the hazardous material is not known, what is usually known is the physical state of the material, i.e., solid, liquid, or gas. Airborne toxicants potentially mean many more victims. Airborne toxicants include not only gases and vapors which are true gases, but also liquid suspensions—fog and mists—and solid suspensions—smoke, fumes, and dusts.

Resource Information

In addition to the required notifications, there are several excellent reference sources available by telephone. These may include national firms such as CHEMTREC (800-424-9300) or local resources such as your regional poison information center. CHEMTREC is a service of the Chemical Manufacturers Association. It has information about shippers, products, and manufacturers. CHEMTREC can be reached at 1-800-424-9300. The Internet address for CHEMTREC is http://www.cmahq.com/cmawebsite.nsf/pages/chemtrec. CHEMTREC provides information, at no charge, 24 hours a day. Details of an incident are relayed to the shipper’s or manufacturer's 24-hour emergency contact and they, in turn, are linked to hazmat incident responders. Technical data is available on handling the substance(s) involved, including the physical characteristics, transportation, and disposal. Additional national resource numbers are shown at the bottom of Figure 2.

Other local resources are available under a series of federal laws designed to protect individuals and communities against hazardous materials emergencies. Among these is your Local Emergency Planning Committee (LEPC). The LEPC is an excellent resource for flight programs and is responsible for many facets of the management of hazardous materials, both in daily operations within the community, as well as during emergencies.

Another excellent resource available to emergency responders, and easily carried aboard medical aircraft, is the *DOT Emergency Response Guide* (ERG, Figure 4). This small reference book starts with a chart similar to Figure 2 and also has four color-coded sections. The yellow section lists thousands of chemicals in the order of their four-digit UN number. The blue section lists the same materials alphabetically. In both cases, the material is referenced against a specific guide found in the orange section. This guide is specific to the general type of material and its properties, and describes its prioritized risks. For example, if the material is more dangerous to "health" than it is to a "fire or explosion" risk, the health paragraph comes before the fire or explosion paragraph. Suggested emergency and personal protection procedures are listed for each type of risk.

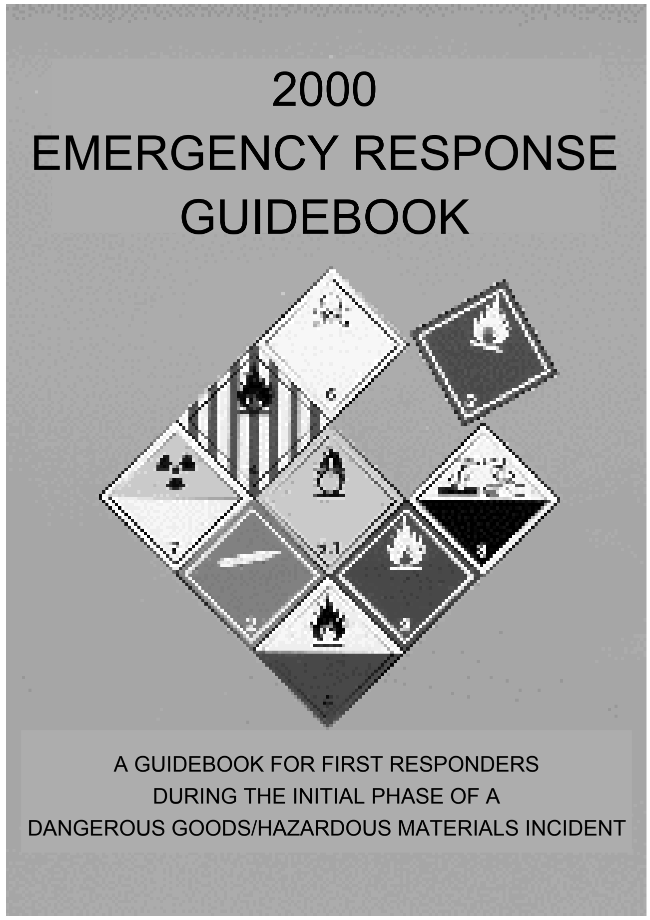
If, in either the yellow or blue sections, the material is highlighted, it is cross-referenced to the final section, which is green. The materials listed in the green section are highly hazardous and have extensive evacuation requirements that are described in detail. The *ERG* is available in bulk quantities, free of charge, from the DOT or your local hazardous material response unit.

In addition to the resources described herein, there are many others that flight programs may find useful to obtain in advance and place either in the communications center or aboard the aircraft. Your local hazardous material response agency can recommend many of these, as can your facility's industrial hygienist or health and safety professional.

WEAPONS OF MASS DESTRUCTION

Although the bulk of this module has referred to hazardous materials as "chemicals", biological agents can be hazardous materials as well. In general, this consideration is already included in the basic hazardous material response guidelines (e.g., there are labels and placards for biological agents), but differences can arise when making notifications involving biological emergencies. This difference is necessitated not only by the differences between biological agents and chemicals, but also because of the growing concern about terrorist use of hazardous materials as WMD.

FIGURE 4



Source: U.S. DOT website, public domain

When a terrorist WMD event with a chemical weapon occurs, it will probably be immediately obvious to the public safety and health care communities that something has happened, and an appropriate response can occur immediately. An oft-cited example of this would be the release of some type of an organophosphate nerve agent in a highly populated setting, such as at a sporting event. In addition to being immediately obvious when some explosive device disburses the chemical, the chemical agent itself will usually cause immediate signs and symptoms.

A terrorist use of a biological agent unfolds quite differently. Given the incubation period of viruses and bacteria, it is likely there will be no 9-1-1 call indicating that an obvious attack has occurred. Therefore, a biological WMD attack is more of a public health consideration than an EMS response. This means that EMS agencies, air medical programs, and emergency departments need to be particularly alert to developing trends in their patient populations, to better recognize an outbreak and help identify its source as soon as possible. Notifying the proper agency(s) of a potential biological event involves a completely different set of resources and contact points than a chemical hazmat incident.

DECONTAMINATION AND TREATMENT

The medical community's weakest link in a hazmat response is that of decontamination and PPE. Air-medical crew members generally are not prepared or equipped to perform decontamination; however, they should be able to determine the efficacy of the decontamination done by the decontamination team in the access corridor of the warm zone. In addition, according to data from the Centers for Disease Control (CDC) and Prevention's Agency for Toxic Substance and Disease Registry (ATSDR), well over half of the patients presenting to hospital emergency departments for treatment have not gone through any organized triage or decontamination process.

In the event of a large hazardous material incident with numerous casualties, it should be anticipated that many of the ambulatory victims would self-refer from the scene to emergency departments prior to formal decontamination. It is crucial to prevent these contaminated patients from entering an ambulance, a helicopter, or a hospital, thereby contaminating these resources and removing them from use. The danger to the flight crew is even greater because treating and transporting a contaminated patient prior to decontamination can cause both pilot and crew to be affected, and could cause a crash.

INITIAL MANAGEMENT OF CONTAMINATED PATIENTS

There are four general concepts to be applied to the initial management of a contaminated patient. First, flight crew members must protect themselves. This can mean not responding until the scene is safe or refusing to transport patients whose decontamination status is questionable. If, however, the air medical crew must assess this, their first consideration should be PPE. Unfortunately, adequate PPE is often not available to flight crew members; in particular, good respiratory protection is often lacking. Conversely, other than respiratory PPE, much of the PPE available to health care workers is sufficient for some hazardous materials. PPE used for universal precautions, particularly when designed for trauma or surgical use, including waterproof clothing or gowns, goggles, and gloves is adequate in many cases. Regardless of whether contamination is suspected, this level of protective clothing is the absolute minimum that must be worn.

The second concept involves time, distance, and shielding. Although this concept is generally associated with radioactive materials, it is useful with other chemicals as well. By maximizing the distance to the victim, minimizing the exposure time, and/or providing some type of shielding (e.g., PPE used for universal precautions), or through some combination of all three, the rescuers are protecting themselves as much as possible under the circumstances.

The third concept is recognizing what is, if anything, contaminated. Usually the vast majority of contaminants can be removed simply by disrobing the victim, leaving only exposed surfaces to be decontaminated. These surfaces, however, include some difficult-to-clean areas such as under the fingernails and in the hair. The most commonly used solution to this problem is irrigation with copious quantities of water (and detergent, if available) while realizing that the run-off may become a contaminant itself and should be contained, if possible, to minimize any environmental impact. During this process, consider modesty issues the patient may have, as well as comfort issues, such as using warm water to decontaminate the patient.

Finally, it may be possible to triage some victims by asking the question, “If the patient is truly contaminated with and dying from a highly lethal agent, will decontamination be of practical use, or should other patients be managed instead?" While this may seem callous, it forces the rescuer to evaluate if there is really a contamination issue or not. If there is, in fact, a spill of a hazardous material and the patient isn’t dead or dying, then there might be minimal contamination in the first place and gross decontamination (with available PPE for the rescuer) may be sufficient. Ultimately, however, the flight crew must err on the side of its safety and modify their triage and transport decisions accordingly.

Once a patient is deemed adequately decontaminated, management of the medical condition can occur. It may be worth asking, however, if clinical concerns should always be subordinate to decontamination issues. The answer may be ‘no’ in some cases and thus the treatment of the medical condition need not wait for complete decontamination of the patient. A good example of this might be a patient with alpha-particle radioactive contamination. The PPE described above, universal precautions used for trauma victims, is more than adequate for protecting the health care provider from the alpha particles that, by themselves, might not be as lethal as underlying burns or trauma. As in all of medicine, the ultimate answer to these questions is in the judgment of the provider and the on-line medical control physician.

After recognizing the hazardous material incident, notifying the proper authorities, identifying and learning about the agent(s) involved, and determining the decontamination status of the patient, the medical crew members can next begin to treat the patient. Unfortunately, the majority of hazardous materials have no antidote and therefore treatment is supportive and symptomatic. An advantage of identifying the hazardous material is that it can perhaps be put into some classification so that a specific therapeutic regimen can be determined. Many hazardous materials can be lumped together with similar agents that cause one of the five most common hazmat toxidromes or hazidromes (Table 4). Recognizing that a hazmat patient has a hazidrome helps to focus therapy and utilize antidotes, if possible (Table 5).

For example, all currently known nerve agents are organophosphates, similar to organophosphate insecticides, whose treatment is familiar to most flight crew members. Otherwise, the most common manifestations of chemical exposures can be anticipated and the flight crew prepared for them. These include GI symptoms; airway/pulmonary complications; metabolic disturbances; cardiovascular symptoms, particularly cardiac dysrhythmias and cardiovascular collapse, and CNS effects. Medical providers should be trained and equipped to deal with these syndromes as they present and not necessarily focus initially on definitive therapy. Your local poison information center may be of great help at this point, not only anticipating what symptoms might present, but suggesting definitive therapies that might not be obvious to air medical crew.

MEDICAL MANAGEMENT OF HAZMAT VICTIMS

DECONTAMINATION

Decontamination has two important functions: altering absorption for the patient and preventing secondary contamination of others. Primary goals at any hazmat incident are protecting emergency responders, preventing secondary contamination, and decreasing morbidity and mortality of hazmat victims.

Exposure solely to gases, such as simple asphyxiants, generally requires no skin or mucous membrane decontamination to prevent secondary contamination of others. However, exposure to highly water-soluble irritant gases, such as ammonia, can cause skin and mucous membrane irritation and chemical burns that are treated with copious water irrigation, i.e., decontamination to treat the patient, rather than to prevent secondary contamination of healthcare providers.

TABLE 4: FUNDAMENTAL HAZMAT TOXIDROMES OR HAZIDROMES

Hazidrome	Typical Toxicants	Predominant Route of Exposure	Predominant Toxicodynamics	Predominant Target(s) of Toxicity
Irritant Gas: Highly water-soluble irritant gas	Ammonia (NH_3) Formaldehyde (HCHO) Hydrogen chloride (HCl) Sulfur dioxide (SO_2)	Inhalation	Irritant & corrosive local toxic effects, by readily dissolving in the water of exposed mucous membranes and the upper airway, forming a corrosive aqueous solution that causes inflammation, edema, & corrosion of the exposed mucous membranes & upper airway	**A**irway
Irritant Gas: Moderately water-soluble irritant gas	Chlorine (Cl_2)	Inhalation	Irritant & corrosive local toxic effects, by dissolving in the water of exposed mucous membranes, and the upper and lower airways, forming a corrosive aqueous solution that causes inflammation, edema, & corrosion of the upper & lower airways	**A**irway **B**reathing
Irritant Gas: Slightly water-soluble irritant gas	Phosgene ($COCl_2$) Nitrogen dioxide (NO_2)	Inhalation	Irritant & corrosive local toxic effects, by slowly dissolving in the water of the alveolar-capillary membrane of the lung, forming a corrosive aqueous solution that causes delayed noncardiogenic pulmonary edema	**B**reathing
Asphyxiant: Simple asphyxiant	Carbon dioxide (CO_2) Methane (CH_4) Propane ($CH_3CH_2CH_3$)	Inhalation	Displacement of oxygen from the ambient atmosphere, decreasing the oxygen supply to the lungs	**C**ardiovascular **D**isability (nervous system)
Asphyxiant: Systemic (chemical) asphyxiant	Isobutyl nitrite [$(CH_3)_2CHCH_2NO_2$] Carbon monoxide (CO) Hydrogen cyanide (HCN) Hydrogen sulfide (H_2S) Hydrogen azide (HN_3)	Inhalation	Interference with oxygen transportation &/or utilization within the blood &/or other tissues	**C**ardiovascular **D**isability (nervous system)
Cholinergic	Organophosphate pesticides Carbamate insecticides	Skin & mucous membranes	Excess acetylcholine accumulation at both types of cholinergic receptors (muscarinic and nicotinic receptors in the peripheral & central nervous systems), due to inhibition of acetylcholinesterase, the enzyme that breaks down acetylcholine	**D**isability (nervous system)
Cholinergic	Organophosphate nerve agents	**Inhalation** &/or Skin & mucous membranes	Excess acetylcholine accumulation at both types of cholinergic receptors (muscarinic and nicotinic receptors in the peripheral & central nervous systems), due to inhibition of acetylcholinesterase, the enzyme that breaks down acetylcholine	**D**isability (nervous system)
Corrosive	Acids (Hydrochloric acid, nitric acid, sulfuric acid, etc.) Bases (Ammonium hydroxide, sodium hydroxide, potassium hydroxide, etc.)	Skin & mucous membranes	Irritant & corrosive local toxic effects that cause chemical burns of the skin and mucous membranes that come into contact with the corrosive solutions	**A**irway **C**ardiovascular
Hydrocarbon & halogenated hydrocarbon	Propane Gasoline Toluene Chloroform	Inhalation of gases or vapors	Inhalation can cause sleepiness to the point of narcosis (deep stupor &/or coma) and cardiac irritability because the heart is sensitized to endogenous catecholamines (epinephrine & norepinephrine)	**C**ardiovascular **D**isability (nervous system)

(Reprinted with permission from the Advanced Hazmat Life Support Provider Manual, 2nd edition, copyright 2000, Arizona Board of Regents, Tucson, AZ)

TABLE 5: HAZMAT ANTIDOTES

NOTE: These are commonly used doses for hazmat poisonings. Specific doses for a given patient must always be determined by the treating clinician. See other chapters for additional information including, indications, contraindications, and complications.

Antidote	Poisoning	Common Adult Doses	Common Pediatric Doses
Atropine*	Organophosphates Carbamates Nerve agents	1–2 mg IV bolus. Titrate with repeated doses.	0.02–0.04 mg/kg IV bolus. Never less than 0.1 mg. Titrate with repeated doses.
Calcium gluconate 10 percent slow IV bolus	Systemic hydrofluoric acid or fluoride poisoning	10–20 mL (1–2 amps). Repeat doses may be required.	0.2–0.3 mL/kg. Repeat doses may be required.
Calcium gluconate 2.5 percent to 10 percent topical gel or solution	Hydrofluoric acid skin burns	Topical application	Topical application
Calcium chloride 10 percent slow IV bolus	Systemic hydrofluoric acid or fluoride poisoning	5–10 mL (0.5–1 amps). Repeat doses may be required.	0.1–0.2 mL/kg. Repeat doses may be required.
USA cyanide antidote kit: Amyl nitrite	Cyanides; Nitriles; Sulfides	By inhalation	By inhalation
USA cyanide antidote kit: Sodium nitrite	Cyanides; Nitriles; Sulfides	10 mL (1 amp) slow IV bolus, over 5 minutes	0.12–0.33 mL/kg slow IV bolus, over 5 minutes, up to a maximum of 10 mL (1 amp)
USA cyanide antidote kit: Sodium thiosulfate	Cyanides; Nitriles	50 mL (1 amp) slow IV bolus, over 10 to 20 minutes	1.6 mL/kg slow IV bolus, over 10 to 20 minutes, up to a maximum of 50 mL (1 amp)
Methylene blue	Methemoglobin-forming compounds	1–2 mg/kg slow IV bolus, over 5 minutes. Repeat doses may be required.	1–2 mg/kg slow IV bolus, over 5 minutes. Repeat doses may be required.
Oxygen	Simple asphyxiants; Systemic asphyxiants; Methemoglobin-forming compounds; Carbon monoxide; & hydrozoic acid; Hydrogen sulfide and sulfides	100 percent, by inhalation	100 percent, by inhalation
Pralidoxime (2-PAM)	Organophosphates Nerve agents	1–2 g slow IV infusion, over 10 minutes, then 500 mg/h continuous IV infusion	20–40 mg/kg slow IV infusion, over 10 minutes, then 5–10 mg/kg/h continuous IV infusion
Pyridoxine	Hydrazines	25 mg/kg IV	25 mg/kg IV

*These atropine doses are much larger than those used to treat bradycardia and asystole in ACLS (Advanced Cardiac Life Support).

(Reprinted with permission from the Advanced Hazmat Life Support Provider Manual, 2nd edition, copyright 2000, Arizona Board of Regents, Tucson, AZ)

When indicated by the presence of adherent solids or liquids on a patient, skin decontamination should be performed in the field, in the decontamination zone. This is a two-step procedure. First remove all clothing, jewelry, and shoes. Bag and tag these possessions. The patient’s possessions should be left at the scene, stored, and may need to be disposed of as hazardous waste. Any adherent solid particles should be brushed away from the patient, and any obvious adherent liquid should be blotted away from the skin. Step two is meticulous washing with large quantities of water, using a mild liquid detergent if the adherent solids or liquids are not water-soluble or if a material’s identity is unknown. Most decontamination solutions are made for equipment, not people. Do not use harsh solutions on people. During the washing, pay close attention to exposed skin in skin folds, the axillae, the genital area, and the feet. Use gentle water pressure and lukewarm water (to reduce the risk of hypothermia) systematically from head to toe, while always protecting the patient’s airway.

Exposed, symptomatic eyes should be continuously irrigated with water throughout patient contact, including transport, if possible. Use of Morgan therapeutic lenses is the most efficient method to decontaminate a patient’s eyes, but this requires an ocular topical anesthetic such as proparacaine. Remember to check for and remove contact lenses as soon as possible.

PRIMARY SURVEY AND RESUSCITATION: THE BASICS

Within the constraints described above, the primary patient assessment and resuscitation are performed only after any necessary skin decontamination is completed in the warm zone. The exceptions are procedures that are commonly performed before any necessary skin decontamination and include opening the patient’s airway and spinal precautions. Common sense dictates that if liquid or solid contamination involves only the patient’s eyes or a small part of the body, such as a hand, then supportive care may be performed while decontamination is in progress. This procedure will also depend on the toxicity of the hazardous material. Remember to not take any unnecessary risks and that rescuers and scene safety always come first.

The primary survey and resuscitation is remembered by using the mnemonic **A, B, C, D, E**: **A**irway with cervical spine control, if necessary; **B**reathing; **C**irculation; **D**isability (nervous system); and **E**xposure with environmental control.

HAZMAT PATIENT HISTORY

Hazmat patient assessment includes a history and physical examination. History is guided by the **AMPLE** mnemonic (**A**llergies; **M**edications; **P**ast medical history; **L**ast normal menstrual period, tetanus shot, meal; and **E**vents).

In addition to the AMPLE information to be gathered for the patient, general information from the scene of the hazmat incident must also be gathered. Initially, determine the events that led up to the hazmat incident. How and why did the hazmat incident occur? Was there an explosion? Was there a fire? When did the hazmat incident occur? Where exactly did the hazmat incident occur? What is the exact identity of the hazardous material? Is there more than one hazardous material?

Next, determine the victim issues of a hazmat release. Who was involved in the hazmat incident? Are there other patients who need to be searched for and rescued? What was the route of exposure? Was there a confined-space exposure? Confined-space exposures usually result in higher concentrations of airborne toxicants, and a toxicant's concentration is proportional to its dose. How long was the exposure? The duration of exposure is proportional to the dose.

And finally, we must also begin to ask ourselves if this hazmat incident is an act of terrorism? Terrorist hazmat incidents can serve as bait for rescuers who are then at risk for booby traps, delayed explosions, or releases. Further more, the reporting and investigative requirements for a terrorist event are clearly and obviously different from those of a more routine hazmat release.

SECONDARY SURVEY

After the primary survey and resuscitation, hazmat patient assessment involves a secondary survey. This hazmat secondary survey focuses on identifying poisoning complications, recognizing preexistent problems that have the potential for exacerbation, assessing for accompanying trauma or burns, and recognizing toxic syndromes (toxidromes). There are five fundamental hazmat toxidromes or hazidromes: the irritant gas toxidrome, the asphyxiant toxidrome, the cholinergic toxidrome, the corrosive toxidrome, and the hydrocarbon and halogenated hydrocarbon toxidrome.

The hazmat patient assessment secondary survey also includes determining whether the patient has complications from poisoning. These complications can involve derangements of the **A**irway, **B**reathing, **C**ardiovascular system, **D**isability (the nervous system), or the organs of **E**limination (the liver and kidneys). Fundamentally, there are only five main ways to die, i.e., from fatal complications involving the **A**irway,

Breathing, **C**ardiovascular system, **D**isability (the nervous system), or the organs of **E**limination (liver and kidneys). Note that the ABCDE of complications and death from toxidromes differs from, but is parallel to, the ABCDE sequence of the primary survey.

For example, the respiratory system (airway and breathing) can react in only a limited number of ways to various insults. The upper airway can become obstructed from edema caused by chemical or thermal burns. Ventilatory insufficiency can be caused by loss of central nervous system respiratory drive, or by neuromuscular blockade with muscular weakness or paralysis caused by organophosphate or carbamate poisoning. Aspiration pneumonitis can be caused by emesis with an unprotected airway. .Acute lung injury (acute respiratory distress syndrome or ARDS) can be caused by direct damage to the alveolar-capillary membrane because of the local toxic effects of slightly water-soluble irritant gases such as phosgene and nitrogen dioxide, or ARDS can be caused by other insults such as prolonged hypoxia or hypoperfusion.

Patient assessment emphasizes that we must treat the patient, not the poison. Knowing what the patient was exposed to does *not* necessarily mean that the patient was poisoned. Although knowledge about the poison is important, knowledge about the patient's condition, derived from the primary survey and continual reassessments, is even more important. Even if the patient has been poisoned, preservation of the patient's vital functions with a primary survey and resuscitation, i.e., basic supportive care, is the cornerstone of treatment, taking precedent over administering any antidote.

POISONING TREATMENT PARADIGM

The poisoning treatment paradigm (**A**lter **A**bsorption, **A**ntidote **A**dministration, **B**asics, **C**hange **C**atabolism, **D**istribute **D**ifferently, and **E**nhance **E**limination) is an important AHLS mnemonic (**A**, **B**, **C**, **D**, **E**) that outlines an algorithm for treating poisoned patients. Again, this ABCDE mnemonic differs from the previous two but follows the basic care principles of primary assessment (with its ABCDE) pathophysiology of poisoning agents (with that specific ABCDE mnemonic) and this treatment paradigm's ABCDE.

Altering **A**bsorption (decontamination) is the cornerstone of toxicologic treatment. Hazmat **A**ntidotes are limited in number but serve an important function in the poisoning treatment paradigm when they are available. **B**asics, i.e., the primary survey and resuscitation are fundamental to the care of all patients, including hazmat victims. Poisonings caused by many hazardous materials can be treated effectively by **C**hanging their **C**atabolism, **D**istributing them **D**ifferently, or **E**nhancing their **E**limination.

An example of changing catabolism is the use of the antidote sodium thiosulfate in accelerating the catabolism of highly toxic cyanide to its relatively nontoxic metabolite, thiocyanate. An example of distributing differently is using oxygen as an antidote to redistribute carbon monoxide away from its binding sites on hemoglobin, so hemoglobin can more readily transport oxygen. An example of enhancing elimination is ventilating with 100 percent oxygen to enhance exhalation of carbon monoxide. Many inhaled toxicants, including gases such as carbon monoxide, are eliminated by exhalation.

SUMMARY

Safety considerations make it unlikely that air medical crews will be solely responsible for the management of a hazardous material incident or the care of a contaminated patient. They might nonetheless play critical roles. They should be able to:

1. Recognize the presence of a hazardous material incident based on clues, labels, placards, and other such evidence.
2. Provide for their safety and know about appropriate PPE while involved in a hazardous material incident.
3. Safely interface with other agencies within the ICS at a hazardous materials incident.
4. Determine, to the degree possible, the identity of the hazardous material and its properties and effects on patients.
5. Recognize the five main hazmat toxidromes (hazidromes).
6. Know sources of information about the materials involved and notify the appropriate agencies.
7. Identify decontamination issues and determine the efficacy of decontamination processes, particularly prior to deciding to fly a patient or not.
8. Anticipate basic symptoms and therapies required for the hazardous material or its general chemical or biological class and provide appropriate treatment for the agent.
9. Recite and use the poisoning treatment paradigm as the therapeutic organization for treating poisoned patients.

EXHIBIT 8-1: HAZMAT ENTRY TEAM PRE-ENTRY EXCLUSION DATA

Respiratory Rate**—Greater than 24 per minute.**

Pulse**—Greater than 70 percent of maximum heart rate (220-age)**

Age	70 percent
20–25	140
25–30	136
30–35	132
35–40	128
40–45	125
45–50	125

Blood Pressure—**Greater than diastolic > 105 mm Hg**
Temperature—**Less than 97.0^0 F or greater than 99.5^0 F**
EKG—**Dysrhythmia not previously detected**
Skin—**Open sores, large area of rash, significant sunburn**
Recent Medical History

Nausea, vomiting, diarrhea, fever, upper respiratory infection, heat illness, or heavy alcohol intake within past 72 hours. New prescription meds taken within past two weeks or over-the-counter meds, such as cold, flu, or allergy meds taken within past 72 hours. Any alcohol within past 6 hours. Pregnancy.

(Reprinted with permission from the *Advanced Hazmat Life Support Provider Manual*, 2nd edition, copyright 2000, Arizona Board of Regents, Tucson, AZ)

EXHIBIT 8-2: HAZMAT INCIDENT RESPONSE AHLS PARAMEDIC WORKSHEET

Chemical name: **Synonyms:**

Physical Properties	**Routes of Exposure**	**Hazard Class**
❑ Solid DLH: ___________ ❑ Liquid P: ___________ ❑ Gas P: ___________ FR: ___________ Solubility: __________	❑ Inhalation ❑ Absorption ❑ Ingestion	❑ Corrosive ❑ Poison ❑ Explosive ❑ Other: __________ ❑ Flammable gas ❑ Flammable solid UN#: ___________ ❑ Oxidizer CAS#: __________

Toxicology

❑ Irritant gas ❑ Simple asphyxiant ❑ Systemic asphyxiant ❑ Carbon monoxide ❑ Cyanide ❑ Methemoglobin inducer ❑ Sulfide	❑ Cholinesterase inhibitor ❑ Carbamate ❑ Organophosphate ❑ Corrosive ❑ Acid ❑ Base	❑ Hydrocarbon or halogenated hydrocarbon ❑ Other: _________________

Signs and Symptoms

Skin	Respiratory	Cardiovascular	Nervous System
❑ Irritation ❑ Chemical burns ❑ Thermal burns ❑ Fasciculations ❑ Diaphoresis Eyes ❑ Constriction / Miosis ❑ Dilation / Mydriasis ❑ Irritation ❑ Lacrimation	❑ Irritation ❑ Laryngeal spasm ❑ Bronchospasm ❑ Bronchorrhea ❑ Depression ❑ Hypoxia ❑ Pulmonary edema	❑ Tachydysrhythmias ❑ Bradydysrhythmias ❑ Angina ❑ MI ❑ CHF	❑ Excitation ❑ Seizures ❑ Depression Other ❑ Emesis ❑ Salivation ❑ Diarrhea ❑ Urination

Airway ❑ Suction ❑ Intubate	❑ Oxygen ❑ Bag valve vent. ❑ Beta-agonist bronchodialator	❑ Monitor ❑ IV ❑ ACLS Guidelines ❑ Fluids ❑ Vasopressors ❑ CPR	❑ Benzodiazepines for seizures Antidote:_____________ Other:________________

(Reprinted with permission from the *Advanced Hazmat Life Support Provider Manual*, 2nd edition, copyright 2000, Arizona Board of Regents, Tucson, AZ)

A. **Bibliography**:

Borak, Jonathan; Callan, Michael; Abbott, William: *Hazardous Materials Exposure: Emergency Response and Patient Care*; Brady Publishing 1991.

Bronstein, A.C.; Currance, PL: *Emergency Care for Hazardous Materials Exposure*; C.V. Mosby Co. 1988.

Carder, T.A.: *Handling of Radiation Accident Patients by Paramedical and Hospital Personnel*; CRC Press 1993.

Chapter 29, U.S. Code of Federal Regulations, Section 1910.120.

Chapter 40, U.S. Code of Federal Regulations, Section 112.

Agency for Toxic Substances and Disease Registry: *Managing Hazardous Materials Incidents Volume I: Emergency Medical Services: A Planning Guide for the Management of Contaminated Patients*: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry: *Managing Hazardous Materials Incidents Volume II: Medical Management Guidelines for Acute Chemical Exposures*: U.S. Department of Health and Human Services, Public Health Service.

Mettler, F.A.; Kelsey, C.A.; Ricks, R.C.: *Medical Management of Radiation Accidents*; CRC Press 1990.

Walter, F.G., Flomenbaum N: Hazmat incident response with pre- and interhospital care of the poisoned patient. Goldfrank L, editor. *Goldfrank's Toxicologic Emergencies*: 7th ed., New York:, McGraw-Hill; 2002.

Walter, F.G., Thomas, R., Klein, R.: *Advanced Hazmat Life Support Provider Manual*, 2nd edition. Tucson, AZ: Arizona Board of Regents; 2000.

B. **Definitions of Keywords**:

Occupational Safety and Health Administration (OSHA)—An agency of the federal government (and many states as well) responsible for ensuring workplace health and safety. One specific OSHA regulation establishes requirements for, among others, agencies whose employees may respond to a hazardous materials incident.

Environmental Protection Agency (EPA)—A Federal agency responsible for protection of the nation's air, water, and lands. As some agencies are exempt from OSHA, EPA has promulgated a parallel hazardous materials regulation to ensure compliance with hazardous materials requirements.

Code of Federal Regulations (CFR)—The document codifying regulations passed by various Federal agencies and contain the aforementioned OSHA and EPA hazardous materials regulations

Advanced Hazmat Life Support (AHLS)—An international training program for the medical management of hazmat victims. AHLS providers are paramedics, nurses, physicians, or other healthcare providers who have successfully completed the 16-hour AHLS Provider Course. AHLS providers are trained in the recognition of signs and symptoms caused by exposure to hazardous materials. AHLS providers are trained to deliver antidotal therapy to victims of hazmat poisonings, as approved by state and local protocols.

Personal protective equipment (PPE)—Clothing and equipment necessary to protect the wearer from certain hazardous materials.

Weapons of mass destruction (WMD)—Chemical, biological, nuclear, incendiary, explosive and/or radiological weapons specifically developed and deployed for the purpose of adversely impacting large populations

Hot zone—The area within a perimeter (whose size and shape are determined by multiple factors and are thus incident specific) wherein a hazardous material has been released and contamination is likely

Fixed locations—Facilities and structures where hazardous materials are generated and/or stored permanently

Placard(s)—Signs affixed to trucks, trailers, shipping vessels, etc. wherein hazardous materials are found that are designed to communicate both the presence and hazards of a material by a diamond shaped, color coded, and numbered symbol

Material Safety Data Sheet—A document required by OSHA/EPA that provides a variety of information on each specific hazardous material and is to be available to responders, shippers, employees, and other individuals who have a right-to-know

Contamination—The actual or presumed presence of a hazardous material on people or items

C. **Test Questions**:

1. Placards always provide specific information about hazardous materials.

   a. True
   b. **False**

2. The local fire department is always the hazardous materials response agency and should be contacted immediately if a flight team suspects they have arrived on hazardous material scene.

   a. True
   b. **False**

3. _______, _______ and _______ should be considered before managing contaminated patients.

   a. Time, distance, chemical
   b. Time, medicine, chemical
   c. Time, distance, shielding
   d. Location, chemical, shielding

4. All victims should be decontaminated without question.

   a. True
   b. **False**

5. In most cases a patient should be decontaminated before management of medical conditions occurs.

   a. **True**
   b. False

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Familiarization with DOT/United Nations (UN) Hazard Classifications and NFPA placards and labeling for hazardous materials

- Case scenario discussions regarding appropriate EMS and air medical response to specific chemical contaminants
- Case scenario discussions regarding response to local and regional fixed and nonfixed hazardous materials locations
- Identification of local and regional sites that could be targeted for the release of biological toxins
- Hands-on familiarization with program specific PPE
- Hazardous materials response drill with other local/regional agencies
- AHLS interactive case studies
- Reciting indications, contraindications, complications, dosage, and routes of AHLS antidotes
- Reciting the poisoning treatment paradigm for indications, contraindications, complications, dosage, and routes of AHLS antidotes

F. **Patient Care Hours**: N/A

MODULE 9: ENVIRONMENTAL FACTORS AND SURVIVAL

Author: Mr. Troy Basham, AS, EMT-P, EMT-T; Aeromed,
Tampa General Hospital, Tampa FL

Reviewer: Mr. Pete Russet, BS, Pilot, Air Methods,
INOVA Fairfax Hospital, Fairfax, VA

KEYWORDS

Topography
Emergency Locator Transmitter (ELT)
Helicopter Emergency Egress Device
Pitch
Yaw
Emergency Personnel Indicator Radio Beacon (EPIRB)

OBJECTIVES

By the end of this module, the student should be able to:

- Identify the environmental factors that impact daily air medical operations
- Contrast the concepts of attitude, pre-planning, physical, and mental conditioning and preparation
- Discuss pre-crash procedures
- Describe crash and post-crash survival strategies
- Identify stressors and management concerns evident during the post-crash stress phase of the event

INTRODUCTION

Whether you are a new air medical flight crew member or an experienced flight nurse or flight paramedic, your thoughts occasionally turn from the excitement and anticipation of the next mission to the always present concern about an in-flight event. How this scenario plays out in your mind and how you react when the real event occurs will determine, to a large degree, the outcome of such an event.

It is 1:10 in the morning as your feet slide into boots that are still chilled from the last outing. You move toward the doors and hear the whine of the jet engines as they begin to generate the power that will turn the heavy rotors. The night air bites as you move to the helicopter that has now sprung to life. You look at the street lamp near the pad. There is a faint halo surrounding its glow. You board and the aircraft lifts, heading to the scene of a motor vehicle crash. The lights of the city fade behind as you move into the wilderness area and, 30 minutes later, into the mountains.

There, halfway up the side of one of the peaks, you see the emergency lights flashing a warning to others but a beacon to you. The landing is uneventful. As you depart the aircraft, the pilot tells you to make it quick and that fog will form soon. You know that you have to hurry. After a quick patient assessment, you and your partner load the trauma patient quickly into the aircraft. You are airborne in less than 10 minutes. Fifteen minutes later, a short crackle of loud, frying static on the radio forecasts a rapid sequence of events that ultimately lead to a fast and unanticipated meeting with the ground. You have crashed. As you and your partner assist the pilot from the helicopter and quickly assess the patient, you see the fog forming and realize that it will be a long cold night.

Less than an hour ago, you were in the safety and warmth of your crew quarters. Now you will have to fight for your life, the lives of your fellow crew members, and the already injured patient. You think back to your survival training.

Many aircrew members have attributed a successful outcome to such an incident solely to survival training. Interviews and testimonials from aircrew members downed during war, at sea, and even in the air medical industry have shown that survival training, even if received long ago or infrequently, was the overwhelming factor in saving their lives.

The emphasis you place on learning the information in this chapter and the zeal with which you pursue the practical aspects of this training may determine the outcome should you find yourself in such an unfortunate situation.

ENVIRONMENTAL IMPACT ON DAILY OPERATIONS AND CREW SAFETY

Although many factors affect the operations of an air medical mission, none is more important than weather. Missions are accepted and declined many times based solely on this factor, wreaking havoc on day-to-day operations. Furthermore, the crew and patient can be adversely affected by the unpredictable and severe weather conditions that can occur during an air medical mission. Crew members should make an operational assessment each shift including an evaluation of their own flight-worthiness, the anticipated performance of other crew members, and the effects of weather on aircraft performance.

Effects of Heat

Heat can hinder human performance in many ways. Effects can be as simple as profuse sweating, or as devastating as heat stroke, which can incapacitate crew members, placing them in as much jeopardy as the patient. The most common malady affecting a flight crew is simple performance degradation from heat and exhaustion. Overheating causes a number of signs and symptoms that should serve as a warning to the crew involved.

The first, and most common, symptom of heat intolerance is usually a headache, which can be profound or just mildly annoying. Irritability often follows and can effect crew cooperation, attitudes and decision making. If left unchecked, more serious signs and symptoms develop, such as confusion, heat cramps, nausea, vomiting, and malaise. At this stage a stricken crew member can no longer function and becomes a patient himself. Heat exhaustion and heat stroke are well known to air medical crew members, but are not usually recognized when they themselves are the patients.

Treatment and prevention go hand in hand. Hydration is a preventative measure that will also serve as a first line treatment. If during the beginning of the shift, crew members note that there will be a threatening heat index for the day's operations, they should make it a point to discuss preventative measures. Increased fluid intake, particularly water, is essential. Sports drinks and other "salt laden" beverages should be diluted to at least half strength before being consumed. Though these products replenish valuable minerals and "salts", they also have the propensity to dehydrate. The concentration of additives that they contain is so high that natural body fluid can be drawn away through osmosis and initially cause further dehydration. A number of newer commercially available products have taken this factor into consideration and provide a less concentrated form of supplement. On the average, a flight crew member should drink 2 quarts of water per hour. This may cause a minor inconvenience by increasing urinary output, but will create a safety margin for an increased workload and a buffer for any unforeseen emergencies.

Rest is an important preventative measure for any crew member. It is estimated that for every hour of flight time, the crew should spend 2 hours at rest. Experienced flight crew members know this to be true but may find application unrealistic. Crews should, however, take advantage of downtime to ensure that energy levels are maintained. Military maneuvers in the desert environment have provided us with a great lesson. The adage, "Never stand when you can sit, never sit when you can lie down, and never lie down when you can sleep" offers sound advice for individuals working in extreme weather and temperature conditions.

Though it may sound a bit unproductive, the philosophy has merit. Failure to rest and maintain hydration can predispose crew members to heat exhaustion and even greater complications.

Heat can similarly affect the patient. Although patient safety and comfort are top priorities for any flight crew member, if we are debilitated by the early complications of heat ourselves, we may have difficulty meeting the patient's temperature regulation needs.

Effects of Cold

The effects of cold on the human body are much more noticeable than the gradual effects of increased heat. Numbing cold announces itself with no cloaking or deception. Anyone who has ever worked in freezing cold knows of the tingling sensation and numbing that accompany cold and forecast further discomfort. Though the initial symptoms of cold injury are usually profoundly noticeable, the ensuing hypothermia can manifest without notice. Initial symptoms of hypothermia include a decreased mental sensorium, uncontrolled shivering, malaise, and eventual unconsciousness. Again, as in the case of heat injury, the flight crew must not allow themselves to cross the line and become patients rather than caregivers.

Prevention is the key. The shift briefing should advise the crew of needed precautions for cold. Wearing layered clothing, gloves and hats, and keeping a spare jacket in the aircraft are always good practices in a cold or potentially cold environment.

Patient care should reflect particular caution in cold weather. Intravenous fluids and medications can be adversely affected by cold. Traumatic injuries can also be complicated by cold. Warming of IV fluids, the use of extra blankets, the use of warming devices and even the use of the on-board heating systems may be needed for the benefit of the patient.

Precipitation can also have a profound hypothermic effect on the patient and crew. Every effort should be made to keep and patient dry. Contamination of injuries, degradation of wound dressings, decreased effectiveness and the compromises of equipment are all additional complications of rain and moisture. Water-resistant covers for equipment, rain gear for the flight crew and properly used patient rain covers will go a long way towards making the best of a wet situation. With a little planning and the right equipment, the air medical specialist can operate effectively in the rain environment with only minimal discomfort.

Effects of Geographic and Topographic Conditions

Access to the patient, treatment in the field, and patient evacuation are all operational considerations that are compounded by adverse terrain and climactic conditions. Difficult topographic areas can cause extended patient down times prior to the rescue crew's arrival. They can also require extended pre-hospital contact with the patient. These circumstances should be covered in training and protocol considerations for the air medical crew. Administration of blood products in the field, surgical procedures, and even wound closure procedures are examples of the types of advanced procedure training and protocol enhancements that should be considered for air medical crew who operate in remote or rugged areas.

SURVIVAL

Pre-event Education: Physical and Mental Preparation

Many factors can affect the survival of individuals on board a medical transport aircraft when it goes down. Although no amount of planning and preparation can address all possible variables and situations, several concepts are universal to optimizing the outcome. Educational preparation of the crew as well as physical and mental preparation for stressful events can go a long way toward ensuring a positive outcome after an untoward event.

- **Survival Education**

  Familiarity with the aspects of survival training is essential in preparation for the events of aircraft crash or unexpected forced landing. These aspects include the disciplines of survival techniques, orientation to your assigned aircraft, an awareness of local climate, and a general knowledge of navigation, topography, and geography as well as more specific knowledge of local conditions and geography. Information about SAR resources, both local and regional, as well as the national SAR operations capabilities will give you an insight into how to be a “better victim”, facilitating an easier search “target” and helping to secure early rescue for you and your crew.

  Physical and mental conditioning is of obvious importance to any air medical crew member, since the nature of air medical mission response necessitates the ability to endure physical and mental hardships. Survival depends on the resources brought to the mission by each crew member, including survival knowledge and skills, a well-conditioned, healthy body, a positive attitude, and a logical approach to problem solving.

A well-rounded knowledge base coupled with good physical and mental conditioning is only good if it is put to use. An adage frequently used in rescue and emergency services regarding rescue techniques is “If you don’t use it, you’ll lose it”. This holds true with survival considerations. Find frequent opportunities to take survival courses in your local area. These are offered at local colleges, wilderness clubs, and through private educational corporations. Additionally, many enterprising educators have established seminars, courses, and experience-based camps utilizing personal and professional survival experiences. These allow participants to test themselves in realistic survival situations and environments that are indigenous to local response areas. They allow self-discovery and permit trainees to experience the “real thing” under controlled conditions. In the absence of such formal courses, try taking a simple journey into the local wilderness for an afternoon and looking at the situation from a survivalist perspective. Specialized courses are also available that will enhance survivability of a crash in water, desolate desert, or extreme ice and snow conditions. Water crash simulators used at some of these courses allow participants to experience the extreme conditions encountered during a water impact event. There are also exercises that enable crew members to learn survival skills specific to extreme hot and cold environments. These experiential courses tend to be quite intense and often lead to personal insights.

- **Physical and Mental Preparation**

  A daily self assessment should be routine for air medical crew members. Take an introspective look at your emotional and mental state. Distracting thoughts and concerns can be magnified under the stress of survival situations and lead to performance degradation. Daily operations need your focus to ensure that decisions and responses are accurate and timely. If you are distracted or focused on other matters you may fail to notice a peculiarity while performing your task of aircraft “walk-around”. This could lead to an unexpected in-flight event or unplanned landing that could jeopardize the safety of all on board. Lack of focus can also result in indecision or even panic at a time that quick, objective judgment is needed the most.

The same concerns apply to your state of health. Air crew members must operate at 100 percent effectiveness. If a crew member is ill or emotionally taxed, it is better to safely ground the aircraft now than have it grounded later due to an incident resulting from these deficiencies.

Once your self-assessment is complete and you have given yourself a “go”, it is time to look at the remaining crew in the same manner. This often proves a little more difficult. Every shift should commence with a crew briefing. This is the prime time for the crew to check each other's attitudes. Crew harmony is as essential in a survival situation as it is in day-to-day operations. Post-flight debriefings are an important venue for discussion of all aspects of mission improvement. Crews should not avoid discussion of potential incidents or near misses but use these instances to explore the “what if" realm. Often these discussions can lead to productive policy and procedure considerations. However, they are always thought provoking and allow the crew to consider their actions and possible solutions to theoretical situations.

- **<u>Aircraft Familiarity</u>**

Familiarity with the assigned aircraft is imperative for all air crew members just as familiarity with the medical equipment is imperative to the medical crew. Each aircraft is different and has its own personality. Knowledge of flight characteristics, design and configuration will be of benefit in daily operations as well as in emergency situations. The crew must be familiar with the location and operation of:

- Doors and exits
- Fire extinguishers
- Fire extinguishing systems
- ELT
- Helicopter Emergency Egress Device (HEED)
- Underwater air supply
- Emergency shut-off switches for fuel, oxygen, and power
- Radios
- Emergency survival equipment

Cockpit resource courses are geared toward making each crew member aware of the importance of his or her contributions and understanding to normal and emergency operations. Though the information presented here is predominantly focused on survival, the obvious best answer to the survival situation is avoidance of the peril. Preventing an incident is much better than practicing the art of survival. Safety should be everyone’s concern and responsibility. This can often be the key to the prevention of an incident wherein survival techniques must be employed. Know your aircraft, personnel, mission, and environment. This information could prove very valuable before, during, and after an incident.

Orientation to local geography, topography, and climatic conditions may aid in navigation, assist in survival preparation, and facilitate a quicker rescue. It is important to keep abreast of one’s position during flight. Crew members should know the lay of the land and its landmarks and should be able to read aeronautical maps and use a compass and the Global Positioning System (GPS) navigation components of their aircraft. Inexpensive, small hand held GPS units are available and should be considered when developing onboard survival kits. This knowledge of geography, climate, mapping, local wildlife, and usable natural resources combined with a calm, objective attitude, and a well-planned survival kit comprise the needed resources for survival after a crash event.

- **Search and Rescue Resources**

Resources for SAR in North America are the best in the world and range from highly capable local volunteer SAR teams to the most sophisticated military satellite-supported search systems available. When a medical aircraft is missing, all agencies collaborate to assure that that all the necessary resources are made available. Those resources may include:

- U.S. Air Force Rescue Coordination Center
- Civil Air Patrol
- U.S. Coast Guard
- Local military resources
- Local and regional government SAR teams
- Other air medical services
- Volunteer SAR teams
- Other civilian entities (media, agricultural aircraft, and private interests)

Over the years, these valuable resources have provided for many successful rescues. They must, however, be requested and coordinated during rescue operations. Air medical programs usually have a working knowledge of local, regional, and national SAR capabilities and the individual program may even form an integral component of this resource. Crew members need to familiarize themselves with the workings of these resources and procedures for activating them.

Safety and Crash Considerations in Day-to-Day Operations

Though we have total faith and trust in our aircraft, fellow crew members, and program, we should always be prepared for the worst. Pessimism is in the nature of the rescue and EMS profession. We should prepare for each flight as if it would end in a crash. Though this sounds harsh and pessimistic, it is necessary if we are to enhance our chances of surviving an incident.

Briefings at the commencement of each shift should refresh our knowledge of emergency procedures and highlight each individual's duties and responsibilities in an emergency. Frequent crash drills or, as a minimum, "table-top" exercises should be conducted to heighten awareness and familiarity with emergency and survival protocols.

Personal safety equipment such as helmets, Nomex flight garments and gloves, as well as flotation and emergency egress devices should be reviewed and their serviceability confirmed prior to the shift. Flotation devices should be worn by crew members during all flights over bodies of water. Helmets must be worn properly and configured for each individual to afford maximum protection during the crash. In the aircraft, equipment must be stowed and secured in its proper place. A small instrument or any other piece of medical equipment can become a dangerous missile during the erratic behavior of the aircraft in a crash or during in-flight turbulence.

- **Survival Equipment**

  Many flight crew members unrealistically assume that with a cell phone, radio, or "change to make a phone call", they will be picked up in an emergency. Although this belief has been professed by many in the air medical industry, history and common sense dictate otherwise. Although SAR technology is highly refined and readily available, crash site access can be delayed for hours and even days. Weather, remote and expansive locations, and simple logistics can hamper even the best SAR units. As an example, in the late 1980s a Military C-130 Hercules went down in Florida on Eglin Air

Force Base. Though the base is home to the most highly trained and experienced military special operations forces, and though massive amounts of military personnel and equipment were brought into play, it took more than 3 days to access the site. This delay occurred even though the search area was much smaller than most remote areas covered by air medical crews. The point is simple. Even in relatively small and nonremote areas, it could be days before help arrives in the event of a crash.

Having a good survival kit can make the stay much more tolerable and may even be the determining factor in survival. These kits are economical to acquire, easy to maintain, and worth their weight in gold when they are needed. Survival kits can be classified in two categories; aircraft mounted and personal.

- ***Aircraft Survival Equipment***

  Aircraft survival equipment, sometimes called a 48-hour pack, can be as extensive as storage space permits. The topography and climate of the response area and flight mission should govern the contents of this pack. Some suggested items are listed below.

  - Supplemental clothing
  - Food such as military-style “MREs”
  - Shelter
  - First aid supplies
  - Hand held radio
  - Emergency locator beacon—in addition to the aircraft ELT
  - Drinking water
  - Flotation device

- ***Personal Survival Equipment***

  The personal survival kit is much smaller, less inclusive, and designed to be carried on the crew member’s person. Often newer crew members will wear oversized survival packs, only to downscale them or discard them completely because they are too bulky and uncomfortable to wear. A compact, waterproof container should be used. Suggested items for the personal survival kit include the following:

- Knife
- Fire starting tools, (waterproof matches, magnesium, flint, steel wool, and battery, NO BUTANE LIGHTERS)
- Plastic bag
- Space or survival blanket
- Fish hooks
- Signal mirror
- Whistle
- Survival saw
- Water purification tablets
- Water collection container
- Heat exhaustion tablets
- Other items as needed for the local response area

- **Personal Flotation Device**

  The best rescue swimmers will tell you that even a minor injury to just one extremity can be debilitating enough to cause one to perish. Lakes, rivers, bays, and swamps: water is everywhere and flight paths are not discriminating enough to discount the possibility of ending a flight in a body of water. Various types of PFDs are available for this application. They should be capable of manual and oral inflation and small enough to not encumber the crew. Caution should be exercised to ensure that the PFDs are not the kind that automatically inflate on contact with the water. These can trap crew members inside the aircraft, pinned against the floor or ceiling by the PFD's buoyancy.

THE CRASH EVENT

Despite the accuracy of crash statistics and the reluctance of flight crew to discuss crash reports, an in-flight event is a real possibility with each flight mission. Given this possibility, it is imperative that all flight crew members and administrative personnel be prepared to deal with the sequence of events that occur in a crash. Knowing the sequence and process of an in-flight event may help you understand what has occurred and improve your likelihood of survival.

Event Announcement

At some point during the sequence of events, the crash will be announced. During optimal conditions, the pilot in command will be able to inform the crew what to expect and how to prepare for impact. During catastrophic conditions, the only warning may be a sudden change in one's comfort level. Reality is often somewhere in between.

It is extremely important that all flight crew members, especially the pilot, be well versed in emergency protocols and able to react in a quick and logical manner. Upon realizing that a crash is imminent, the PIC and should inform the crew of the nature of the event, whether fire is involved, the degree of severity of the problem, expected outcome of the event, potential aircraft behavior, and any duties or tasks that the crew will need to perform.

Often the PIC is unable to provide such extensive information. Crew members must make every attempt to remain calm and overcome the urge to flood the intercom or radio with questions or unnecessary conversation. Radio and intercom silence is a must. The air medical crew should follow the pilot's instructions and provide any assistance needed. This could include execution of an emergency checklist, identification of local landmarks, map orientation, or assistance in making radio transmissions.

Crew members should ensure that all equipment and other loose items are secured and assume a "crash position". They should place their helmet face shields down and loosely lock them into position. The sleeves of the flight suit should be rolled down and the seat restraint harness locked in place. They should find a pre-planned hand position reference point that will allow them to identify their exit in relation to their position and assist in maintaining their spatial orientation after any violent motion during the landing has ceased. This will enable them to exit the aircraft quickly and with less confusion.

Aircraft Behavior

During an event, there are three potential attitudes that the aircraft can take. It may pitch nose up or nose down; roll, shifting left or right of the center axis; or yaw, twisting on its center of gravity in a flat plane. Or, it may do a combination of two or all three. The potential of violent movement of the aircraft makes it essential that crew members lock their harness and maintain a fixed reference point.

Impact

The type and severity of the impact are affected by multiple factors. Aircraft attitude, speed, design and control as well as the terrain and topography can affect the outcome. Aircraft attitude and speed will be contingent on the pilot's ability to maintain control. Aircraft design is such that the energy of an impact is partially absorbed through destruction of the airframe, similar to car "crumple zones". The aircraft's honeycomb design and energy-absorbing seats assist in dissipating the energy of the impact. The individuals posture and position can also assist in diminishing injury during the impact.

There are three possible impact types: roll, slide, or pancake. Sliding dissipates energy through friction with the surface of the aircraft and landing area and eventually through the destruction of the aircraft body. Rolling allows the energy to be used up through friction but to a lesser degree and with more denting of aircraft surface than the "chewing away" caused by sliding. The pancake is a straight-in impact, the most instantaneous energy exchange and therefore the most severe.

During the crash, debris, dust, water, and fuels may be flying about. As the aircraft comes to rest, crew visibility will be reduced. Crew members must use their pre-planned hand reference points to facilitate egress from the aircraft. As the aircraft ceases violent motion, the crew should begin their exit. Exiting the aircraft before this time could result in further injury. Moving parts of the aircraft dislodged by the crash can be a hazard to the crew. Unplug the communications cord, unbuckle from the harness, and exit. Crew members should rendezvous at a pre-designated location. This should be a safe distance away and at the 12 o'clock position of the aircraft.

If the pilot is incapacitated, it may be necessary to shut down the aircraft engines, switch off the fuel flow, and turn off electrical power in order to safely exit. Turning rotors, spinning propellers, and running jet engines could pose a hazard to exiting crew members. If the battery is not turned off, sparking electrical circuits can ignite fuel spilled during the crash. The entire flight crew should be familiar with the procedure for shutting down the aircraft.

In a water crash, the procedures are basically the same. Wait until all violent motion of the aircraft has ceased. The crew should also wait until the aircraft has filled with water before unbuckling and attempting to exit. Failure to wait for this could result in the weight of the in-rushing water pinning crew members even further in the wreckage. Inflation of the PFD must be deferred until crew members are clear of the aircraft. Prematurely inflating the PFD can entrap the victim inside the wreckage. If the entry into the water is planned, the pilot may instruct that doors be opened or jettisoned. The helicopter pilot may also elect to hover long enough for the crew to jump and then ditch the aircraft a short distance away.

THE RESCUE

All crew members must be accounted for before rescue of a patient is attempted. Patient rescue is manpower intensive and could result in the loss of additional life through the delay in rescue of more easily extricated and less incapacitated victims.

Each crew member should perform a self-assessment for injuries and in-turn assess each other. Injuries should be identified and treated immediately. Worsening injuries can be both debilitating and demoralizing for the entire crew.

Once the crew is out of the aircraft, the pilot will determine if and when it is safe to return to the aircraft. If the aircraft is deemed safe, an assessment must be made to determine what resources are intact and available for salvage. The radio system and any portable radios or phones carried by the crew should be evaluated and salvaged for use in communicating with rescue teams. If accessible, the ELT or EPIRB should be turned off and re-initiated every fifteen minutes. This will conserve the batteries and lengthen the life of the system. Emergency communications should be transmitted via radio even if there is no reply. Remaining calm, patient, and objective will greatly improve the likelihood of rescue. Your own program’s preparation for these untoward events will support and sustain the SAR effort.

Flight Following

The filing of a flight plan is essential and required by the FAA. This requirement can be waived if the flight program utilizes a means of flight following. This can be accomplished by periodic position reporting outlining operational status, current position, any deviation from the flight plan, and ETA to the planned destination. Pre-established procedures are initiated in the event the aircraft fails to check in or is overdue. Newer technology affords the ability to constantly monitor the aircraft’s position by use of a GPS linked transmitter that relays the information to a display or computer program in the flight operations center. Every air medical program must have one of these methods in place to monitor and track all flights.

Personal Attitude

A crew member's attitude can be the pivotal factor in crash survival. Many times the best approach is to realize “It has happened, we have crashed, now get over it.” The universal adage about survival is “Survival is a matter of will”. This cliché is truly on the mark. You must remain focused and maintain your mental edge, since this is your most valuable tool. You need to operate in the here and now. Other than training, events of the past have no place in survival, nor do thoughts of the distant future. Your attitude and resulting actions will affect the entire crew. Complaining, finding fault, or becoming angry or despondent will trigger similar feelings within other crew members and diminish your ability to think clearly and make rational decisions.

As in every well-run emergent situation, pre-assigning tasks, establishing priorities, and working collaboratively are important to a successful outcome. Rather than sit complacently, do something. Do assigned tasks such as radio contact or finding shelter. If you are cold, find a way to get warm. If you are hungry, work toward obtaining food. Leadership of the group will evolve. Avoid conflict. Be cautiously aggressive and work together as a team to resolve your situation. Maintain your spirit and the spirit of those around you. Finally, from the wisdom of downed crew men throughout history and the manual for aircrew survival from all of the branches of the U.S. military, pray. It has a profound effect. Strength, will, unity, hope, and peace are all gained through this simple act.

Environment

The environment in which the incident occurs will often determine the outcome. Climate and geography are the biggest contributing factors to the severity of injuries and likelihood of crash survival. Factors influenced by the climate include weather, regional topography, plant and animal life, and habitation. Plants and animals are generally indigenous to specific climatic regions, and species that are similar in appearance can differ from area to area. These differences can be behavioral, affecting accessibility as a food source or predatory inclination. Animal behavior can also change radically with different seasons. Species that are timid or docile during portions of the year can become aggressive and threatening at other times. The differences in their behavior and seasonal changes can also impact their value as a food source or threat to the survivors.

Climate and geographic makeup of the program response areas will dictate what training you should have, what equipment you carry in your survival kit, and many other aspects of survival preparation.

Climactic Conditions

- **Mild**

  Obviously, the mild climatic regions will be the least threatening and probably provide more resources for survival activities. However, never underestimate the weather in these climates nor the hazards that indigenous threats such as wildlife and topography may pose. Climactic regions that are generally mild are also prone to rapid changes in severity of weather. Additionally, these regions tend to support a larger and more diverse flora and fauna that could include predatory animals or otherwise dangerous animals and plants as well. Your index of preparedness must remain high in these areas, due to the broad spectrum of conditions and situations you may encounter.

- **Tropical**

  Tropical climates are a bit more extreme and will necessitate a little more preparation with consideration for equipment, training, and conditioning. There will be a greater abundance of resources for survival. Along with this abundance of goods comes the potential for a negative interaction with the environment. The heat and humidity in this type of climate can have a devastating impact by sapping energy, frustrating efforts. These conditions can be psychologically demoralizing and incapacitate the crew member without much warning. Water intake and energy conservation are critically important during any survival situation, but nowhere more important than in the tropical region. Dense foliage growth can impede mobility and prove difficult for search crews looking for wreckage or other indicators of the site. Amid such foliage, the surviving crew may need to modify their signaling techniques.

- **Arctic**

  Cold, desolate, and lifeless. These adjectives describe the wintry environment of the arctic, sub-arctic, and even the median extremes of the northern or southern hemispheres. Maintaining energy and body temperature is of prime importance in a cold climate. Frostbite and hypothermia are the enemies, and must be taken into consideration when preparing for the possibility of a survival situation. Treatment is geared towards prevention. Hypothermia can be debilitating mentally as well as physically, and crew members need to ensure that they do not fall victim to cold related injuries.

The crew must periodically assess one another for evidence of health problems or injury. Additional clothing, shelters, and thermal energy sources should be considered in the aircraft survival kit. Only available resources and imagination limit the construction of supplemental makeshift clothing. Sheets, stretcher mattresses, and seat cushions can all be made into protective clothing as needed. Sunshades that could prevent snow blindness can be improvised with virtually any material. Training in snow shelter building, and a study of hypothermia; its prevention, signs and symptoms, coupled with a sound familiarity with the region's wildlife and plant life will help the survivors hold their own in this harshest of climates. Hydration is another issue in this environment. Fluid intake remains important, survival technicians all discourage eating snow as a means of hydration. The energy lost through the body's warming of this source of water far outweighs the value gained by consuming it. Snow or ice should be heated by a means other than direct consumption. Crew members should strive to attend specific training for cold or arctic survival if they frequent this type of climate.

- **Desert**

The desolation of the desert or semi-arid region is similar in many ways to that of the arctic region. Heat becomes a strong opponent in this situation. Dehydration and heat related injuries, thermal and solar burn, heat exhaustion, and heat stroke await unprepared and unprotected crew members in the desert. Days are hot and nights are cool in the typical desert environment. Survivors must be prepared to meet both these extremes to deal with the situation. Activities such as travel, forays for food and supplies, or anything other than the most immediately necessary tasks are ill advised in the daytime heat of the desert. Crew members can learn from the animals that dwell in each environment and mimic their behavior. In the desert, animal activities are minimized during times when the heat is at its peak. Nights can become quite chilled, and activity can be best suited to this time to conserve energy and minimize the potential effects of the heat. Clothing can be made from resources outlined in the arctic section of this chapter. Eye protection from the harsh sunlight is also essential and can be fashioned out of virtually any nontransparent material with slits cut for sight. Attend a survival class or seminar highlighting survival techniques specific to the desert environment if your program frequently flies over or responds to these areas.

- **Mountain**

  Mountainous terrain provides several survival challenges found nowhere else. Inaccessibility to SAR crews, severe variances in weather conditions, and harsh topography all make for difficult survival conditions. Though not truly classified as a climate, the impact of mountainous conditions is nonetheless significant. Mountains can harbor climates that range across the entire spectrum. Desert, tropical, and arctic conditions can all be found within a given mountain range. Crew members flying over these regions should receive training in surviving all climates found in the area.

Weather Conditions

Weather is defined as the day-to-day changes in the climate. Sudden changes in temperature, rainfall, or visibility conditions can severely affect all aspects of survival. Activities and survival contingencies must be planned with consideration for weather. During cockpit resource classes or even during “down-time discussions”, the crew can learn much from experienced pilots regarding weather predictions and behavior. This can be valuable knowledge for the crew member in daily operations as well as in survival situation(s).

SURVIVAL PRIORITIES

Having considered the conditions potentially encountered during the crash phase, having developed an awareness of the climate in the flight response area, and having been trained in the art of survival, the crew member is now better prepared for the unexpected.

Post-Crash

The post-crash phase of survival is where it all comes together. The first order of business should be to perform an assessment. Starting with themselves, crew members must perform an injury survey. This must continue and include the remainder of the crew until all crew members have been completely assessed for injuries. The slightest of injuries can become debilitating or pose such a hindrance as to lead to other problems in the survival situation. Once all injuries have been identified and addressed, the crew must then individually and collectively inventory all resources. This must be done as soon as possible since some resources may dissipate or become otherwise unavailable to the team. Crew should return to the aircraft only after the pilot has determined that it is safe to do so. If a fire erupted during the event, wait until the aircraft has cooled before returning.

The mind is the first and most important resource to be considered in survival. A commonality among all survival texts is that survival is a matter of will. Nothing has a greater impact on the outcome of any given situation than the drive to make it through the ordeal. Tales of survival against staggering odds all share the trait of strong willpower and clarity of mind. In this arena, panic and lack of focus can become the enemy.

Mental stress is a profound enemy of a sound mind and clear thinking. Stress can be viewed as a ladder that can lead to panic and indecision. Factors causing stress are rungs on this ladder that can increase the severity of the fall: pain, suffering, fear, frustration, hopelessness, and disharmony among the crew are but a few of the feelings that can lead to failure. Dealing with the stresses imposed by the post-crash situation requires a keen mind and an attitude of perseverance. Some of these stresses are physical and some are mental. Each stressor must be dealt with to avoid compounding others. Managing stress is important in any part of life, but here the consequences of mismanagement can have more profound and immediate consequences.

During the hours after the in-flight event, the crew will experience many emotions and feelings. It is important to have an understanding of these and how to address them. Assume that reality will establish itself in the harshest manner possible. Conditions of cold or heat, jungle damp or desert dry, pain of injury, and discomfort of deprivation all add to the severity of the situation. These can attack and disable our most important asset—our clear thinking and logical mind-set. One of the most debilitating attitudes that the survivor can experience is one of futility and resignation, the feeling that all hope is lost. Remember the preliminary discussions, preparations, and drills that you and your colleagues participated in prior to the event. These are the thoughts that will ensure your survival and best possible outcome. You will survive.

Resources

Each survival situation will present itself with different resources, needs, and goals. There are, however, certain necessities that should be considered as priority items. Prioritization of these items will vary with each personal survival philosophy. A consensus of survivors reflects the following items in order of priority:

- **Water**

  Though it varies from person to person, the human body can be sustained for weeks without food. Without water one can only survive about 3 to 5 days, depending on the weather, climatic conditions, and injuries. Dehydration is as debilitating as it is deadly. Initial symptoms include profound headache and irritability. This can compound an already emotionally stressed situation and have a deleterious effect on rational decision-making. Realizing that the mind is the most important tool of survival, this aspect alone would make it essential that water be secured immediately. The average person needs about two quarts of water per day just to survive. If there is an increase in work, ambient heat, or other factors associated with energy use, the need increases to as much as two quarts or more per hour.

  There are many ways to secure water. Where there is plant life, water exists. Though there may not be a sparkling stream of pure water nearby, moisture is there. The core of a desert cactus will contain enough moisture to sustain a crew. A solar still can be constructed using a plastic bag, a pit, and leafy vegetation. Through the construction of a solar still, harvested vegetation can yield up to two quarts of drinkable water per day, per still. All reputable survival schools teach methods of retrieving water because it is such an important element in the survival process. Regardless of its source, all water should be purified by some means. Water purification tablets should be an integral part of any personal survival kit. Running water such as found in a stream should be selected over standing water. This reduces the potential amount of organisms present in the source. Drinking urine or salt water should be avoided. The amount of fluid lost through the body's reaction to this source of water offsets any hydration afforded by this practice.

- **Fire**

Fire is perhaps the most diverse resource available to the stranded flight crew, providing more uses than any other element. It provides warmth, light, and a means to purify water and a way to cook food. At night the light from a well-maintained fire can be a signal beacon seen for miles depending on the terrain and visibility. The smoke also works well for daytime signaling. Even in short term situations, fire provides a measure of comfort and security that no other resource can.

Fire building is simple but should be practiced before the event to reduce frustration and stress. There are many styles and methods of fire building. The experienced survivalist will be capable of performing the task in a number of ways and under varied circumstances. The survival kit should carry several types of fire starting tools. Safe fire practices should be observed when performing the task of fire starting.

- **Shelter**

If crash survivors expect that more than 24 hours may pass before any rescue efforts, a base camp must be established. Statistically, it is better to remain in proximity to the crash site for a more expedient rescue. The shelter site should be far enough away from the wreckage so as not to remind crew members of any dismal aspects of their situation and to ensure safety of crew in the event of a fire or other complication at the wreckage. But the site should be close enough to be seen by SAR crews finding the crash. Avoid selecting exposed open areas for the shelter site. This will help reduce the effects of the weather on the crew. The choice should also be based on location of water source and evidence of wildlife activity. The crew should avoid a process of “natural selection”, which may put the team in competition with wildlife for shelter or food. For instance, evidence of rooting of wild pigs should cause the survivor to seek another camp site. In the most extreme circumstances, failure to consider evidence of wildlife activity could also place the crew in danger of being targeted as prey by larger carnivorous animals inhabiting the area. Often shelter may be provided by natural formations such as bent trees, or even rock overhangs or caverns.

A constructed shelter can be simple or complex, limited only by the imagination and skill of the builder and the availability of resources. It could be as simple as a single pole lean-to or as elaborate as an elevated multi-room dwelling. Parts of the wreckage may be used to build a shelter, but using the wreckage for shelter is ill advised and should be a last resort. The psychological ramifications, coupled with the potential instability of the wreckage, make it a poor choice for shelter.

- **Food**

Though a person can last many days without food, food deprivation is not a recommended course of action. Food, while not the top priority, is of great value when maintaining comfort and strength and reducing stress. Maintaining a stable blood glucose level by even minimal intake can enhance the survivor's ability to remain clear-minded and logical.

Volumes have been written on what is edible and what is not. Diets of birds, lizards, rodents, and insects seem repulsive to some. These food sources are rich in protein and have been known to sustain stranded victims for months. In order to provide this source of food, the survivor must secure and prepare the food for consumption. Animal habitat knowledge, skill in hunting and trapping, and patience all go a long way toward creating a successful meal for the crew.

Plants too can provide much needed nourishment. Though providing less nourishment and requiring greater quantities as a foodstuff, plants are very abundant, require less skill and effort to obtain, and are easier to prepare than animals. We can look to other cultures and indigenous peoples for guidance on what is edible in particular localities. A study of literature on this subject or a related class can also be beneficial in preparing for a survival situation.

Some foodstuffs should be contained in any survival kit. Hard candy or commercially available energy supplements will provide a much-needed energy boost to bridge the time until food can be procured or rescue attained. Resources should be consumed conservatively to accommodate physical activity and consideration for other crew members' needs. Some war time and private sector crash survivors have offered the following practical advice: "Always have lemon drops, they provide sugar and energy, ease your thirst, and give you something pleasant to contemplate while you are gathering your thoughts and planning your next actions."

- **Signaling and Being Seen**

Stay near the crash site! Most SAR specialists and survivalists agree that unless there is an urgent need to move or you are sure that help is near, staying in the vicinity of the crash site is best. Flight following procedures should give the search crews a general idea of the location of the crash. This will lead them to that area first. The disruption of the natural landscape by a crash event is usually noticeable from the air. It is very disheartening to SAR crews to arrive at a crash site after an extensive search and trek into the brush only to find no one remaining at the site. Obviously, if the conditions in proximity to the crash site create an increased risk to the crew, then they should relocate. If there is a reasonable belief that safety or rescue can be attained a short distance away, then this too should be considered. This is viable only if the crew is capable of travel and reasonably sure that they can attain their objective.

Fire is one of the best methods for maintaining a sustained signal. In addition to providing all of the previously mentioned attributes, the light and smoke of fire can be seen for a considerable distance. The fire should be maintained with due care to prevent any safety hazards and to ensure that it remains burning. Fuel for the fire should be maintained close at hand. Green leafy branches can be added to the fire to increase smoke when a search plane is heard or seen. At night, pine branches will briefly increase fire intensity to enhance visibility of the signal. Regardless of the style of fire making or pit employed, safety must be the most important consideration.

Hand-held flare and smoke signaling devices are of some value and should be considered for the survival kit. Smoke generating devices should emit a strong plume of smoke for no less than 4 minutes in order to be even minimally effective. Flares should be aerial and attain a height of 400 feet burn for at least 6 seconds.

Clothing worn by crew members can afford high visibility if it contrasts with the surrounding environment. Exaggerated movements in a cleared area will afford the crew maximum visibility.

Reflective materials can be used to alert any aircraft flying overhead. Panels specifically designed for aircraft signaling are commercially available, but there is a lot to be said for ingenuity and the use of other aircraft parts, medical supplies or linens, instead of dedicated signaling panels. Other signaling devices include mirrors, strobe lights, hand-held flashlights, and chemical lights. These are effective to varying degrees. What works well in one environment may be ill suited for another. When correctly used and under the proper conditions, the signal from a mirror can be seen by an aircraft as far as 25 miles away. Strobes offer a significant signature in a darkened environment but have limited usefulness in daylight. Hand-held flashlights fall under the same restrictions and must be manipulated to afford maximum visibility.

Snow or sand writing can be seen readily by crews passing directly overhead but may prove ineffective in certain situations. However, this technique can be an effective means for communicating the direction of travel that a crew has taken. Arranging stones and other debris can provide the same results.

Trained search crews and planes receiving a signal should acknowledge by dipping their wings repeatedly. Seeing this signal should cause the crew to stop any travel and await ground rescue crews or other evacuation.

- **Navigation, Topography, and Geography**

Though travel may be considered a last resort and somewhat risky, crew members should have a working knowledge of navigational techniques. In extreme situations, reconnaissance, forays for food, water, and other needs as well as search for suitable sites for encampment may necessitate extended travel. Maintaining orientation is essential in these instances. Getting separated from your crew can make a bad situation worse.

There are several things that crew members can do to enhance their ability to navigate. Though hand-held GPS units are inexpensive and accurate, the use of a compass and knowledge of map reading and navigation are still essential to effectively orient oneself in any travel situation during the survival event. Knowledge of natural navigation techniques will also enhance one’s ability at orienteering.

Furthermore, when possible, you should maintain a position orientation when flying, keeping track of local geography, landmarks, and location of roads and towns. It is important to know where you are at all times.

SUMMARY

The environment, including weather, climate and geographic conditions, can impact greatly on the day-to-day functioning of an air medical program. Pre- and post-crash, these factors become even more important and may facilitate the survival or complicate the rescue of the downed aircraft and crew. Understanding the safety concerns of the flight environment, knowing the topographic and climatic specifics of the response area, and having confidence in the flight crew capabilities will optimize even the most harsh and challenging crash event. However, no amount of reading about survival skills can equal the learning from a survival situation. Short of the harshness of a crash or similar event, nothing can better prepare crew members to survive a crash in any given environment than attending a formal survival course or survival experience. Such endeavors can teach participants much about themselves, their strengths, limitations, abilities, and personalities. Such an experience could well mean the difference between surviving an event or succumbing to the situation.

A. **Bibliography**:

US Army Survival Manual, FM21-76, Dorset Press, Headquarters, Department of the Army, 1994.

Air Crew Survival, AF Pamphlet 64-5, Department of the Air Force, 1985.

Outdoor Survival Skills, by Larry Dean Olsen, Chicago Review Press, 1990.

B. **Definitions of Keywords**:

Topography—Relief features of a land area as often seen on a map

Emergency Locator Transmitter—FAA-required transmitter activated by an impact of greater than 4 G, which emanates a pulsating signal on the emergency frequencies

Helicopter Emergency Egress Device (HEED)—Miniature SCUBA that integrates all the components of SCUBA gear (compressed air tank and regulator) into a single small device that will fit into a large vest pocket or holder. Depending upon the design selected, it will give the user up to 48 breaths of air.

Pitch—Headlong fall or slope, either up or down; characteristic movement of a missile or aircraft

Yaw—The twisting motion of a missile or aircraft on its center of gravity and in a flat plan

Emergency Personnel Indicator Radio Beacon (EPIRB)—Similar in function to the ELT, but in a compact, handheld size that fits in a vest pocket and often has a waterproof case

C. **Test Questions**:

1. After the impact of an aircraft crash, a/an _______ will help the crew escape the wreckage.

    a. Compass
    b. Pre-planned reference point
    c. HEED
    d. Pilot

2. Crew members must not exit a crashed aircraft until_______

    a. All violent motion has ceased
    b. The pilot instructs them
    c. It is on the ground
    d. Fire is out

3. The patient should be rescued before any crew member in a crash.

    a. True
    b. False

4. Which list shows the order of priority for survival resources?

    a. Food, shelter, fire, water
    b. Water, shelter, food, fire
    c. Water, fire, shelter, food
    d. Food, water, fire, shelter

5. The crew should never leave the site of the crash

    a. True
    b. False

D. **Didactic Hours**: 4

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Aircraft egress
- Situation assessment
- Resource evaluation
- Resource procurement
- Fire building
- Shelter construction
- Navigation
- Problem solving

F. **Patient Care Hours**: N/A

CHAPTER 4: SYSTEM DEVELOPMENT

Module 10: Mass Casualties/Search and Rescue

Module 11: Communications Systems and Technology

Module 12: Ethical and Legal Issues

Module 13: Quality Assurance and Utilization Review

MODULE 10: MASS CASUALTIES/SEARCH AND RESCUE

Author: Dr. Debra Perina, University of Virginia, Pegasus Flight Operations, Charlottesville, VA

Reviewer: Mr. Steve Trammel, RN, Lifeguard, Emergency Service, University of New Mexico Hospital, Albuquerque, NM

KEYWORDS

Mass casualty incident (MCI)
Large emergency response
Incident commander (IC)
Staging area
Triage area
Treatment area
Transportation officer
START
Jump tracking
Circular sweep
Grid search

OBJECTIVES

Upon completion of this module, the student should be able to:

- Describe the provider roles within a Mass Casualty Incident (MCI) response
- List common MCI sectors and outline their functions
- Identify 5 functions that can be fulfilled by the air medical crew during an MCI
- Discuss a plan of operations for a search and rescue mission
- List the factors used to determine the urgency of response for a search and rescue mission

INTRODUCTION

All air medical programs should be an integral part of the local or regional disaster or emergency response team and function within the guidelines of mutual aid agreements. There are numerous roles that the flight program and the flight crew can perform within the scope of a MCI or search and rescue mission. The role of aircraft-based EMS personnel differs from that of their ground EMS colleagues, in that the transport response times can be significantly shortened, the medical cabin and environment have more restrictions due to altitude and safety concerns, and the presence of an aircraft on the scene can be a complicating factor if ground personnel and first responders are not adequately trained in operations in and around an aircraft. Most important, the air medical program should always be a contributing member in all disaster planning discussions that might involve patient evacuation. An extension of this participation is the responsibility of the air medical program to provide education to other disaster management personnel in the use and operation of an aircraft.

MASS CASUALTY INCIDENTS (MCI)

To function effectively, it is critical that all air medical crew have a working understanding of the components of an organized MCI disaster response. A mass casualty scene is frequently chaotic with many different personnel and organizations represented. It is essential that air medical crew understand the principles of response, the roles of various organizations at the scene, and the role of the helicopter and air medical crew.

Provider Roles

- It is customary that local fire department personnel take responsibility for overall scene incident command, any fire and hazard suppression, and any search and rescue duties.
- Law enforcement personnel are responsible for securing the perimeter of the incident, assuring the safety of the individuals on-scene, and any related investigational activities.
- EMS, both ground and air personnel, are responsible for the triage, treatment, and transportation of victims from the scene.

Sector Responsibilities

Disaster response includes creating specific areas/sectors near the incident to adequately evacuate and care for victims. Each area should have a designated “sector officer” that oversees activities in that area. All officers coordinate with, and answer to, the Incident Commander (IC). Most sector officers are EMS providers, since they possess the background and knowledge of fire, EMS, and hazardous materials response. All units, including helicopter or flight services, report to the IC initially for their assignment. The most typically assigned areas of responsibility include:

- **Triage Sector**

  This is the area where decisions regarding extrication, distribution of resources, and identification of patient severity initially occur.

- **Treatment Sector**

  This area is responsible for assessing all victims, treating life-threatening injuries and making a determination as to required treatment and transport.

- **Transportation Sector**

  This sector is responsible for the actual transportation arrangements made for each victim. All communications with receiving facilities are also handled by this sector officer.

- **Staging Sector**

  When multiple EMS vehicles are required to transport the volume of victims involved in the MCI, ground vehicles and aircraft are grouped or “staged” at designated locations that will allow for quick response when they are requested by the transportation sector officer.

- **Supply Sector**

  Especially during a large-scale event, large quantities of equipment and supplies are required. Equipment and supplies on-board individual ground units and aircraft are adequate to handle en route treatment of 1–2 patients, but it is often necessary to collect back-up supplies and equipment from multiple agencies and facilities to address the on-scene needs. Procurement and assembly of these resources is the responsibility of the supply sector.

- **Communications Sector**

  This function is closely tied to the activities of the IC. Maintaining radio communication between sector officers and IC is imperative, but can be hindered by too much information, too many providers with radios transmitting unnecessary frequencies, the use of codes that might not be understood by all providers, and unauthorized use of the chosen frequency by media and other non-vital entities. Other necessary communications with hospitals or agencies may need to be conducted on another designated channel to decrease the confusion between the sector officers and IC.

Air medical Responsibilities

The helicopter and air medical crew can fulfill several functions within large emergency response scenes or mass casualty incidents.

- **Patient Transport**

  The rapid transport of critical patients to a trauma center is the primary mission of the air medical program within an MCI. The advantages of this mode of transportation are the short en route times, the expanded skill of the flight crew and the short turn-around times for the aircraft and returning resources.

- **Transport of Resources**

  A flight program can accomplish transport of medical supplies and specialized equipment to the scene quickly and efficiently. A helicopter can fly to multiple agencies or facilities, collect equipment and supplies, and return to the scene in a much shorter time than a ground unit can drive.

- **Transport of Personnel**

  In the event of multiple critical or severe injuries at one scene, hospital personnel such as emergency department physicians and nurses may be requested to assist in the field. A helicopter is extremely helpful in facilitating the transport of these individuals, especially when the scene is remote or difficult to access.

- **Search and Rescue**

  When adequate search and rescue vehicles are not available, private sector air-ambulance services may be called in to assist the local law enforcement, public safety, and/or military services. Unless an aircraft and crew are trained in search and rescue as part of their primary mission and scope of practice, the flight crew must take on a support role and allow direction to come from the aircraft commander in charge of the search operation.

- **Scene Surveillance**

  An air medical crew and pilot may also be requested to assist in scene surveillance, especially if the scope and distribution of the incident has not been identified of mapped.

- **Other Duties**

  On occasion and depending on the availability of manpower, the air medical crew may be asked to assist at a MCI in other ways. Treatment and triage of victims still on-scene may be quite an appropriate task for the air medical personnel. Another role may be the inter-facility transport of patients late in the incident response phase.

Communications

Communication is the single biggest problem in large-scale emergency or disaster response. Effective communication is absolutely essential between the sector officers and IC. A single IC must be identified by the first responding units and changed only when higher ranking officers or personnel arrive on-scene to assume command. The flight crew must follow established regional or local disaster response guidelines to ensure safe operations in and around the aircraft. Ground-to-air communications must be clear, concise, and timely. Information that is misunderstood, too lengthy, or delivered too late may cause a delay in resources, hinder patient care, or impact scene and personnel safety.

Aircraft must not land unless radio communications are established with the transportation officer. Each participating aircraft must establish this communication so that the sector officer has an accurate understanding of the number of available aircraft and the skill levels of the responding personnel. To accomplish this, all radios should be on the same frequency as IC and sector officers.

START TRIAGE SYSTEM

Triage of patients involved in large-scale emergency responses is accomplished somewhat differently than triage performed at smaller crash or incident sites. Under normal operations, triage results in the sickest patients being cared for first. In large emergency operations, this concept changes to “do the greatest good for the greatest number”. In these MCI responses, only minimal intervention is done and resources are not expended on moribund patients. One approach to large-scale incidents is to use the START system. START refers to Simple Triage and Rapid Transport. The START system focuses on three areas: respiration, circulation and mental status. This simplified approach is helpful to expedite the assessment, treatment, and transport of the most viable patients at the scene.

AIR MEDICAL ROLE IN SEARCH AND RESCUE

Search and rescue is generally conducted by law enforcement, public safety, or military helicopter services. Most air medical programs do not offer this service as part of their primary mission or scope of practice, although some programs do assist when requested. Helicopters can be very valuable in search and rescue operations because of their maneuverability, low altitude flight capabilities, and ability to quickly access remote areas. In some cases, a helicopter may also be used as an airborne command center, especially if the terrain and other obstacles hinder radio communication.

Plan of Operations

When an air medical program is called upon to participate in search and rescue missions, there must be a thorough understanding of the operational plan and its various components. It is potentially dangerous for an inexperienced flight program to engage in search and rescue activities if crew members have not been thoroughly briefed on the area specific plan.

Prior to the actual search, an organizational plan must be developed by the participating agencies. The plan should include identification of an IC, identification of sectors, designation of responsibilities, delegation of authority to the sector officers, and establishment of a communications network. These efforts are usually coordinated by the law enforcement or public safety agency most familiar with the area. The highest-ranking officer for this lead agency usually functions as the IC. Depending on the nature and scope of the anticipated search and rescue operation, it must be determined whether or not aircraft services will be required. Only services that have guidelines or policies in place for their support role in search and rescue activities should be called upon to participate.

A mobilization plan should be discussed and implemented outlining the anticipated equipment and staffing needs, the pre-assigned tasks for each agency or service, and the reporting procedures that will be utilized to keep the IC appraised of all activities. Once the plan has been outlined, a debriefing must be held for all participating agencies, response teams, and air medical providers.

Conducting the Search

Before a search and rescue mission can be initiated, the urgency of the response needed must be established. The response can be an incremental one where search investigators make a cursory search to clarify the situation, or a full emergency response if a life-threatening event is suspected. Factors used to grade response urgency include existing and predicted weather conditions, victim's age and medical condition, interviews with family and witnesses, and terrain or area hazards.

- **Search Logistics**

  Several items must be considered when planning the logistics of conducting a search and rescue mission. The factors that determine urgency of response guide the search priorities, whereas logistical factors determine the actual activities to be carried out. As in all EMS responses, frequent and succinct communications are very important. The logistics of radio availability, accessible frequencies, and personnel experienced in the use of communications equipment must be considered early in the operational plan. Available lighting from natural sources, floodlights or aerial spotlights must be assessed. A participating air medical program may be able to assist in providing additional search lighting if the helicopter is equipped with high wattage searchlights. Many EMS personnel are experienced in special procedures or rescue operations. It is important for the IC to know these qualifications in order to maximize the personnel and capabilities on scene and to match the provider groups with the job or function with which they are most experienced. Special skills may include, but are not limited to, communications, topographic map reading, search techniques, canine-assist teams, or critical incidence debriefing. Although it is rare to re-assign air medical personnel to another function during a search and rescue operation, individual team members may have specialized skills that are vital to the search and rescue mission. Examples might include long-line, confined-space, or swift-water rescue. The IC and preferably the flight program medical director or administrator on-call should communicate directly about such assignments, identifying any scope of practice or jurisdiction concerns. A briefing should be conducted to update all search and rescue personnel of the operational and mobilization plans, including the resources on-scene, back-up personnel, and the logistics of carrying out the search and eventual rescue.

- **Search Patterns**

Several types of search patterns are utilized during search and rescue missions.

Jump Tracking—When tracks identified as belonging to the victim are located and a direction of travel established, the estimated course is usually plotted on a topographical map. Helicopters are ideally suited to follow tracks and transport jump trackers to the scene where they can follow the projected track.

Circular Sweep—This type of search begins at the victim's last known position and is conducted in a 360-degree sweep until tracks or other evidence is found.

Grid Search—If the victim's tracks seem to wander without apparent direction or no evidence or tracks have been found, search teams are assigned to each grid outlined on a topographic map. This provides for a systematic and detailed search.

- **Search Enhancement**

Air medical crews may wish to be familiar with the operation of several search enhancement devices that can be used to supplement the mission.

Night Vision Goggles/Scope—These devices can allow personnel to see clearly at night or in low-level lighting conditions such as twilight. They can be extremely useful in spotting victims in an aerial search under these conditions. Some air medical programs may also use these devices as a matter of routine policy for night missions, since safety is enhanced if the pilot's night vision is protected and enhanced. If these devices are to be employed under search and rescue conditions by the air medical crew, familiarity with their use before hand is essential.

Infrared Heat Detecting Devices—These specialized devices allow for detection of body heat. They can be a great value in an aerial search to identify the location of a victim, particularly at night or under conditions where visibility might be restricted by conditions like a thick forest canopy. These devices should be employed only by individuals skilled in their use.

SUMMARY

The MCI and search and rescue roles of an air medical program and helicopter crew may vary greatly from locality to locality. For many law enforcement, public safety and military operations, search and rescue is a part of their primary mission and scope of practice. For most air medical programs, however, search and rescue is provided as a support service to other agencies and rescue operations. Helicopters are able to expedite incidence response and search activities because of their ability to reach remote and inaccessible areas quickly. Scene surveillance can be conducted over large areas to determine scope of the incident, and need for additional personnel and equipment. The helicopter's speed and agility enable personnel to be airlifted closer to the incident site, allow for quicker access to resources, and facilitate rapid evacuation of the victim(s). Regardless of the area served, the air medical program should work collaboratively with local and regional disaster management and search and rescue services to identify the ways that an air medical team and rotor-wing aircraft can assist in their missions.

A. **Bibliography**:

Coates J., Wilson AW, Cross, FW, On-scene medical decision making and overtriage, *Br J Surg*, 80, 1993, 1291–1293.

Federal Aviation Administration, Integrating helicopter and tiltrotor assets into disaster relief planning, *Advisory Circular* 00-59, U.S. DOT, Nov 13, 1998.

Fenn, J., Rega, P., Stravos, M., Buderer, N., Assessment of U.S. helicopter emergency medical services' planning and preparedness for disaster response, *Air medical J*, 18, 1999, 12–15.

Fromm, R.E., Training of the air medical flight crew: practical applications, in Blumen I, Rodenberg H, ed. *Air medical Physician Handbook*, Air medical Physician Association, Salt Lake City, 1996, p 1–6.

Gans, L., Kennedy T, Management of unique clinical entities in disaster medicine, *Emerg Clin* of North Am, 14, 1996, 301–26.

Kennedy, K., Aghababian, R.V., Gans, L., Lewis, C.P., Triage: Techniques and applications in decision making, *Ann Emerg Med*, 28, 1996, 136–144.

Martchenke, J., Lynch, T., Pointer, J., Rooker N, Aeromedical helicopter use following the 1989 Loma Prieta earthquake, *Aviat Space Environ Med*, 66, 1995, 359–63.

National Association of EMS Physicians Consensus Document*, Air medical Dispatch: Guidelines for Scene Response*, NAEMSP, Kansas City, MO,

National Association of EMS Physicians Consensus Document, *Criteria for Pre-hospital Air medical Transport: Non-Trauma and Pediatric Considerations*, NAEMSP, Kansas City, MO.

Thomas, S.H., Harrison T, Wedel SK, Thomas DP, Helicopter Emergency Medical Service Roles in Disaster Operations, *Pre-hosp Emerg Care*, Vol 4, No 4, Oct–Nov 2000, p 338–344.

B. **Definitions of Keywords**:

MCI—Any emergency response that exceeds the ability of the usual emergency response agency to handle alone

Large emergency response—Any emergency response that requires multiple agencies.

Incident commander (IC)—The individual in charge of coordinating the entire MCI response. Usually this is the fire chief, or senior fire or EMS provider

Staging area—The location near the MCI where equipment is taken and assembled prior to deployment to the scene at request of the IC

Triage area—The area where MCI victims are taken after evacuation from the site of the incident. Primary function of this area is to triage and tag victims according to treatment priority. Generally this is very close to the actual site. Little or no treatment takes place in this area beyond very rudimentary ABC's.

Treatment area—The area where victims are taken once they have been triaged. Some limited treatment and stabilization occur here prior to transport. Patients are then transported according to priority of triage tags. For a small scale MCI, patients may be transported immediately after being triaged.

Transportation officer—The individual responsible for coordinating triaged patients and transport modes, as well as for releasing vehicles from the scene and requesting additional vehicles

START—A method of triage based on assessment of respirations, circulation, and mental status; mnemonic stands for **S**imple **T**riage **A**nd **R**apid **T**ransport

Jump tracking—A method of tracking that establishes the direction of travel, based on the pattern of tracks identified as belonging to the victim. Usually this course is plotted on a topographical map. Helicopters are ideal to follow tracks and transport jump trackers to the scene, where they can follow the projected track or direction of travel.

Circular sweep—A method of search that begins at the victim's last known position. The search is conducted in a 360-degree sweep until tracks or other evidence is found

Grid search—A method of search utilized if the victim's tracks wander without apparent direction or no evidence or tracks are found. In this type of search, teams are assigned to each grid derived from a topographic map

C. **Test Questions**:

1. The agency most often responsible for scene incident command during an MCI is:

   a. EMS
   b. Law enforcement
   c. Fire
   d. Hospital representatives

2. The type of search most likely to be used if the victim's tracks are identified wandering in no apparent direction is:

   a. Jump tracking
   b. Grid search
   c. Circular sweep
   d. Line-of-sight search

3. Potential roles for helicopter transportation in MCI's are

   a. Rapid patient transport and transport of hospital teams
   b. Inter-hospital transfer of patients and triage teams
   c. Rapid transport of supplies and patient triage
   d. Search and rescue and inter-hospital transport

4. Safe helicopter operations when landing at a MCI include all of the following EXCEPT:

   a. Direct ground-to-air communications
   b. Landing site secured away from immediate incident
   c. Ability to land without direct communications with sector officer
   d. Landing site has been appropriately secured

5. The role of an air medical helicopter and crew during search and rescue includes:

   a. Act as an airborne command platform
   b. Quickly evacuate victims
   c. Conduct rapid searches
   d. All of the above

D. **Didactic Hours**: 3

Presentations on MCI/disaster response, search and rescue concepts, and specific equipment needed for search enhancement and night operations.

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Disaster tagging concepts and color codes
- Communications during MCI / large emergency response
- Difference in field treatment with magnitude of MCI
- Use of night vision equipment
- Understanding of grid search concepts
- Ability to read topographic maps
- Compass reading
- Lat/Long navigation methods for remote areas
- Repelling and operation of safety lines/wench
- Special missions decision making
- Tabletop and simulated MCI drill exercise

F. **Patient Care Hours/Simulated Search and Rescue Drill**: 4

This may be done in conjunction with an MCI drill if desired. Participants should actually locate and rescue a pre-placed “victim” by utilizing appropriate procedures and equipment. Initial training should combine classroom and simulated search and rescue. It is recommended that the exercise take place at least partially at night to allow for use of night vision equipment. Recurrent training of this type of exercise should be repeated at least yearly.

MODULE 11: COMMUNICATIONS SYSTEMS AND TECHNOLOGY

Author: Mr. Robert Broome, RMH-LifeCom, Omaha, NE

Reviewer: Ms. Shelly Sholl, RN, Northwest Med Star, Spokane, WA

KEYWORDS

Communications system
Dispatch
NAACS
Amplitude Modulation Frequency Modulation Wavelength
Simplex
Duplex
CTCSS
Transmitter
Repeater
Trunked

OBJECTIVES

Upon completion of this module, the student should be able to:

- List at least 3 duties of the communications specialist
- Discuss the primary regulatory agencies involved in air medical communications
- Describe the communications equipment used by a typical air medical program
- Demonstrate proper technique in using a hand-held radio
- Discuss the importance of critical decision-making in air medical communications

INTRODUCTION

Excellent communications is the key to a successful air medical program. Although the communications systems and standard operating procedures vary from program to program, there are a few key concepts that should be universal to all professional air medical services.

First and foremost, having a staff of well-trained and conscientious communications specialists is imperative. Second, radio communications equipment must be current and compatible with the larger EMS dispatch services in the response area. Third, Federal and state guidelines for the use of various communications technologies must be reviewed and followed. Also, there should be collaboration between the various flight services, with aircraft and crew safety being the top priority.

COMMUNICATION SPECIALISTS

Overview

Communications specialists are an important part of the flight program. Their knowledge, organizational capabilities, and public relation skills can affect the safety, efficiency, and reputation of the program. The many roles and responsibilities of communication specialists range from community interface to navigation assistance to aiding in search and rescue efforts.

Job Title

Since there is an FAA-defined job description termed “dispatcher,” this term will not be used for the role described here. There are many terms used across the country to describe this role, including flight coordinator, communicator, communications technician, and communications specialist.

Performance Standards

As in the medical profession, performance standards for the communications specialist should be well defined by the program’s policies, and assessed by a well defined, competency based evaluation. These standards should translate into practical roles and responsibilities. The standards should include, but are not limited to:

- Able to multitask, make reasonable decisions, and to think quickly
- Able to implement decisions based on the program policies, guidelines, and values
- Timely and efficient during call taking and reporting of information to pilots and medical crew members
- Familiar with program specific tools: local and regional maps, hospital levels of care, local trauma triage protocols and plans, physician and medical specialty directories, LZ reference books, etc.
- Competent in use of a Computer Aided Dispatch (CAD) program if required by the flight service
- Familiar with program policies, procedures and guidelines
- Able to use data base management systems, as required by the flight service
- Area-specific knowledge of landmarks, hospital capabilities and locations, and the role of the flight program in local disaster response
- Serves as a liaison between agencies involved in the transport

- Is customer-service oriented, displays confidence, and understands of the customer's needs and requirements
- Performs other functions as indicated by the program management
- Complies with the standards of practice and training put forth by the National Association of Communications Specialist (NAACS)

Duties and Responsibilities

The communications specialist is responsible for many areas of communications and safety. The following duties relate to the areas of primary responsibility.

- **Flight Following**

  The most critical role of the communication specialist is tracking and documenting an aircraft's location. This is referred to as flight following. Documentation can be done in a database, in a log, or marking the position on a map.

  The position report can be given in a number of ways:

  - By latitude and longitude
  - By reference to a distance and radial from a VOR
  - By reference to a landmark on the ground

  In addition to the location, the groundspeed of the aircraft and its fuel status may also be recorded.

  The Federal Aviation Regulations, Section 79 of Part 135, outlines service responsibilities for flight following. This Part is as follows:

  - "Sec. 135.79 Flight locating requirements.
    (a) Each certificate holder must have procedures established for locating each flight, for which an FAA flight plan is not filed, that—
      (1) Provide the certificate holder with at least the information required to be included in a VFR flight plan;
      (2) Provide for timely notification of an FAA facility or search and rescue facility, if an aircraft is overdue or missing; and
      (3) Provide the certificate holder with the location, date, and estimated time for reestablishing radio or telephone communications, if the flight will operate in an area where communications cannot be maintained.

(b) Flight locating information shall be retained at the certificate holder's principal place of business, or at other places designated by the certificate holder in the flight locating procedures, until the completion of the flight.

(c) Each certificate holder shall furnish the representative of the Administrator assigned to it with a copy of its flight locating procedures and any changes or additions, unless those procedures are included in a manual required under this part."

In addition, the CAMTS specifies a 15-minute flight following interval.

- **Search and Rescue or Mass Casualty Incidents**

  Some flight programs perform a role in search and rescue in their community. Other programs do not perform these duties, but rather leave them to state or municipal services. For programs that do perform these missions, it is important that the communications specialist be familiar with the expectations and limitations of their program's involvement. Involvement by the communications center in the planning stages of these multiagency events will lead to smoother, more efficient rescue efforts.

- **Pre-Accident/Incident Plan (PAIP)**

  One of the most important duties of the communications specialist is in assisting in the coordination of the Pre-Accident/Incident Plan (PAIP).

  The PAIP establishes procedures to be followed by the communications specialist and administrative personnel in the event of an overdue aircraft, aircraft incident, accident, or other unexpected event.

  Some of the possible reasons for activation include:

  - Missing or overdue aircraft
  - Mayday report
  - FAA-defined incident or accident
  - Injury of support personnel

  In addition to providing assistance in locating a missing or overdue aircraft, the communications center can provide a central point of coordination in cases of a major incident.

Response plan drills should be conducted on a regular basis. All agencies and personnel should be advised that the incident is simulated and under no circumstances should anyone be left to believe that there is an actual emergency.

The central coordinating agency for all searches in the U.S. is Scott Air Force Base. The base will coordinate with local agencies to identify the location of a missing aircraft.

- **Interface with Outside Agencies and Personnel**

The communications specialist serves as a liaison between agencies involved in a transport. These agencies can include hospitals, public service dispatch centers, other air transport services, and ground transport services.

Upon the initial receipt of a request for service, the communications specialist should obtain the basic information required for the pilot to make a determination as to whether flight is possible or not. This information may include:

- Call-back number
- Referring agency
- Receiving agency
- Patient weight

The communications specialist will then:

- Select and confirm availability of the appropriate aircraft and team
- Alert the flight team

Then, if the pilot accepts the request, additional information may be obtained. This additional information may include:

- Patient condition
- Referring and accepting physician
- Patient location within referring facility
- Special equipment required (balloon pump, incubator, etc.)

The medical report should be complete but concise. It should contain information that will be relevant to the caregiver. For maximum standardization, a consistent report format should be used. See Exhibit 11-1 at the end of this module for a sample format.

Additionally, the communications specialist may be asked to perform a phone/radio or phone/phone patch between the medical caregiver and the accepting physician or emergency department in order to establish medical control. If at all possible, this line should be recorded. The communications specialist should avoid relaying medication or treatment orders.

After the patient is picked up from the scene or referring agency, a report may be relayed from the medical flight crew to the accepting facility. This report should be brief, and should comply with program standards.

- **Crew Communications**

  The communications specialist must relay information in an effective manner to the flight crew. This information may include:

  - Initial flight request
  - Patient report or condition update
  - Location of the scene or patient location within the referring facility
  - Scene description and security information
  - Frequency information
  - Weather update

  Since the flight crew's ability to communicate with outside agencies or facilities may be limited, the communications specialist becomes the conduit by which these communications are facilitated.

Safety and Quality Assurance

After every flight, there should be a debriefing between the pilot, medical crew, and communication specialist. This allows everyone involved in the flight to discuss what went well, and to determine areas that require improvement.

Since the communications center should be an integral part of the safety program, they should provide a representative to the safety committee. The communications center should also be included in the overall quality assurance program, insuring that communications issues are addressed in a timely and objective manner.

Education and Outreach

Communications specialists should be included in any educational opportunities that arise. While most communications centers do provide discipline-specific continuing education, there are usually many offerings for medical personnel that could also benefit the communication specialist. The more knowledgeable they are about the medical and aviation fields, the greater the contribution they can make.

A formalized continuing education program can serve to raise the level of knowledge, and thus professionalism, of the communications specialist. A minimum number of hours and a specified list of topics are two important components of this program.

Communication specialists should be included in any outreach events offered by the flight program. Their knowledge of communications systems, provider agencies, and hospital resources is a very valuable addition to outreach efforts and can serve to strengthen the bond between the requesting agency and the flight program.

REGULATORY AGENCIES

Several regulatory bodies influence the air medical communications center. These bodies and their importance to the industry are described here.

The Federal Communications Commission (FCC)

The FCC was established by the Communications Act of 1934 as an independent United States government agency, directly responsible to Congress. The Act, which has been amended over the years, charges the Commission with establishing policies to govern interstate and international communications by television, radio, wire, satellite, and cable.

The FCC is responsible for allocating frequency bands for specific uses. These are described in Title 47, chapter I, part 2 of the Code of Federal Regulations. The relevant frequency bands are discussed later in this module.

The National Association of Air medical Communication Specialists (NAACS)

NAACS is a professional organization representing communications personnel and serving as a liaison to other air medical and aviation organizations. Its mission is to provide representation for the air medical communications specialists on a national level, and to enhance the professionalism of the air medical communications specialists through education, recognition, and standardization. The organization also provides training material for the initial training of communications personnel.

A proposed professional certification for communications specialists, would provide a set of expectations that a flight program can rely on and serve to further enhance the professional image of the Communications Specialist

The Commission on Accreditation of Medical Transport Systems (CAMTS)

The CAMTS is the accrediting body for air medical transport programs. With respect to communications centers, CAMTS provides detailed standards pertaining to the following areas:

- Equipment
- Training
- Policies
- Coordination
- Fixed-wing
- Flight following
- Communications center

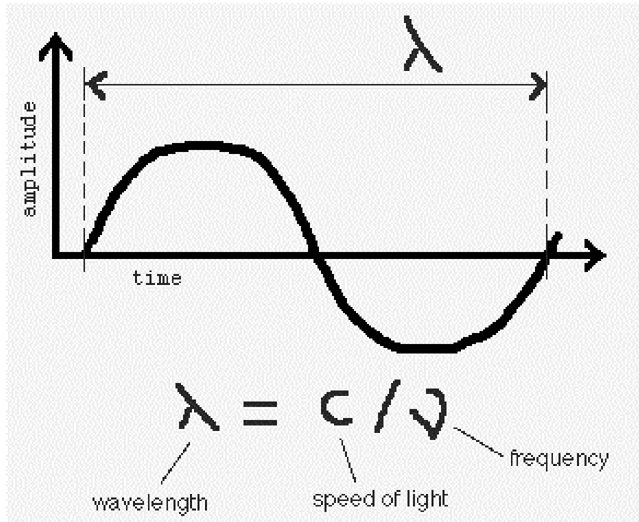
RADIO/COMMUNICATIONS TECHNOLOGIES AND SYSTEMS

Introduction

In addition to a professional Communications Specialist, a flight program must have a reliable communications system and hardware. This section describes the background behind the technology, and discusses various hardware components found in a typical system. This section describes some of the concepts required to understand and implement a communications system.

Frequency and Wavelength

Frequency and wavelength are two concepts used to describe the properties of an electromagnetic wave. Frequency describes the number of times a wave is repeated in a given time frame, while wavelength describes the distance between the peaks of two adjacent waves. This illustration will help to illuminate these ideas:

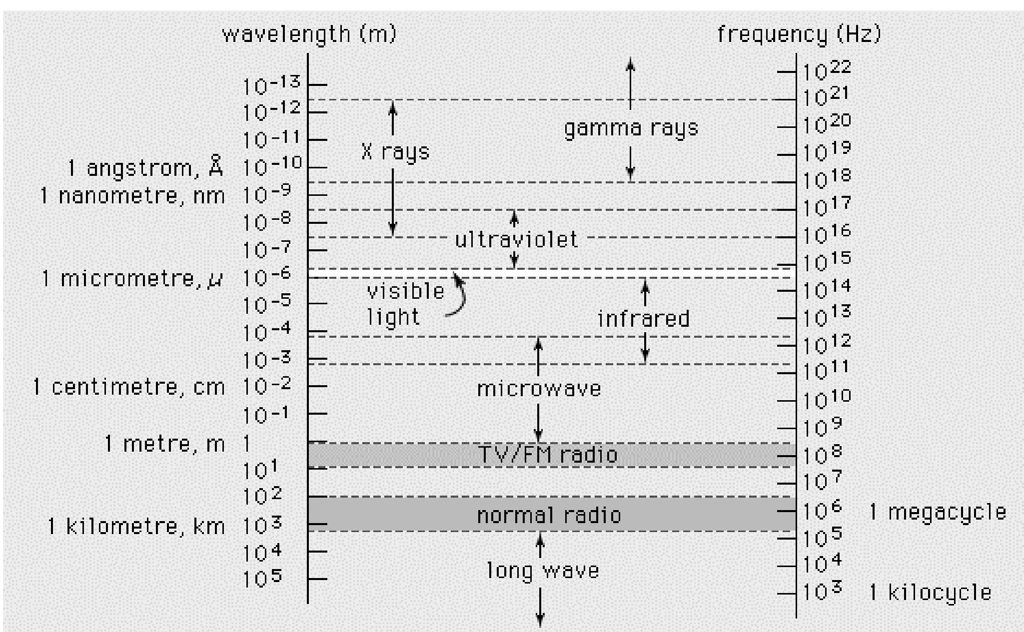


Electromagnetic Spectrum

The electromagnetic spectrum is a term used to describe the collection of bands of radiation. Radiation is simply a stream of photons, each traveling in a wave-like pattern. Some examples include:

- Visible light
- Radio waves
- Microwaves
- X-rays

As can be seen in this diagram, radiation exists along a continuum, with the frequency and wavelength varying as the spectrum is traversed.

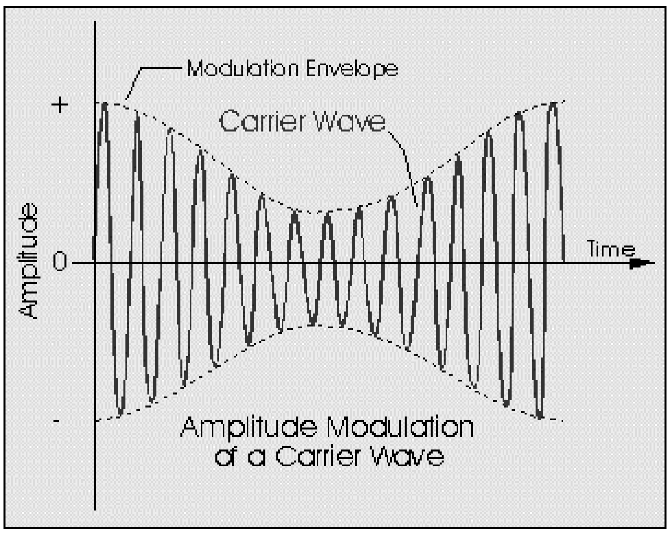


Alteration of the Electromagnetic Spectrum

Information (voice or data) can be transmitted over the electromagnetic spectrum by altering the spectrum in defined ways. There are several ways that this alteration can take place.

- **<u>Amplitude Modulation (AM)</u>**

  In amplitude modulation (AM), information is sent by varying the amplitude of the carrier to match the fluctuations in the signal being transmitted.

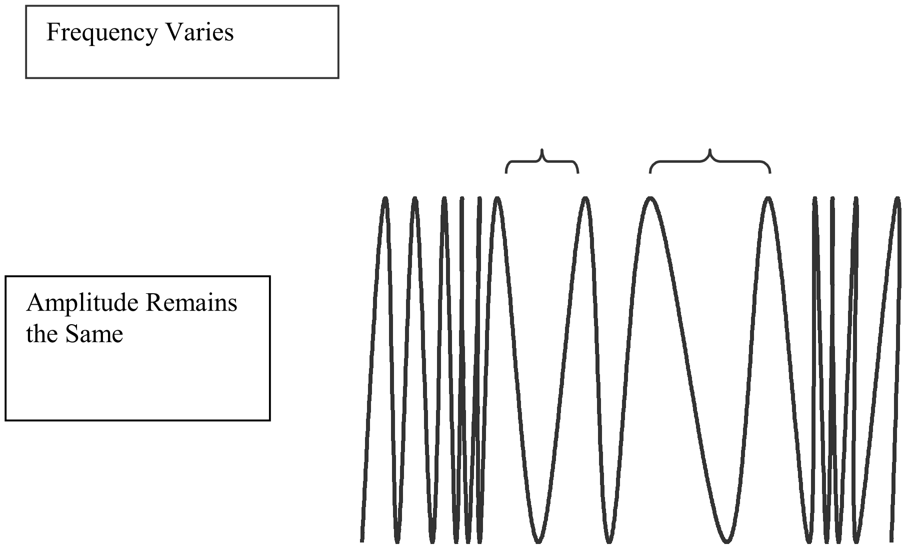


amplitude modulation

- **<u>Frequency Modulation (FM)</u>**

  In frequency modulation (FM), unlike AM, the amplitude of the carrier is kept constant, but its frequency is altered in accordance with variations in the audio signal being sent.

  An advantage of FM is that it yields a higher quality signal, and is less affected by certain kinds of interference. However, in day-to-day operations, AM is of acceptable quality.



- **<u>Megahertz/CPS</u>**

  The frequency of a radio signal is measured in megahertz (MHz), which is essentially the same thing as cycles per second (CPS). Thus a signal that is transmitted at 123 cycles per second is referred to as 123.0 MHz.

- **<u>Frequency Bands</u>**

  The radio frequency portion of the electromagnetic spectrum can be divided into different regions, or “bands.” Different frequency bands are used for different purposes. The Federal Communications Commission assigns bands for use by different entities. Here is a table showing the use of different bands:

Band Number	Frequency Subdivision	Frequency Range
4	VLF (very low frequency)	Below 30 kHz
5	LF (low frequency)	30 to 300 kHz
6	MF (medium frequency)	300 to 3000 kHz
7	HF (high frequency)	3 to 30 MHz
8	VHF (very high frequency)	30 to 300 MHz
9	UHF (ultra high frequency)	300 to 3000 MHz
10	SHF (super high frequency)	3 to 30 GHz
11	EHF (extremely high frequency)	30 to 300 GHz
12	[not named]	300 to 3000 GHz

Different wavelengths possess different characteristics. The longer the wavelength, the longer it will carry, but the more easily it is deflected by obstructions.

For our purposes, here are the most important frequency bands:

- **VHF (AM)—Aviation (118–136 MHz)**

  This wavelength is in the moderate range, which means that it carries fairly well, depending on the terrain.

  This frequency is designated for use only by aircraft. The specific frequency can be changed in the change aircraft. The range of the signal is usually very good since it is used at altitude.

  Since this band is designated by the FCC for aviation use only, there is usually minimal interference from other radio sources.

- **VHF (FM)—Low Band (30–50 MHz)**

  This frequency band has a very long wavelength, which means the signal carries a great distance. The wavelength is several feet long. This causes the signal to be deflected by structures, such as tall buildings, or atmospheric conditions. This band is clear in open terrain, but it can be subject to interference in cities.

- **VHF (FM)—High Band (148–174 MHz)**

  This frequency band is of moderate wavelength, which makes it a good choice for normal communications. Radio transmissions are good in terrain as well as in city locations. The wattage of the transmitter tends to affect the quality of communications in this band.

- **UHF (FM)—Ultra High (450–470 MHz)**

  This frequency band has a very short wavelength, which means the signal is clearer in city locations. The signal is not subject to deflection or interfered with as much as lower band frequencies. This bandwidth has such a short wavelength that all communications are referred to as “line of sight,” which means their frequencies do not carry well over open terrain. Because of this, most frequencies in this range use repeaters to boost the signal, which in turn, allows clear communications over greater distances.

- **Trunked—(800–900 MHZ)**

  Trunking is the automatic sharing of channels in a multiple repeater system. One of the advantages of trunking is that there is less waiting to access the system and an increased channel capacity for a given quality of service. Since the probability of all channels being busy at the same instant is low (especially in larger systems), the chance of being blocked is much less than when only one channel can be accessed.

Trunking concepts can be applied to radio systems because individual subscribers typically use the system only a small percentage of the time, and a large number of users do not use the system simultaneously.

Most trunked systems are designed to incorporate several jurisdictions or agencies. The most common examples are police, fire, EMS and public works departments

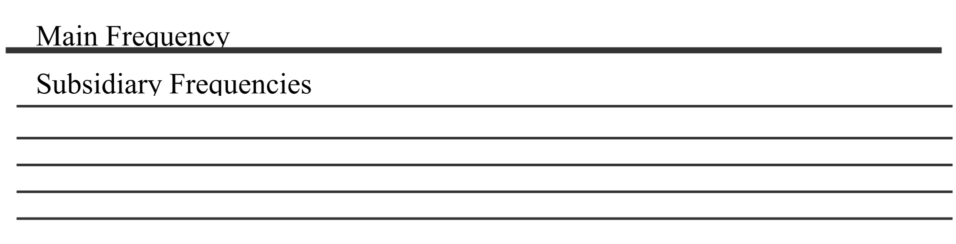
- **<u>Simplex and Duplex Frequencies</u>**

  If two radios use the same frequency to communicate, this is referred to as using a "simplex" frequency. Consider, though, the situation in which there is an obstruction between the two radios.

  In order to communicate with someone on the other side of the obstruction, you could use a "repeater" on top of the obstruction. This repeater takes the signal from one radio and amplifies it and sends it out again. In these setups, a second frequency is used. The radios on each end are programmed to transmit on one frequency and receive on another. This is referred to as a duplex frequency.

- **<u>Tone Codes</u>**

  The number of frequencies available is limited. However, there is a method by which a number of agencies can use the same main frequency. Essentially, there are a number of "auxiliary" frequencies that can be used in conjunction with the main frequency. Each of these auxiliary frequencies can be thought of as a private gate into the main frequency.



There are two advantages to this system. First, as mentioned above, it allows greater use of the limited bandwidth. Additionally, while the main frequency in use by agencies is public knowledge, the private line frequency can be kept confidential.

These auxiliary frequencies also go by the name tone code, or CTCSS (continuous tone-controlled sub-audible squelch) code. These frequencies may be referenced in different manners, depending on the radio that is installed in the aircraft. If a Wolfsburg radio is in use, they may be referenced as Wolfsburg tones. If another type of radio is in use, they may be referred to as "standard" tones or PL tones. Yet another designation is EIA tones. A table translating these designations from one to another should be kept in the communications center.

The fact that a frequency may be duplex and may also utilize a CTCSS code means that there may be up to four "frequencies" that you will need to know in order to communicate with a ground unit:

- The transmit frequency
- The CTCSS code of the transmit frequency
- The receive frequency
- The CTCSS code of the receive frequency

A list of frequencies of each commonly contacted ground unit should be kept in the communications center, and, these frequencies should be pre-programmed into the aircraft's radio.

Communications Equipment

Any communication system is composed of several different pieces of equipment. These are detailed here:

- **Transmitter**

  A transmitter is the piece of equipment that relays the radio signal from a portable, mobile, or base station. This piece of equipment is more accurately termed a "transceiver," since it both transmits and receives signals.

- **Repeater**

  A repeater is a piece of equipment that receives a signal on one frequency and transmits it on another. This is typically used in conjunction with a duplex frequency.

- **Portable**

  A portable radio is a small, handheld device typically used by an individual, which allows communication to other portables, mobiles, or base stations. Its range is more limited than a base station because of its limited power. A portable typically puts out 5 watts of power.

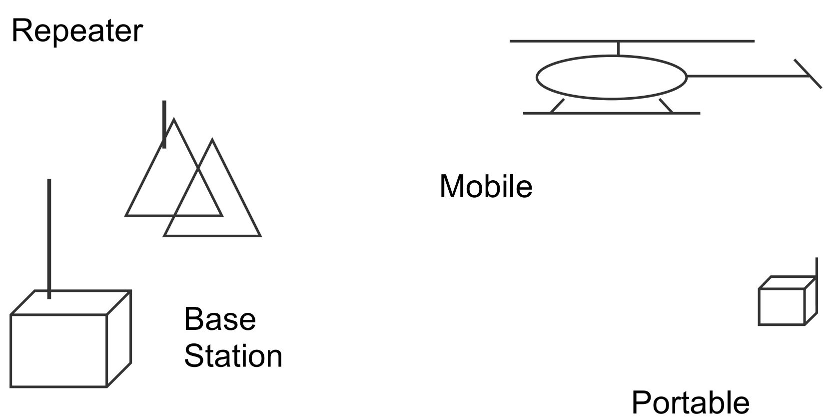
- **Mobile**

  A mobile is a device that can be used to communicate with other portables, mobiles, or base stations. This device is typically mounted in an aircraft or other vehicle. Since a mobile can include an externally mounted antenna and larger power source, it possesses improved range when compared to a portable radio. However, mobiles used in aircraft are restricted in the power settings they are allowed to use since if they transmitted at higher power settings, they could interfere with adjacent frequencies.

- **Base Station**

  A base station is a device that is typically mounted at a site and allows communication to portables or mobiles. Since the base station is not as limited in space as portable or mobiles, and can possess a larger antenna, it can produce greater power and greater range than a portable or mobile.

  Here is a drawing of a typical air medical communications system:



- **Cell Phones**

  Cell phones work in the gigahertz range of the electromagnetic spectrum. They utilize a system of tower sites spread around the country. A signal is sent from the phone and the system determines which tower receives the strongest signal. This tower is used to affect communications. If the caller moves from one location to another, a different tower site may be used.

The FCC prohibits the use of cell phones in flight per the FCC Code of Federal Regulations, part 22, subpart H, section 22.925:

> Cellular telephones installed in or carried aboard airplanes, balloons or any other type of aircraft must not be operated while such aircraft are airborne (not touching the ground). When any aircraft leaves the ground, all cellular telephones on board that aircraft must be turned off.

> This is due to the altitude of the aircraft, since many cell sites will be accessed at once and tie up the system. However, carrying a cell phone on the aircraft is a good policy, since it could be used in the case of an emergency, or when a landing takes place in a location where radio contact is not possible.

- **Trunked**

  Another method of increasing utilization of limited bandwidth is through use of a “trunked” system. In this system, there are a limited number of frequencies that are shared between multiple users. If a user keys a microphone, a signal is sent to a control station. That station determines which frequency is open at that time and the signal is transmitted over that frequency. The next time someone keys a microphone, if that frequency is busy, the signal will be transmitted over a different frequency. In addition to the increased utilization of bandwidth, this system also makes it more difficult for someone to scan, thus yielding increased privacy.

Networked System

A “networked” system is similar to a trunked system in that it uses multiple frequencies. However, in a networked system, each tower can be connected to the others via a special type of phone circuit. Thus, the coverage range is greatly increased. One version of this is termed EDACS.

Limitations of Radio Use

- **Line of Sight**

  Most radios can only be used when there is no major physical obstruction between the radio components. This is referred to as "line of sight." Most radios used in the air medical environment possess this limitation.

- **Range**

  The distance over which radio communication is possible is referred to as "range." The range of a radio component is limited by power, obstructions, and atmospheric conditions.

COMMUNICATIONS SYSTEMS

The HEAR System

The HEAR system comprises a set of frequencies that is used nationwide for hospital and EMS communications. Thus an ambulance traveling across country with a patient could communicate with a hospital for medical control if needed.

Mutual Aid Frequencies

Commonly, a frequency will be designated as "mutual aid." This frequency is designed to facilitate incidents involving multiple agencies and should be accessible by any EMS agency in the area. Since so many agencies have the ability to use this frequency, it is commonly used in air-to-ground communications. This frequency may vary in different parts of a state.

Incident Command System

- An Incident Command System (ICS) is used in incidents involving multiple victims and typically involving multiple agencies. Usually, a ground provider will "establish command" and name the incident after a nearby landmark or location. Thus, "Engine 232 establishing Freeport Command." The call sign to be used will thus be "Freeport Command."

TECHNOLOGICAL AIDS

A variety of technological aids can help you perform your job more effectively. A few are discussed here.

Alphanumeric Pagers

Alphanumeric pagers can be used in conjunction with a computer aided dispatch system to automatically page crew members with relevant information, such as scene locations, patient destination, and ground contact information.

Pagers can also serve as a backup to radios in case of mechanical difficulty or range. Two-way pagers allow crew members to page one another from the small keyboard embedded in the pager.

Personal Digital Assistants (PDA)

Personal digital assistants (PDAs) are hand-held devices that can store a variety of useful information. They can store lists of frequencies, landing zone information, drug dosages, cardiac algorithms, frequently called phone numbers and addresses, and copies of program policies and procedures. They can be synchronized with PCs at the crew quarters to update information as it changes. PDAs can also be linked to a GPS receiver and display the current location of the aircraft. In some cities, these devices can receive information over the Internet. The PDA can be hooked into a small, collapsible keyboard and thus could be used for patient charting. Upon return to base, this information could be loaded onto the PC for inclusion in the program database.

- **Laptop Computers**

  Laptop computers can perform all of the functions mentioned above for PDAs, as well as others. Due to their larger size and heavier weight, some programs would consider them for use, but only on fixed-wing aircraft. If a small printer were included, the chart could be printed out after the completion of a flight, even before returning to base.

RADIO TECHNIQUE AND USE

Technique

The manner in which you communicate on the radio is very important. Good communication can lead to enhanced safety, improved patient care and increased efficiency of operations. Here are some guidelines that can serve to improve communications:

- Speak at a normal volume and in a normal tone of voice. Speak clearly, but there is no need to over-enunciate.
- Be clear. Avoid the use of ambiguous pronouns (Example: “He is signaling that there are wires to his left.”)

- Prepare what you will say before beginning to speak. Be succinct.
- Limit the length of your transmission to 30 seconds in length.
- Limit radio usage to required transmissions only. Someone else may have a more important matter.
- For repeated frequencies, hold down the microphone control for an extra second before transmitting.
- Avoid the use of “10-codes.” Not every agency uses the same codes, and not everyone will remember every code.
- Maintain confidentiality. Do not use a patient’s name over the radio. Use initials if necessary.
- Give the other party’s identifier first, then your own. E.g., (“Walmouth Fire, MedFlight 1.”)
- Be aware that others may be listening to your transmissions. Be professional at all times.

Phonetic Alphabets

A variety of phonetic alphabets can be used to represent letters. You should use the one specified by your program policies. The most common in this industry are the aviation and law enforcement alphabets. They are displayed here:

Letter	Aviation	Law Enforcement
A	Alpha	Adam
B	Bravo	Boy
C	Charlie	Charles
D	Delta	David
E	Echo	Edward
F	Foxtrot	Frank
G	Golf	George
H	Hotel	Henry
I	India	Ida
J	Juliet	John
K	Kilo	King
L	Lima	Lincoln
M	Mike	Mary
N	November	Nora
O	Oscar	Ocean
P	Papa	Paul
Q	Quebec	Queen
R	Romeo	Robert
S	Sierra	Sam
T	Tango	Tom
U	Uniform	Uniform
V	Victor	Victor
W	Whiskey	William
X	X-ray	X-ray
Y	Yankee	Young
Z	Zebra	Zebra

Radio Terminology

Ten codes are used to simplify routine transmissions and to hide the nature of incidents from people with scanners. Most flight programs avoid the use of 10-codes, using instead normal language, or “clear text.”

Many terms that are used on the radio have specific meanings in the aviation industry. Some of these terms are listed below:

- Acknowledge: To indicate understanding of a statement. Frequently used to confirm receipt of information given.)“Please acknowledge that you copied coordinates.”)
- Affirmative: A positive response to a question. This is easier to understand over the radio than a simple “yes.” (“That is affirmative, I can accept the flight for weather.”)
- Break: An indication that although a transmission is continuing, that it is meant for a different person or aircraft. It serves to catch the attention of the intended recipient. (“Care Flight 2, your patient weighs 250 pounds, break, Care Flight 1, your destination is St. Joseph’s.”)
- ETA: Estimated time of arrival.
- ETD: Estimated time of departure.
- ETE: Estimated time en route.
- Go ahead: Proceed with your message.
- Negative: An indication that the answer to a question is “no.” This is easier to understand over the radio than a simple “no.” (“Negative, I do not have the parent on board.”)
- Roger: Your transmission has been received and a reply is expected.
- Say again: A request to repeat a transmission. (“You were broken, please say again.”)
- Stand by: Hold your transmission for the moment.
- Wilco: An aviation term indicating that a transmission is understood and will be complied with. (“Copied last, wilco.”)

The Sterile Cockpit Concept

After liftoff and on arrival in a busy metropolitan area are workload-intensive periods for the pilot. Therefore, many flight programs have instituted the “sterile cockpit” concept. This means that during these specified periods of flight, no unnecessary conversations will take place. This allows all crew members to be especially vigilant for other air traffic. This period may be specified as 5 minutes after lift-off, after crossing into busy airspace, or a specified number of minutes prior to arrival at a receiving hospital.

JUDGMENT AND DECISION-MAKING

Overview

The decisions of the communications specialist, pilot and medical crew must reflect the policies and values of the flight program. Thus, it is crucial that they be familiar with any program policies that may affect a required decision. The review of program policies and procedures should be part of the initial training as well as the continuing education program. Equally as important, the flight crew and all support staff must also be aware of the *values* held by the flight program. Different programs may consider some values more important than others. For example, one flight program may consider the cost and reimbursement associated with a flight to be the biggest priority, while another program does not. Some other examples of values that may vary from program to program include safety, speed of transport, patient care, and the impact of public relations activities.

Personality Types

In aviation, as in many professions, assumptions have been made regarding the assumed personality or interaction style of various crew members.

While these assumed personality types may or may not apply to specific persons, personality type can affect decision-making. Management personnel need to be aware of the personality and human factors that contribute to the decision-making process. This awareness reinforces the need for active air medical management training.

Accelerating the Development of Good Judgment

Good judgment goes hand in hand with good communications skills. While judgment is typically acquired over time, and after a considerable amount of experience, it can be argued that the time it takes to acquire good judgment can be decreased by following a systematic method of judgment development. This system can include drills, scenarios, and discussions relating to the flight program’s mission and values. For example, at staff meetings, a number of “what if” questions can be posed and then discussed. In this way, alternative answers can be evaluated and the best solutions identified. Additionally, these discussions can facilitate an improved understanding of the values and philosophies of the flight program.

Process of Acceptance or Denial of Mission

Good judgment must be executed at every decision-making point during an air medical mission. One practice that may be helpful in this regard, while at the same time maximizing the safety and integrity of the mission, is “blinded acceptance or denial” of flights. In this case, the pilot is not advised as to the nature of the patient’s injury or illness until after the acceptance or denial of the mission. This allows for the decision to be based on objective information such as weather, aircraft readiness, and flight crew preparedness. This will help to relieve the pressure to accept a flight that may otherwise be declined.

The Future of Communications in the Air medical Industry

Each year new technologies are developed that make communicating over long distances less difficult and more accurate. Some of these technologies are already in use in the military, aviation and space technology arenas, while others are still in development. Methods that may be applicable to the air medical environment include:

- GPS for voice communications
- Camera link between aircraft and communication center
- Routine GPS flight following
- Real-time, in-flight transmission of EKGs, fetal heart rate tracings, and other diagnostic information
- Echo-Flight methods of flight following
- E-mail between aircraft, communication center and facilities
- Satellite based flight following-FAA data

SUMMARY

Good communication skills, objective decision-making capabilities and state of the art communication technologies are all integral parts of a successful and safe air medical program. All members of the flight crew, including all support staff must collaborate and cooperate to assure the success of each mission. The communications specialists are pivotal in this effort, as they complete an array of critical activities including flight following, public relations, report taking, and flight coordination.

Associated with this module is Exhibit 11-1: A Sample Report Format.

EXHIBIT 11-1: SAMPLE REPORT FORMAT

Scene/Inter-facility Information:

Time __________ Caller's Name _______________ Agency _______________

Callback # ___________ Call-sign _____________ Frequency ____________

Scene Location ____

____

Referring Facility ________________________________ Unit _____________

Referring Facility, City/State ____

Mechanism/Diagnosis ____

____

Receiving Facility _______________________________ Unit ______________

Receiving Facility, City/State ____

Pt. Age _______________ Pt. Sex _________ Pt. Weight _________________

Maternal Y / N; Neonatal Y / N; Pediatric Y / N; Balloon Pump Y / N

Other____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

____

Put caller on hold, alert crew, obtain the following information…

Pt. Name: Last ________________________ First ___________________

DOB ____________ Gestational Age ______ Diagnosis _______________

____

Referring MD ___________________ Receiving MD ___________________

Vital Signs: Pulse _________ Resp. _________ BP __________ T ________

GCS ____________ GCS ____________ Pupils ________________________

O2 % ________ POx ________ Mode __________ Airway Adjunct _______

IV's ____

____

Medications ____

____

Other Information (Labs, EKG, X-Rays, etc.) ___________________________

____

<u>IF VENTILATED:</u> Vent Settings: FiO2 ____% Rate ____ Tidal Vol. ______

PIP ________ PEEP/CPAP ________ Mode_________________________

<u>IF CARDIAC ASSIST DEVICE:</u> Pt. Height ____________ Ratio _________

Type: Balloon Pump ________ LVAD _______ RVAD ______ TAH _______

____

<u>IF MATERNAL</u>: G _____ P _____ AB _____ Est. Gestational Age ______

EDC ____________ History _______________________________________

Contractions Y / N Frequency ______ Duration ______ Dilation______

Membranes: Intact ____ SROM ____ PROM ____ Fluid ______ Station ___

A. **Bibliography**:

Auf der Heide, E. *Disaster Response: Principles of Preparation and Coordination*. Mosby. 1989.

Broome, Robert. "The Development of a Continuing Education Program for Communications Specialists." Air medical Transport Conference lecture. 1999.

Broome, Robert. "Judgment and Decision-Making." National Association of Air medical Communication Specialists Management Track lecture. 2000.

Commission on Accreditation of Medical Transport Services. (http://www.camts.org).

Encyclopedia Britannica. (http://Britannica.com).

Federal Aviation Administration*. Aeronautical Decision-Making*.

Federal Aviation Regulations. Section 79, Part 135.

Federal Communications Commission. *Code of Federal Regulations*. *Title 47, Chapter I, Part 2*.

Federal Communications Commission*. Code of Federal Regulations*. *Part 22, Subpart H, Section 22.925.*

Federal Emergency Management Agency*. Incident Command System.*. (http://www.fema.gov/emi/is195lst.htm**).**

Laboratory for High Energy Astrophysics at NASA/Goddard Space Center. "Imagine the Universe." . (http://imagine.gsfc.nasa.gov/).

National Association of Air medical Communication Specialists. *Training Manual*. 2000.

National Association of Air medical Communication Specialists. (http://www.naacs.org).

B. **Definitions of Keywords**:

Communications system—A collection of hardware, personnel and procedures designed to provide the method by which the transmission and reception of sound can take place

NAACS—The National Association of Air medical Communication Specialists. This is the professional organization that represents communications personnel on the national level and interfaces with the other air medical professional organizations.

Amplitude modulation—A method of modifying a wave's height in order to relay information

Frequency modulation—A method of modifying a the number of times a wave occurs in a specified time period in order to relay information

Wavelength—The distance between two adjacent peaks in a wave

Simplex—The use of a single frequency to communicate

Duplex—The use of two frequencies to communicate. One is used to transmit, while the other is used to receive

CTCSS—Continuous tone-controlled subaudible squelch. This is an ancillary frequency that allows a larger number of entities to use the same primary frequency. It also provides a greater amount of privacy.

Transmitter—A physical device that is used to disperse a radio signal

Repeater—A physical device that receives a radio signal, then amplifies and rebroadcasts it

Trunked—A communications system wherein a small number of frequencies can be shared by a number of entities. This allows a more efficient use of the available spectrum

C. **<u>Test Questions</u>**

1. The FAA recommends that flight following be performed by the flight program, but it is not required.

   a. True
   b. **False**

2. Cell phones are authorized for use by air medical providers in a Special Memorandum of Agreement issued by the FCC.

   a. True
   b. **False**

3. What is the professional organization that represents communications specialists at the national level, and serves as a liaison to the other professional organizations?

   a. CAMTS
   b. **NAACS**
   c. FCC
   d. CTCSS

4. A “CTCSS tone” serves which of these functions?

   a. **Allows a greater number of entities to use the same primary frequency**
   b. Allows the use of both VHF and UHF frequencies without the need for separate equipment.
   c. Provides the location of the aircraft to a ground station via a global positioning satellite
   d. Allows the pilot to switch between two frequencies without requiring a separate control device

5. What is the CAMTS recommended maximum interval of flight following?

   a. 10 minutes
   b. 15 minutes
   c. 20 minutes
   d. 25 minutes

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Radio report and communication practice
- Radio/telemetry practice and role playing
- Review and practice with computer/PDA-based charting systems, as applicable
- PAIP drill with multiple agencies

NOTE: If the PAIP is exercised on a regular basis, this can serve to alleviate the stress that may be incurred if it were only drilled on an annual basis. The drill could be as simple as having the pilot state, “Where am I now?” and having the communications specialist determine the location con a map. Later, this location can be compared to the actual location. As confidence is built up, the exercise can be made more complex.

As the exercises progress in complexity, survival training can be incorporated into the drill; the communication specialist could simulate the aircraft location process; the pilot could practice the use of predetermined radio codes (e.g., “Code 76”) which simulates loss of contact; the communication specialist could identify and make the contacts necessary to locate the aircraft; and local ground agencies can be involved, serving as a multi-agency event.

- Map reading practice
- Visit city/area/state communications centers to observe

F. **Patient Care Hours**: N/A

MODULE 12: ETHICAL AND LEGAL ISSUES

Author: Ms. Abigail Williams, JD, RN, Worcester, MA

Reviewer: Ms. Shalyn Sutton, RN, REACH, Redding, CA

KEYWORDS

Competency
Consent
Battery
EMTALA
Civil
Criminal
HIPPA
Fee Schedule

OBJECTIVES

Upon completion of this module, the student should be able to:

- Discuss the importance of documentation as a component of the delivery of care
- Describe proper reasons for adjustments to the medical record
- Discuss competency and consent in the delivery of health care and demonstrate the proper documentation of consent or refusal of care
- Define the situations that may constitute civil or criminal battery
- Discuss the regulations set forth by the Emergency Medical Treatment and Active Labor Act (EMTALA)
- Discuss the implications of the new Medicare Fee Schedule on EMS reimbursement
- Understand the requirements of HIPAA

INTRODUCTION

There are many issues that must be considered prior to undertaking the responsibility of air medical patient transports. The top priorities for an air medical transport company should include the provision of safe and appropriate patient care; transfer of the patient to an appropriate facility via a medically configured, staffed, and maintained aircraft or ground unit; compliance with air medical, EMS, and regulatory guidelines; and thorough documentation.

PATIENT CARE DOCUMENTATION

Documentation is a very important aspect of the patient care process. Without adequate documentation, the continuity of care between levels of providers would be lost. In addition, thorough documentation of patient conditions, patient care interventions, and sequence of events may be useful in the following situations:

Civil lawsuits involving the patient
Criminal prosecutions on behalf of the patient
Criminal prosecutions against the patient
Malpractice litigation involving health care providers

When documentation is inadequate and/or absent, there is a legal presumption that care not documented is care that was not given.

Principles of Documentation in the Field

The air medical provider should understand the documentation essentials in a field situation involving both scene response and hospital response:

- **Scene Notes**

  The air medical provider must obtain sufficient information to memorialize and record a complete and accurate report. This information includes:

  - Patient identification
  - On-scene observations of the patient's condition and the patient's mechanism of injury
  - Physical surroundings and potential hazards
  - Initial and ongoing patient assessment
  - Observations
  - Vital signs
  - On-scene and ongoing interventions
  - Discussions with medical control and protocols that are being followed
  - Any changes in condition
  - Information obtained at the scene and from whom
  - Times for all entries
  - Unusual weather or scene conditions affecting extrication
  - Any care or transport that occurred

The air medical provider should also document the name of the person who assumed care of the patient at the destination hospital and condition of the patient at time of relinquishing of care.

- **Inter-facility Hospital Transport Notes**

  The air medical provider must obtain information to complete transport report. This information includes:

  - Patient identification
  - Transferring physician information
  - Reported condition of patient
  - Patient's history
  - Destination hospital's consent to transfer the patient
  - Patient records
  - Personal belongings to accompany patient

  The air medical provider should also record his or her initial, independent assessment of the patient prior to transport and any continued observations of the patient's condition during transport. This information includes:

  - Interventions and packaging actions
  - Periodic vital signs
  - The patient's condition during transport

  The air medical provider should note unusual situations affecting care or transport. This includes documenting the name of the person who assumed care of the patient at the destination hospital and the condition of the patient at time of relinquishing of care.

- **Errors, Corrections, and Late Entries**

  The air medical crew member should be able to describe proper reasons for adjustments to the medical record and the proper manner in which to make those adjustments.

  Valid reasons to make adjustments in the medical record include:

  - To provide information accidentally omitted from the record prior to the filing of the medical record or report
  - To correct information, spelling, or grammar during the completion of the record or report
  - To provide omitted information or to correct information in the record subsequent to filing the record or report.

There are appropriate methods to use when amending or changing a medical record. One method is the single line cross-out of errors, initialed, dated, and corrected within the same report. Supplemental reports can be completed and filed contemporaneously with the original report to add or correct information. Supplemental reports are usually completed within the same shift. Late entries should be made by filing a separate report detailing the facts omitted or details to be corrected in the medical report, together with an explanation of the reasons why the information was not included in the original report.

- **Confidentiality of Records**

The air medical provider should be aware of the confidentiality of medical records and information obtained in the process of patient care and transport.

Any information conveyed in the chain of care is generally considered within the bounds of confidentiality. Access to information is legally restricted. Despite widely held beliefs, the patient’s spouse does not have an automatic right to information. In addition, the parent of a child with legal right of consent does not have automatic right to access to information involving the child’s condition. The legal age of consent varies by state as to the age and the circumstances under which the child has the right of consent. Law enforcement agencies does not have the automatic right to information regarding the patient’s condition, especially when inter-hospital transfers are involved.

A breach of confidentiality occurs when a person discusses details of any information obtained in the course of rendering care to a patient in a context where the information might be linked to an identifiable patient and where the details are heard by a person not privileged to have that information.

Persons who are HIV positive or who have AIDS may have specific state-mandated protection that prohibits the sharing of information outside the chain of care without written consent of the patient. The air medical provider should be familiar with their state's specific regulations pertaining to the confidentiality afforded to HIV/AIDS patients receiving medical care.

A written consent for release of medical information is the safest method of addressing the issue of confidentiality of medical records. A pre-printed release of information should be included in the standard transfer forms signed by a patient. The signature by a family member may only be sufficient for chain of care purposes and should be supplemented by that of the patient whenever possible.

Radio communications pose a particular challenge to EMS providers. These transmissions are not secure and should be conducted with care. Patient identifiers such as name or address should not be used, nor should any other information specific enough to independently identify that patient be used. Patient identifiers that should not be used include the title of known a politician or community member and/or a descriptor such as “principal of ‘blank’ school.”

- **Transport of Records**

  Transport team members should be given copies of the patient’s medical records prior to their departure from the referring facility. All procedures, treatments and responses, and lab results should be included as well as any pertinent medical history. The crew should also verify the records provided and sign a receipt for acceptance of the records.

  Transport team members should have access to those items of information and records, to the extent that the information is reasonably related to continuity of care during the transport process. This information should be provided to the receiving facility when the care of the patient is transferred. The receiving hospital should provide signed acceptance of the patient records at the time the air medical crew relinquishes care of the patient.

COMPETENCY AND CONSENT FOR CARE

The EMS provider may need to determine whether or not the patient is competent to give consent regarding medical treatment. To make this determination, the provider must understand the principles of competency, consent, and refusal. In general, the competent, conscious, adult patient (or minor given the right to consent to medical care under the laws of the state where the patient is located) has an inherent right to consent or refuse medical care to be rendered to their person.

Types of Consent

- **Informed Consent**

  The patient signs a consent that explains the risks and benefits of the proposed actions in general or specific detail.

- **Expressed Consent**

  The patient asks for or consents orally or in writing to the care or procedure at issue.

- **Inferred or Imputed Consent**

  The patient is conscious and able to consent or refuse care and remains silent while the care is rendered under conditions where a reasonable person would voice a refusal.

- **Substituted Consent**

  The patient is unable to understand or make an informed choice, but the law provides for consent by another person, such as a member of the family or a court appointed guardian.

- **Implied Consent**

  The patient is unconscious or in a medical condition where he or she is unable to understand and make an informed choice, but where the law presumes a reasonable person would consent.

Types of Battery

- **Civil Battery**

  The patient sustains physical or mental injury as a result of physical contact by another individual. This physical contact may result in a civil lawsuit wherein the reasonableness of the action or contact will be the deciding factor in whether a tort has been committed.

- **Criminal Battery**

  Criminal charges may result when physical contact by another individual is of an insulting, provoking, or injurious nature. Criminal charges require an element of intent and are usually based on a specific intent to make contact without consent, rather than the intent to specifically harm the patient.

Determining Competency in the Field

The EMS provider should be aware of the difficulties determining competency in the field and be familiar with the mechanisms of dealing with issues of competence in the field.

The patient refusing treatment should be presumed competent and capable of refusing care, even when the lack of care may be life threatening. It is incumbent on the air medical crew to recognize those circumstances where the patient is not capable of refusing care and differentiating those cases from cases where the patient is injured but competent to refuse care, even at a risk of death. Conditions or observations that may indicate that a patient is not competent include:

- Head injuries by complaint or by mechanism of injury
- Internal injuries or shock by complaint, observation, or mechanism of injury
- Irrational behavior
- Inability to respond to questions appropriately
- Inability to comprehend that they are injured
- Available family member to consent
- Field DNR orders in some states that must be honored by EMS providers and health care professionals.

Documentation and a thorough description of why the patient is not deemed capable of refusing care in the field is essential and must be linked to the concern the caregiver has for the medical safety of the patient. There are several strategies that can be utilized as alternatives to physical force to obtain consent for treatment and transport. Family influence or that of an authority figure, such as police or an employer, can be helpful in eliciting compliance and consent from the patient. Force, including restraint, may cause further harm to the patient and put the intent of the caregiver in question. Use only restraint sufficient to protect the patient during movement or transport.

Establishing Informed Consent

The elements of informed consent must be understood by the air medical crew member. In obtaining a valid informed consent, the air medical provider must remember that:

- In scene response situations, a general consent is sufficient if it indicates that the patient consents to medical care and treatment necessary for his or her medical safety and transport by aircraft.
- In inter-hospital transfers, federal law requires the sending institution to obtain consent for transfer describing the risks and benefits of transfer.
- The air medical crew typically obtains their own consent to transfer patients, which often contains a list of the possible risks of air transport.
- Informed consent may be obtained from a family member or other legally authorized person under the terms of state law or under a

health care power of attorney, durable power of attorney, or other advanced directive.

- A statement that risks and benefits were discussed with the patient is insufficient to sustain an informed consent; the consent form should include a summary of the risks and benefits discussed in sufficient detail to demonstrate an informed consent.
- The nature of the risks that must be disclosed vary by state with the two primary standards being:
    - The risks disclosed must be those that a reasonable physician would disclose under the same or similar circumstances.
    - The risks disclosed must be those that a reasonable patient would want to know in making a decision to consent or refuse care. This is a more detailed standard requiring more extensive disclosure of risks but provides the most assurance of informed consent.
- Failure to adequately disclose risks results in the consent being invalid.
- Risk may be stated in ultimate outcome rather than specific mechanisms of medical risks, such as:
    - Patient may experience sudden or aggravated medical problem that may lead to death or disability.
    - Air transport has the inherent risk of being outside of the hospital, and this means limited personnel and equipment to deal with any change in condition.

Obtaining Informed Consent

Transferring hospitals are required to obtain informed consent to transfer under federal EMTALA. These consents are primarily medical in nature and typically are created to protect only the hospital in the transfer process.

Air medical services typically require their own consent forms to be signed to clearly delineate the risks associated with air transport and to protect the air medical crew from consent issues in the event of an adverse event or outcome.

MANAGED CARE AND THIRD-PARTY PAYERS

There is a defined relationship between the provision of air medical services and the payment for those services.

Field Response Situations and Payment

When an air medical unit responds to a scene, it does so on the basis of either a contract basis or on the basis that it has offered its services to the public. In either event, it is not a concern of the air medical crew whether or not payment will be made for the service or by whom. The sole concerns of the crew should be for air safety, scene safety, and patient care.

Inter-Hospital Transfer—Pre-authorization Requirements

Where the air medical unit is providing elective transport between hospitals, the service is concerned with the need for pre-authorization of the transport either through contracts with the sending institution, insurance, or other payment sources. Where the crew has been dispatched to provide transport, it is not the function of the crew to confirm or initiate pre-authorization for the payment approval for the flight. The crew may be expected by the air medical service to obtain a form documenting the necessity for air ambulance transport, which must be signed by the transferring physician.

Emergency Transfers—EMTALA Issues

The sending facility, medical staff, and employees can initiate emergency transfers of patients requiring a higher level of care. Federal law requires the sending institution to “provide” appropriate transfer, which means ultimate financial responsibility for effecting the transfer is that of the hospital. Funding is generally addressed by service contracts between the hospital and the air medical provider. The patient and/or their insurance carrier may be billed for the services.

Government Reimbursement Rates

Medicare establishes standards for reimbursement of air ambulance services. There is a base rate for services and an additional component for mileage. Mileage allotments are to the nearest facility that might minimally meet the needs of the patient. Transport to a further hospital that might be more appropriate for the patient is frequently denied. The air medical crew may be expected by the air medical service to obtain a form documenting the necessity for air ambulance transport, which must be signed by the transferring physician. The crew should transport the patient to the destination selected by the transferring physician as the most appropriate destination for the patient without regard to alternative hospital options.

LIABILITY ISSUES IN DISASTER RESPONSE

There are many implications for legal liability involving air medical programs responding to disaster scenes.

Scope of Practice

Disaster response across jurisdictional boundaries raises questions about the use of “foreign” licensed personnel. While most states have emergency and mutual aid provisions, it is important to be aware of the scope of service allowed in the different jurisdictions to which air medical service might be asked to respond. In some cases, reciprocity between states can be requested, although the scope of practice may differ.

Insurance Coverage

Insurance coverage of air medical services and their personnel typically covers all services rendered by the program, regardless of location or level of provider. Legal counsel should review the documents to assure that the insurance carrier covers out-of-state operations. It is important to note that some types of insurance exclude benefits for personnel injured or property damaged by acts of terrorism, war, or natural disasters. Because disaster response may involve such acts, legal counsel should review the issue of coverage in an effort to select the most appropriate insurance plan. All personnel should be aware of the scope of coverage for both insurance and workers compensation benefits.

Triage of Resources

Air medical services in a disaster situation should be carefully conserved to provide optimum benefit in the emergency. Tactical control should be provided and decisions on where a unit is to be deployed should be primarily decided by the incident command. Air medical services should exercise their medical judgment in triage of patients for air transport based on the overall needs of the situation, patient condition, and transport conditions, especially when more than one patient is involved. Air medical services should be familiar with the triage protocols of the ground units and agencies that they are likely to assist and should maintain direct communications with the incident command, if possible.

Scene Security and Safety

As in all scene responses, the air medical crew should consider flight safety and scene security the ultimate priorities. Disaster scenes pose additional hazards that are much greater and often less obvious than single incident responses. The air medical crew should be aware of these dangers and take appropriate safety precautions to address the potential for unforeseen hazards.

Good Samaritan Laws

Most states provide laws that relieve voluntary emergency personnel from liability for good faith efforts to assist the victims of an emergency. Whether these laws cover paid personnel varies from jurisdiction to jurisdiction. Although the air medical crew should be aware of the general provisions of the jurisdictions they serve, primary defense against potential claims lies in having adequate liability and professional liability insurance.

REGULATORY AGENCIES: EMTALA

The air medical crew should have a working knowledge of the regulations specified by the primary regulatory body for inter-hospital transfers. The Health Care Financing Administration (HCFA) under the Emergency Medical Treatment and Active Labor Act (42 USC 1395dd), has set regulations which apply to hospitals, hospital-owned ambulance services, and hospital-owned air ambulance systems.

Decisions regarding transport of a patient lie with the transferring physician, although the air medical crew retains final authority over whether they deem the flight or the patient situation to be safe for transfer.

Mode of Transfer

The decision on mode of transfer is primarily that of the transferring physician. Often it is necessary to educate medical personnel and physicians on the capabilities and limitations of an air medical aircraft. Single versus multiple patient capability, seating and stretcher configuration, the availability of a pressurized cabin and IFR versus VFR capabilities are a few of the operational considerations that referring personnel may find helpful.

Necessary Attending Personnel

The decision regarding the level of personnel needed to attend the patient during transport is that of the transferring physician. The type of crew that will be required for the transport is often the determining factor in the selection of a helicopter or fixed-wing transport. In some settings, the hospital may be expected to supplement the crew based on patient need, system policies, and lift capacity. When necessary personnel cannot be accommodated, the physician must reassess the risks and benefits of transfer by this mode without those personnel or opt to utilize ground transport. Professional guidance by the receiving physician, the physician providing on-line medical direction, or the air medical team may provide assistance to the referring physician, but the final decision is that of the physician unless the crew deems it to be an unsafe flight.

Necessary Equipment in Transport

The decision regarding the necessary life support equipment is determined in part by the individual state regulations governing air medical programs. Program accreditations may also determine what equipment is necessary on particular missions. In the case of critical-care or medically complex patients, additional equipment may be required. In these situations, the referring physician may determine the type of equipment or supplies and request such items as a transport incubator, cardiac assist device, blood products, antivenin, etc. Professional guidance by the air medical team may provide assistance to the physician in making these decisions, but the final decision is that of the physician unless the crew deems it to be an unsafe flight.

Consent and Facility Acceptance

The transferring physician, or nurse in contact with the physician by telephone, must sign a transfer certification listing the risks and benefits of the transfer and obtain an informed consent to the transfer. The transferring hospital must obtain and document advanced acceptance by the receiving hospital prior to liftoff. That acceptance must be contained in the referring medical record and the in-flight record. Where any question exists about the advanced acceptance, it is prudent for the air medical team to contact the destination to confirm that they are expecting the flight and patient. Copies of records are to be provided by the transferring hospital and transported by the air medical crew to the receiving facility.

Role of the Air medical Crew in EMTALA Compliance

The air medical crew may remind the transferring hospital of the proper procedures for making an EMTALA transfer to a higher level of care. However, it is not the role of the air medical crew to enforce the requirements, and they are not liable for any violation by the sending facility. It does remain the proper role of the air medical team to question unsafe transport situations.

Questions often arise regarding of when control of the patient passes from the referring physician to the air medical crew. Under Federal EMTALA law, the physician in the transferring hospital remains in control and responsible for the decision to transport until the patient is lifted off the hospital property. While air medical crews typically assume care and packaging of the patient for transport, they remain subject to the direction and control of the transferring physician in patient care issues. When physician orders violate system protocols or good medical practice, the crew is responsible for contacting their medical control to assist in negotiating proper care or to give instructions on what the crew is to do under the circumstances.

HCFA has ruled that air medical services may use an uninvolved hospital's helipad without creating EMTALA responsibilities for the uninvolved hospital. Aircraft may meet an EMS ground unit to load or discharge a patient on the premises of the uninvolved hospital without having to take the patient inside for assessment by the uninvolved hospital. This includes use of a rooftop pad. An exception to this occurs when the ground unit crew or the air medical crew requests medical assistance with the patient, as opposed to help lifting or use of a phone. In this situation, the hospital that owns the helipad establishes a relationship with, or duty to, the patient. The air and ground services have the primary responsibility regarding when to ask for medical assistance, and they should exercise prudence to insure the patient's welfare and safety.

Reimbursement under the Federal Medicare Program

Fee Schedule for Payment of Ambulance Services

Background

The Medicare program pays for transportation services for Medicare beneficiaries when other means of transportation are contraindicated. Ambulance services are divided into different levels of ground, which includes water, and air ambulance services based on the medical necessity of the treatment provided during transport.

The levels of service approved for Medicare reimbursement for medically necessary transports are:

Ground:

- Basic Life Support (BLS)
- Advanced Life Support, Level 1 (ALS 1)
- Advanced Life Support, Level 2 (ALS 2)
- Specialty Care Transport (SCT)
- Paramedic Intercept (PI)

Air

- Fixed Wing Air Ambulance
  Medicare definition: Fixed wing air ambulance is the transportation by a fixed wing aircraft that is certified by the Federal Aviation

Administration (FAA) as a fixed wing air ambulance and the provision of medically necessary services and supplies.

- Rotary Wing Air Ambulance
  Medicare definition: Rotary wing air ambulance is the transportation by a helicopter that is certified by the FAA as a rotary wing ambulance, including the provision of medically necessary services and supplies.

Medical Necessity Requirements

As a general rule, Medicare covers ambulance services, including fixed wing and rotary wing ambulance services, only if they are furnished to a Medicare beneficiary whose medical condition is such that other means of transportation are contraindicated. The patient's (beneficiary) condition must require both the ambulance (this includes fixed and rotary wing) transportation itself and the levels of service provided in order for Medicare to cover the services as medically necessary

History of Medicare Ambulance Services

Under section 1861 (s)(7) of the Social Security Act, Medicare Part B covers and pays for ambulance services, to the extent prescribed in the regulations, when the use and other methods of transportation would be contraindicated. The intent was that Medicare would provide coverage for ambulance transportation services only if other means of transportation were contraindicated by the patient's medical condition, and only transportation to local facilities would be covered unless necessary services were not available locally, in which case, transportation to the nearest facility furnishing those services would be covered. Medicare coverage was also extended to cover medically necessary transportation from one hospital to another, to a patient's home, or to an extended care facility.

Balanced Budget Act of 1997 (BBA)

Section 4531 (b)(2) of the Balanced Budget Act added a new section 1834 (1) to the Social Security Act. Section 1834 (1) of the Act requires the establishment of a national fee schedule for payment of ambulance services under Medicare Part B through the negotiated rulemaking process. The section also required that in establishing the ambulance fee schedule, Medicare would:

- Establish mechanisms to control increases in expenditures for ambulance services as a benefit under the Part B program;

- Establish definitions for ambulance services that link payments to the types of services furnished;

- Consider appropriate regional and operational differences;
- Consider adjustments to payment rates to account for inflation and other relevant factors;
- Phase in the Fee Schedule in an efficient and fair manner; and,
- Require that payment for ambulance services be made only on assignment-related basis.

On February 27, 2002 a final regulation implementing the new ambulance payment system was published in the Federal Register. 42 CFR Parts 410 and 414 define the levels of service, payment, and medical necessity requirements for ambulance transportation.

Under the fee schedule system, ambulance service providers will be paid a pre-established fee for each different service provided. This is similar to the method of payment Medicare has progressively adopted for hospitals, nursing homes, home health agencies and other health care providers.

An important new protection for patients requires ambulance service providers to accept the Medicare approved fee as their full payment. This means that patients enrolled in the Medicare program will not pay more than 20 percent of the approved amount, once they have met their annual Medicare Part B deductible.

The new payment system was produced under the negotiated rulemaking process that included affected industry, professional and governmental groups.

The new fee schedule will be phased-in over a five-year period that began on April 1, 2002. The new phase-in blended existing rates on April 1, 2002 with the new fee schedule rates. In 2002, the blend was 80 percent of the existing rates and 20 percent of the fee schedule. For 2003, the blend is 60 of the pre-fee schedule rate and 40 percent of the fee schedule. In 2004 the blend will be 40 percent of the pre-fee schedule rates and 60 percent of the fee schedule. In 2005 the blend will be 20 percent of the pre-fee schedule rate and 80 percent of the fee schedule, and beginning in 2006, payment will be based 100 percent on the fee schedule.

Levels of Air Ambulance Service under the Fee Schedule

The Final Rule stated that there would be two levels of air ambulance services to distinguish fixed wing from rotary wing (helicopter) aircraft. In addition, to recognize the operational cost differences of the two types of aircraft, there would be two distinct payment amounts for air ambulance mileage. The air ambulance services mileage rates would be calculated per actual loaded (patient onboard) miles flown, expressed in statute miles (ground miles, not nautical miles)

Coverage of Air Ambulance Services under the Fee Schedule

Fixed Wing Air Ambulance (FW)

Medicare has determined that fixed wing ambulance services would be covered when the point from which the patient is transported to the nearest hospital with appropriate facilities is inaccessible by land vehicle, or great distances or other obstacles (i.e. heavy traffic) and the patient's medical condition is not appropriate for transport by either BLS or ALS ground ambulance.

Rotary Wing Air Ambulance (RW)

Medicare has determined that rotary wing (helicopter) air ambulance services would be covered when the point from which the patient is transported to the nearest hospital with appropriate facilities is inaccessible by ground vehicle, or greater distances or other obstacles (i.e. heavy traffic) and the patient's condition is not appropriate for transport by either BLS or ALS ground ambulance.

Components of Ambulance Fee Schedule Payment Amounts

As defined in the Act, ambulances may be ground, water or air. The fee schedule bases payment on a base rate and mileage. The base payment amount for each air ambulance service paid under the fee schedule is the product to two primary factors: (1) a nationally uniform unadjusted base rate; and (2) a geographic adjustment factor for an ambulance fee schedule area.

Anticipated Effects of the Fee Schedule

Implementation of the fee schedule will have some general effects. Section 1834 (1)(3)(A) of the Act requires that the aggregate amount paid under the fee schedule not exceed the aggregate amount that would have been paid without the implementation of the fee schedule. The pre-fee schedule payment system paid varying amounts for the same type of service depending on the location where the service was provided. In effect, the fee schedule lowers payments in areas of high levels of payment and raises payments in areas of low levels of payments. Under the fee schedule, a given area could experience a large reduction in payment only because such an area had historically been paid at a rate higher than average for the type of service provided. Even after reductions, some areas may continue to have payment rates under the fee schedule that remain higher than the national average.

Conclusion

Ambulance fee schedule amounts for providers/suppliers that have historically received lower that average payment rates will be relatively higher and the fee schedule amounts for providers/suppliers that have historically received higher that average payment rates will be relatively lower. This will translate into higher rates for rural transports, lower rates for urban transports, and higher rates for air ambulance services.

The HIPAA Privacy Rule

What is HIPAA?

The Health Insurance Portability & Accountability Act (HIPAA) was initially introduced in Congress in 1996. It was introduced to improve the efficiency and effectiveness of the health care system by ensuring portability and continuity of health insurance coverage for groups and individuals; to combat fraud, waste, and abuse in health insurance and the delivery of healthcare services; to improve access to long-term care services and coverage, and simplify the administration of health insurance. The program sets standards for the use and disclosure of Protected Health Information along with measures to ensure the secure transmission and storage of medical records and other individually identifiable or demographic information.

HIPAA is divided into 3 sections

1. Transaction & Code Sets
2. Security
3. Privacy

The Privacy Rule was published as a Final Rule in the Federal Register in August 2002. The effective date of compliance to the Privacy Rule is April 14, 2003

Who is effected by the Privacy Rule?

The Privacy Rule effects all “covered entities”. Covered entities are identified as:

- A Health Plan
- A Healthcare Clearinghouse
- A Healthcare provider who transmits any health information in electronic form

What does the HIPAA Privacy Rule do?

The Privacy Rule creates national standards to protect individual’s medical records and other personal health information

- It gives patients more control over their health information
- It sets boundaries on the use and release of healthcare records
- It establishes safeguards that healthcare providers and others must achieve to protect the privacy of health information

- It holds violators accountable, with civil and criminal penalties that can be imposed if they violate the patient's privacy rights
- And it strikes a balance when public responsibility supports disclosure of some forms of data—to protect public health

For the patient—it means being able to make informed choices when seeking care and reimbursement for care based on how personal healthcare information may be used

- It enables patients to find out how their information may be used, and about certain disclosures of their information that have been made
- It limits release of information to the minimum reasonably needed for the purpose of disclosure
- It generally gives patients the right to examine and obtain a copy of their own Health records and request corrections
- It empowers individuals to control certain uses and disclosures of their health information

Requirements of the HIPAA Privacy Rule

The Privacy Rule requires covered entities to take reasonable steps to limit the use or disclosure of, and requests for, "Protected Health Information".

Protected Health Information is classified as:

- Individually identifiable or demographic information
- Information regarding past, present or future physical or mental health or the provision of care to an individual
- Information created or received by a healthcare provider whether oral or recorded in any form i.e. Patient Care Reports, Medical Necessity Forms, Hospital face sheets, etc…

For the average healthcare provider the Privacy Rule requires the following:

- Notifying patients about their privacy rights and how their information can be used
- Adopting and implementing privacy procedures
- Training employees so that they understand privacy procedures and practices
- Designating an individual to be responsible for seeing that privacy procedures and practices are adopted and followed
- Securing patient records containing individually identifiable health information so that they are not readily available to those who do not need to know them

Notifying the patient about their privacy rights

A covered entity is required to provide each patient with a written copy of the covered entity's privacy practices. The notice must identify how and for what purposes information about the patient will be used and disclosed, what the patient's rights are, and how the patient can file a complaint if they feel that their protected health information was used or disclosed improperly.

The notice is to be given to the patient, or their personal representative, at the time services are provided. For emergency services, the notice, if it cannot be obtained at the time services are provided, may be sent to the patient via mail or electronic mail as soon as practicable. The covered entity is required to keep an "acknowledgement receipt" signed by the patient or their person representative, on file.

Patient's rights under HIPAA

Patients have the right to the following:

- Receive a copy of the covered entity's Notice of Privacy Practices
- Restrict the use and disclosure of their Protected Health Information
- Gain access to their medical records
- Request amendments to their medical records
- Designate a "Personal Representative" to act on their behalf
- Request notification of any and all disclosures of their Protected Health Information
- File a complaint with the covered entity or with the Secretary of Health and Human Services

Use of PHI without consent or authorization of the patient or their personal representative

Under the HIPAA Privacy Rule, a covered entity may use and disclose Protected Health Information for the following purposes without the patient's consent or authorization:

- To provide care/treatment
  "Treatment" generally means the provision, coordination, or management of health care and related services among health care providers or by a health care provider with a third party, consultation between health care providers regarding a patient, or the referral from one health care provider to another.
- For the purpose of obtaining payment
  "Payment" encompasses the various activities of health care providers to obtain payment or reimbursement for their services and of a health plan to obtain premiums, to fulfill their coverage

responsibilities and provide benefits under the plan, and to obtain or provide reimbursement for the provision of health care.

- For matters related to health care operations
  "Health Care Operations" are certain administrative, financial, legal, and quality improvement activities of a covered entity that are necessary to run its business and to support the core functions of treatment and payment. An example of healthcare operations is conducting CQI/QA functions
- As required by law
  - Public health activities
  - Abuse/Neglect activities
  - Government oversight activities
  - Judicial proceedings
  - Certain Law enforcement purposes
  - Organ/tissue donation

For all other purposes, patient authorization is required before PHI can be used or disclosed.

Steps to take to ensure compliance with the HIPAA Privacy Rule Standard

- Designate a Privacy Officer
- Designate Privacy Officials
- Develop a Notice of Privacy Practices to be given to every patient
- Develop an "Acknowledgement of Receipt of Notice of Privacy Practices" to be signed by the patient or their designated "Personal Representative"
- Develop the following forms:
  - Patient Request for Access
    All patient requests for access to their medical records should be made in writing and filed with the Privacy Officer. Records should not be accessed without having a signed request submitted.
  - Denial of Request for Access
    Under certain circumstances, the covered entity may deny access to records. When this action is taken, the patient, or their personal representative, is entitled to receive written notification that explains why they have been denied access to their records. Patients may appeal the decision or file a complaint with the Secretary of Health and Human Services.
  - Patient Request to Amend Protected Health Information
    Under HIPAA, the patient, or their personal representative, may submit a written request to amend Protected Health Information that the covered

entity was responsible for preparing and can be identified as incorrect.

- Acceptance of Request for Amendment of Protected Health Information

  When the request to amend Protected Health Information has been approved, the patient or their personal representative, is to be notified in writing of the changes made. Additionally, the patient or their personal representative may designate other parties to receive a copy of the amended Protected Health Information.
- Denial of Request for Amendment of Protected Health Information

  In certain circumstances, the covered entity may deny a request to amend Protected Health Information. When the request is denied, the patient, or their personal representative, must be notified in writing of the decision and the reason(s) for the denial. Patients may appeal the decision or file a complaint with the Secretary of Health and Human Services.
- Patient Request for Restriction

  A patient has the right to restrict the use and disclosure of their Protected Health Information by submitting a written request to the Privacy Officer. The covered entity does not have to accept the request for restriction if the information is to be used for the purposes of providing care, obtaining payment information, or healthcare operations.
- Authorization to Use and Disclose Protected Health Information

  For all purposes not covered under the "Treatment, Payment, Health Care Operations, and certain cases as Required by Law, patient authorization is required before their Protected Health Information may be used or disclosed.
- Patient Accounting

  For each used and disclosure, if requested, the patient or their personal representative has a right to know who received their Protected Health Information and the purpose for receiving it. When requested, this must be provided to the patient, or their personal representative, in writing.
- Privacy Training Record

  Each employee, contractor, volunteer, or other individual performing work on behalf of the covered entity and has access to Protected Health Information must receive HIPAA Privacy Training. Once completed, the individual must sign a record of completion that will be maintained by the Privacy Officer as well as being filed in the appropriate employee or contractor record.

- Develop a "Business Associate Agreement"

  A "business associate" is a person or entity that performs certain functions or activities that involve the use or disclosure of protected health information on behalf of, or provides services to, a covered entity. The Privacy Rule requires that a covered entity obtain satisfactory assurances from its business associates that the business associate will appropriately safeguard the protected health information it receives or creates on behalf of the covered entity. The satisfactory assurances must be in writing, whether in the form of a contract or other agreement between the covered entity and the business associate

As required under the Privacy Rule Standards, covered entities must develop operating policies that address the following:

- Designated Record Sets
- Procedures for Request for Amendment to Protected Health Information
- Patient Access, Amendment and Restriction on Use of Protected Health Information
- Use of Computer and Information Systems and Equipment
- Security Levels of Access and Limiting Disclosure and Use of Protected Health Information
- Privacy Training
- Complaint Management

HIPAA Considerations for Pre-Hospital Care Providers

Communications

The air medical service must take precautions to ensure that a patient's Protected Health Information is protected and communicated to others strictly on a "need to know basis"—or as defined in the HIPAA standards, "Minimum Necessary".

The regulation does not specifically state the mode of disclosure/transmission, so it is acceptable to pass on information in a written form, oral communication—discretion and a low voice is always advised when communicating orally and in a public setting, or via radio for the purposes of providing a radio “patch” to the receiving medical facility. In order to protect Protected Health Information during a radio patch, information should be limited to what the receiving facility needs to know about the patient to prepare for their arrival and treatment.

Informing the Patient of their Rights

Every patient is entitled to receive a copy of the covered entity’s Notice of Privacy Practices. The Notice explains when and how the covered entity can use and disclose the patient’s Protected Health Information without their consent and explains the patient’s rights regarding the use and disclosure of their Protected Health Information, along with their right to file a complaint.

It is imperative that this Notice is provided to all non-emergency patients at the time services are provided, and a signed receipt of the patient’s acknowledgement is obtained. In the event of an emergency transport, it is best to accomplish this, if the patient is able, at the time services are provided, however, if this is not practical, the Privacy Officer must be notified, in writing, so that other means may be take to ensure delivery of the Notice to the patient or their personal representative within a reasonable period of time.

Exchanging Protected Health Information with Medical Facilities

As required under the Ryan White Act, pre-hospital care providers are mandated to provide a copy of their Patient Care Report to the receiving medical facility upon arrival. This practice is permitted under HIPAA and does not violate the standards established in the Privacy Rule. Additionally, the HIPAA standards published in the Final Rule permit covered entities to share and exchange information with each other for the purposes of providing care/treatment, obtaining information for payment, and using the information for health care operations (i.e. quality assessment/quality improvement, education, etc.) without the consent or authorization of the patient or their personal representative. Thus medical facilities may provide pre-hospital care providers with face sheets and other records for these purposes without patient consent or authorization.

Safeguarding Patient Information

As a standard practice, all covered entities must have systems in place that assures the secure handling and safe storage of patient’s records containing Protected Health Information.

In conclusion, everyone has an important role to play to ensure compliance with these new standards.

The Privacy Officer is the key person in this setting as it is their job to ensure that all standards are met and policies enforced.

It is the responsibility of the staff who have direct contact with the patient to deliver and explain the organization's written privacy practices to the patient, and obtain, when possible, the signed acknowledgement receipt.

It is everyone's responsibility to ensure patient confidentiality and protect medical records and other individually identifiable information.

The consequences of not being compliant with these mandates is severe. Fines ranging from $25,000.00 to $250,000.00 along with civil and criminal prosecution are the price to pay for not complying with the HIPAA Privacy Rule.

ETHICAL ISSUES IN SELECTIVE PATIENT ACCEPTANCE OR REFUSAL

There are ethical considerations in the approval or denial of a patient for transport. When an air medical program is utilized as an EMS service making scene responses, the ethical use of the service requires that responses be made based on the time of the flight request without regard to means or ability to pay for those services.

Air medical services sometimes serve as a contracted transportation system. When conducting contracted transports, the decision to divert for an emergency request is that of the command and dispatch. Once a patient is on-board, the service is ethically obligated under the doctrine of "abandonment" to see the transport through to safe conclusion.

The air medical service must ethically put the safety of the aircraft and crew first, and any issues about the safety of the transport must be quickly and definitively resolved. Scene safety is the second priority, and the service must be concerned not to place the lives and safety of the public in jeopardy by attempting a landing or liftoff under unsafe scene conditions. Conditions that should cause concern include flying debris, downed electrical wires, multiple aircraft and/or vehicles already on scene, and the proximity of the public to the landing zone or aircraft. The patient acuity, safety concerns, and distance to the most appropriate facility may all pose ethical and legal concerns for the air medical provider. Whenever questions arise regarding appropriateness of air transport, a full description of the issues should be documented.

The air medical service may have affiliations and loyalties to particular hospitals and services that are in direct competition with each other or with particular flight or EMS services. It is not ethical to allow those competitive considerations to affect the delivery of competent health care in the air medical setting or to restrict access to emergency services based on relationships with specific hospitals. The air medical crew is ethically expected to act in the interests of mission safety and patient safety without regard to affiliation and to treat other services and their members with professional dignity and without demeaning or slandering the other service or hospital, its personnel, or its credibility.

Air medical personnel should be familiar with the contracts entered into by the service and respond as agreed with whatever personnel, response capability, and equipment contracted for. Specific procedures required by the contract should be complied with within the bounds of ethics, safety, and physical capability.

SUMMARY

The air medical transport environment poses many challenges for the vendor, agency, and EMS providers. Safe and appropriate patient care must remain the first priority regardless of the patient type, mode of transport, or geographic area served. The decisions and actions of the air medical crew will have a direct impact on the patient outcome and ultimately the liability of the agency, provider, referring facility, and receiving facility. Thorough documentation regarding the scene, patient assessment findings, treatments, and patient responses is the key to assuring the best possible prognosis for the patient while protecting the rights of the provider.

Exhibit 12-1: Air medical Aspects of COBRA is associated with this module.

EXHIBIT 12-1: Air medical Aspects of COBRA

COBRA (Consolidated Omnibus Budget Reconciliation Act) was passed in 1986 in response to the perceived need for federal law to guarantee access to health care for emergency patients. The law is also known as EMTALA (Emergency Medical Treatment And Labor Act). Various amendments to the law have added scope and details to the law, and regulations were issued by the Health Care Financing Administration (HCFA) in 1994 and site review guidelines were issued in 1994 and revised in 1998.

In addition, almost 1200 citations against hospitals to date have given insight into the interpretation of COBRA provisions by HCFA, and various court cases have defined how the courts will apply the law—sometimes with inconsistent standards.

In 1998, the Office of Inspector General (OIG) who is responsible for COBRA fines announced that it would also investigate transfers as potential Medicare Fraud and Abuse issues.

In 1999, the US Supreme Court issued an opinion that defines the medical screening requirements of the law as a “stand alone” provision, and that the transfer and stabilization rules of COBRA are to be read separately from those of the medical screening requirements. The practical effect of this is to apply a definition of COBRA rules that cover all patients, guests, and employees on hospital premises, if they are known to have an emergency medical condition. This represents a significant expansion of the scope of COBRA coverage as understood by many hospitals and systems.

The following material provides an overview of the current state of the law, regulations, and HCFA interpretations, along with risk-management recommendations for the air medical teams that are often involved in a transfer.

As court cases, HCFA and OIG enforcement actions, and legislative changes occur, this law will continue to evolve. Air medical systems should remain alert and prepared to adapt to the developing requirements and the potential for conflict with other state and federal requirements that affect the system.

It is important to note that hospital owned and operated systems have some direct duties under this law that do not apply to independent systems. Because of the complex organizational schemes in some health care organizations and air medical systems, your system attorney should carefully analyze whether your system is deemed “hospital owned and operated” for COBRA application.

Prepared by AMPA General Counsel:

Abigail R. Williams RN, JD, MPH
Abigail R. Williams and Associates, PC
370 Main Street Suite 1035
Worcester, MA 01608
1-508-795-1955

Regulation/Guidelines	Transport Team Implications
§489.24(a) **Definition: Emergency Medical Condition** means a medical condition manifesting itself by acute symptoms of sufficient severity (including severe pain, psychiatric disturbances, and/or symptoms of substance abuse) such that the absence of immediate medical attention could reasonably be expected to result in: ➢ lacing the health of the individual (or, with respect to a pregnant woman, the health of the woman or her unborn child) in serious jeopardy; ➢ Serious impairment to any bodily functions, ➢ Serious dysfunction of any bodily organ or part, or ➢ With respect to a pregnant woman who is having contractions that there is: inadequate time to effect a safe transfer to another hospital before delivery OR that the transfer may pose a threat to the health or safety of the woman or unborn child	The scope of an "emergency medical condition" is much more broad than the medical concept of an "emergent" patient. Care must be used to avoid lapsing into medical definitions when attempting to determine whether COBRA applies to a specific situation. The duty of the hospital where the patient presents is to provide a medical screening examination, including any necessary testing, to determine whether or not an emergency medical condition is present. Where a hospital mistakenly applies the standard of "emergent" to the situation, they often fail to provide sufficient evaluation or determine that they may move the patient to another facility when COBRA rules provide that they are required to retain the patient and provide services within their capabilities. The air medical service system is not responsible for making the determination of whether or not a patient has an emergency medical condition under this law, but may on occasion observe circumstances where the appropriate designation of a transfer as an emergency transfer or routine transfer is in question. The proper classification of the transfer is based on the legal definitions rather than medical definitions, and a general duty may arise to warn the transferring facility if the movement of the patient is counter-indicated in a medical sense, or when there is a question of the adequacy of transfer arrangements considering possible COBRA implications.
Definition: Active Labor, as defined in this section means the process of childbirth beginning with the latent or early phase of labor and continuing through the delivery of the placenta. A woman is in true labor unless a physician certifies that, after a reasonable time of observation, the woman is in false labor.	Active labor is essentially eliminated as a standard under COBRA, because the law has created a special COBRA protection for pregnant females experiencing contractions—they are deemed to be in true labor under this rule unless the physician has come in, examined the patient, and certified that the patient is in false labor. Generally speaking, an air transport of a pregnant female beyond 20 weeks gestation with contractions present involves a COBRA transfer of an unstable patient. This does not automatically preclude the transfer, but makes the transfer automatically subject to COBRA rules.
Definition: §489.24(c)(1) **Capabilities of a medical facility** means that there is physical space, equipment, supplies and service that the hospital provides (e.g. surgery, psychiatry, obstetrics, intensive care, pediatrics, trauma care) **Capabilities of the medical staff** means that the level of care that the personnel of the hospital can provide within the training and scope of their professional licenses	A hospital is required to provide services within its capabilities to evaluate and stabilize a patient, including the use of its on-call medical staff. Hospitals with the capabilities to treat a COBRA patient may not transfer them, except for patient requested transfers. Lateral transfers to essentially equal institutions are not permitted for COBRA patients, except by patient request. Hospitals and their medical staffs are not allowed to pressure patients into transfers for financial reasons. Air medical teams are not responsible for determining the capabilities of a hospital.
Definition: To Stabilize to provide necessary medical care to assure, within reasonable medical probability, that no material deterioration of the condition is likely to result from, or occur during, the transfer of the patient A non-labor patient is deemed stable under this rule if ➢ The treating physician has determined with reasonable clinical confidence that the condition has been resolved ➢ The patient is not at risk to deteriorate from or during the transfer process	When a patient has a risk of deterioration, or where the patient has not been completely evaluated, such as a patient being transferred for a "rule out" situation, CT scan, MRI, or diagnostic cath, the patient is deemed not to be stable by COBRA standards. Although COBRA places the responsibility to determine the stability of a patient under the law on the physician effecting the transfer, transfer crews have a general duty under negligence law to draw unsafe transfer conditions to the attention of the transferring facility prior to transfer. Where additional qualified personnel or life support equipment is not provided under circumstances where it is possible to add the weight to the transfer, it should be requested. If transport by air is not appropriate, the transferring facility should be advised prior to departure.

<table>
<tr><th>Regulation/Guidelines</th><th>Transport Team Implications</th></tr>
<tr><td>If the patient is pregnant with contractions present, the patient is not legally stable until the delivery of baby and placenta.

If there is a disagreement between the treating physician and an off-site physician about whether the patient is stable prior to transfer, the medical judgment of the treating physician usually takes precedence over that of the off-site physician.</td><td></td></tr>
<tr><td>Definition: Transfer means the movement including discharge of a patient outside a hospital's facilities at the direction of any person employed by (or affiliated or associated, directly or indirectly with) the hospital.</td><td></td></tr>
<tr><td>§489.24(d)(1) RESTRICTIONS ON TRANSFER:

If an individual at a hospital has an emergency medical condition (as defined by this section) the hospital MAY NOT TRANSFER the patient unless—
➢ The transfer is patient-initiated and is in writing documenting the hospital's obligations and the risks and benefits of the requested transfer

OR

➢ A physician has signed a certification that the medical benefits reasonably expected from transfer outweigh the risks to the patient or mother and unborn infant, and the certificate closely matches the time of the actual transfer

AND

➢ The transfer complies with the requirements for a medically appropriate transfer under the rules</td><td>Although the transfer crew has no COBRA duty to enforce the transfer standards, they should be aware of the requirements so that they know what to expect, and so that they can coach transferring hospital personnel on the usual documents and procedures that are expected in COBRA cases.

The transfer certificate signed by the physician should accompany the patient. The physician should be present and sign and time the certificate virtually as the patient departs the facility. Very short periods of time between signature and departure—as little as 8 minutes in one case—have resulted in citations. Similarly, the transferring facility must have discharge vitals timed at the time of departure. It is permissible for the transferring institution to document the transfer team vitals on hospital records in lieu of taking their own.</td></tr>
<tr><td>Definition: Medically appropriate transfer:

➢ Transferring hospital renders all care within its capabilities to minimize the risks of transfer

➢ The receiving hospital has accepted the patient for transfer prior to departure from the transferring hospital

➢ The transferring hospital sends all readily available medical records or copies with the patient</td><td>The requirements of a medically appropriate transfer are fairly self-explanatory, but deserve comment from the transfer team perspective.

If the transfer team questions the appropriateness of a transfer from medical grounds, it should draw the issue to the attention of attending personnel and attempt to obtain the necessary stabilizing care for the patient as necessary to minimize the risks to the patient, even if that means surgical or other interventions prior to transport.

The transport team should be reasonably assured that the destination hospital is aware of the transfer and has accepted the patient prior to departure with the patient. This seems prudent in all inter-hospital transports.</td></tr>
</table>

Regulation/Guidelines	Transport Team Implications
➢ The transfer is effected through qualified personnel ➢ The transfer is effected through qualified transportation equipment ➢ The transfer includes the use of necessary and appropriate life support equipment ➢ A written consent to transfer has been signed by the patient or responsible person acting on behalf of the patient ➢ Transfer is to a higher level of care	COBRA anticipates that the transfer crew will be provided the records of the patient for safe delivery to the receiving facility. The transferring facility may ask the transfer team to sign a form or other document evidencing receipt of the records. Qualified personnel are determined by the transferring physician. Where the flight crew does not have the qualifications or experience to effect the transfer safely, this should be made known to the transferring physician prior to transfer. It is reasonable for the transfer team to verify that the appropriate consents for transfer have been obtained prior to transfer. Many services use their own transfer consent form in addition to the hospital documentation to address those particular issues associated with air transport. It is not the transfer team's responsibility to determine whether the transfer is truly for a higher level of care, but where the transfer destination appears inconsistent with the patient's condition, the team may wish to inquire about the reason for the destination as an additional safe-guard.
"Comes to the Hospital" § 489.24(a) Requirements of this law apply only to individuals on hospital property. Hospital property includes ambulances (including helicopters) owned and operated by the hospital, even if the ambulance is not on hospital property. Hospital property includes non-owned ambulances that have entered onto hospital property. Tag A406—A patient has not come to the hospital for COBRA purposes if the patient is in a non-owned ambulance when personnel contact the hospital by radio or telemetry	If an air medical system is owned and operated by a hospital and makes scene responses, the patient is deemed to have presented to the hospital at the moment that they enter the aircraft. This is generally known as the ambulance rule. At least one hospital has been cited as a result of the hospital owned and operated helicopter taking a scene response patient to a hospital other than the owning hospital. HCFA activities with ambulances indicate that when the patient enters a hospital owned and operated ambulance or helicopter, the patient must be taken to the owner-hospital for medical screening and stabilization, unless: ➢ The patient or responsible party on behalf of the patient refuses transport to the owner hospital (preferably in writing) and requests another hospital OR ➢ A formal COBRA transfer is made via medical control prior to departing the scene The mere fact that state EMS regulations, system regulations, or trauma center regulations require a patient to be taken to the nearest facility to a trauma center or other specialty center does not authorize transport to those non-owner hospitals under COBRA. A recent court decision allowed a hospital owned ambulance to rely on directions given by the unconscious patient's employer to take the patient to a different hospital. It is uncertain whether HCFA would accept a verbal direction of a third party as sufficient, so it would be prudent to obtain written direction if possible. REPEAT: state law or system rules DO NOT control, COBRA rules do. The only exception to this is an untested reference in the site review guidelines that allows for compliance with "Community EMS Plans". The basis for a plan would be that it involves all hospitals, EMS providers, 9-1-1 dispatch, local governments, etc., so that all have agreed to its terms. The essence of the community plan is that the individual patient destination is controlled by objective standards that negate any chance of payment status influencing patient destination.

Regulation/Guidelines	Transport Team Implications
Diversionary status **§489.24(a) TAG A406** A hospital may deny access to patients when it is in "diversionary" status because it does not have the facilities to accept any additional emergency patients at that time. However if the ambulance disregards the hospital's instructions and brings the patient onto hospital grounds, the hospital cannot deny access for services.	Hospital-owned ambulances and aircraft would not be allowed to be diverted because when the patient entered the ambulance or aircraft, the patient was "on hospital property" Ambulances or aircraft that are not owned by the hospital, but have crossed onto the property (or landed) cannot then be diverted or patient refused.
USE OF HELIPADS Although there is no specific exception from the "on the grounds" definition of when a patient has come to the hospital contained in the regulations, HCFA has indicated in written opinions that use of a helipad located on hospital premises does not automatically involve the hospital where the pad is located if— ➢ The pad is used for exchange of the patient from ground ambulance to or from a helicopter for specific pre-arranged transport to another hospital No request is made by the ambulance crew or helicopter crew for assistance from the hospital upon whose pad the helicopter has landed or will land	If the sole purpose of using the pad at hospital A is to facilitate movement of the patient to another hospital (excluding hospital owned systems), HCFA is allowing the "on the property" rule to be ignored. Examples given by HCFA officials include helipads located on the roofs of the hospital as NOT creating COBRA liability for the hospital under these circumstances. Other examples given by HCFA officials state that if the helicopter crew asks for physical assistance in loading the patient, this is NOT a request that would make the hospital responsible for COBRA compliance with the patient—i.e. medical screening and stabilization. Even the situation where the air crew requested to use a treatment room to complete packaging of an ambulance patient before a helicopter transport was used as an example of the helicopter pad rule, stating no COBRA duty was assumed by the hospital for allowing use of the treatment room. (Now, hospital counsel might have medical malpractice or medical staff privilege issues with that situation.) It appears that if the ambulance or helicopter crew requests medical assistance with stabilizing the patient, the hospital with the helicopter pad has assumed full COBRA responsibility for the patient.
Transfer of responsibility for the patient: COBRA does not specifically address the issue of hand-off of medical responsibility for the care of the patient.	The transferring physician remains responsible for COBRA compliance until the actual departure of the patient. That responsibility will make the physician responsible for assuring that a medically appropriate transfer was initiated, but actual care of the patient becomes a question of professional liability once the transfer is made. That liability typically is that of the flight crew and their medical director, or the physician providing online medical control during the flight.
Potential penalties for violation of the law: COBRA provides specific penalties for technical or substantive violations of the law, regulations, and rules. No patient harm need occur for administrative penalties. ➢ Hospital—Notice of termination from Medicare (23-day notice) ➢ Hospital—Fine of up to $50,000 per violation ➢ Physician—Fine of up to $50,000 per violation Any patient injured by a violation of COBRA is authorized to file a special COBRA lawsuit in state or federal court.	Only hospitals and physicians are subject to HCFA fines or exclusion from Medicare. Only hospitals are subject to COBRA law suits. Nurses, physicians, paramedics, and others in the health care system are not directly liable for COBRA violations, although professional discipline actions have been based on COBRA violations by individual health care providers. It is also possible to use COBRA as a standard for medical malpractice actions.

A. Bibliography

Accreditation Standards of the Commission on Accreditation of Medical Transport Systems. 4th ed. South Carolina: 1999.

Air medical Crew National Standard Curriculum. 1st ed. California: ASHBEAMS, 1988.

Lee, Genelle. *Flight Nursing Principles and Practice*. Mosby, 1991.

McCleary, Nancy. “Air medical Transfers: Are you COBRA Compliant?” *AirMed* Oct–Dec, 1997: 113.

B. Definitions of Keywords:

Competency—Capable, having sufficient ability

Consent—To give permission or approval

Battery—Intentional and wrongful physical contact with a person without his or her consent that causes an injury

EMTALA—A law governing the examination, stabilization, and treatment of a person presented to an emergency department that receives Medicare and/or Medicaid funding

Civil—Relating to the private rights of an individual

Criminal—Relating to or being a crime and its punishment

C. Test Questions:

1. Who is responsible for transporting records on an interfacility transport?

    a. The receiving hospital
    b. The transferring hospital
    c. **The transport team**
    d. The patient’s family

2. Who is required to obtain informed consent to transfer under federal EMTALA rules?

    a. Air medical providers
    b. **Transferring hospitals**
    c. Receiving hospitals
    d. The patient’s family

3. What is EMTALA?

   a. Emergency Medical Transfer Act
   b. Emergency Medical Transfer and Liability Act
   c. **Emergency Medical Treatment and Active Labor Act**
   d. None of the above

4. What does EMTALA require?

   a. Payment for the transfer of the patient
   b. **The sending institution to provide an appropriate transfer of the patient**
   c. For the patient to be transferred if they are unable to pay
   d. None of the above

5. What are the key ethical issues in selective patient acceptance or refusal?

   a. Competitive considerations
   b. Patient's ability to pay for the services
   c. **Responses must be based on the time of the flight request**
   d. All of the above

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Federal regulations and how they affect the air medical program's daily operations, etc.
- State-specific rules and regulations regarding scope of practice, liability, reciprocity of practice with other states, etc.
- Program-specific information on insurance coverage, consents, hospital agreements, etc.

F. **Patient Care Hours**: N/A

MODULE 13: QUALITY ASSURANCE AND UTILIZATION REVIEW

Author: Ms. Connie Schneider, RN, Senior Associate, Fitch & Associates, Platte City, MO

Reviewer: Dr. Ira Blumen, FACEP, Program/Medical Director of UCAN, University of Chicago Hospitals; Associate Professor, Dept. of Emergency Medicine, University of Chicago, Chicago, IL

KEYWORDS

Quality
Quality assurance (QA)
Continuous quality improvement (CQI)
Total quality management (TQM)
Indicator
Thresholds/benchmark
Process
Utilization review

OBJECTIVES

Upon completion of this chapter, the participant should be able to:

- Define quality assurance, quality improvement and quality management
- Describe the role of regulatory agencies in monitoring quality and appropriateness
- Discuss the "Baldrige Award Criteria" and how it applies to transport services
- Identify the components to be included in a quality management plan for the transport service
- Discuss the roles and responsibilities of the medical director and off-line medical control physician in the quality program

INTRODUCTION

Webster defines quality as a "degree of excellence." W. E. Deming defines quality as "the means anticipating the needs of the customer, translating those needs into a useful and dependable product, and creating a system that can produce the product at the lowest possible price, so that it represents 'good value' to the consumer and profits for the enterprise." Every employee should understand how their organization defines quality and be responsible for incorporating quality and excellence into every aspect of the organization.

As medical professionals, we have been used to describing quality in terms of delivering patient care. Today, most organizations, including hospitals, define quality in terms of how the customer's expectations are met. Customers are not only patients and their families, but include employees, referring and receiving physicians, nurses and pre-hospital personnel, payers, suppliers, businesses, regulatory agencies, and many others who want better access to health care, safe transports, lower costs and the highest quality.

QUALITY ASSURANCE AND QUALITY IMPROVEMENT

QA in health care was defined and started by the Joint Commission on Accreditation of Hospitals (JCAH) in 1979. JCAH introduced quality assurance, and hospitals began auditing their quality activities.

QA is a problem-driven process and has a beginning and an end. That is, for example, work processes are not addressed until problems with those processes are identified. Additionally, finite numbers of data are collected to prove or disprove the presence or absence of a problem. QA has traditionally focused first on the "problem" identified and second on the individual who caused the incident or problem. Typically, QA involved only one or two individuals (a QA coordinator) who would perform retrospective audits on identified items (such as documentation), and there was little or no participation from the rest of the organization. Additionally, there was little or no training provided to employees and management about quality assurance.

In 1987, JCAH implemented new standards requiring the integration and coordination of quality assurance activities into a hospital-wide program that was comprehensive in nature and focused on problems relating to patient care. The 10-step QA model is defined as follows:

- Assign responsibility
- Describe the scope of service
- Identify aspects of care that are high-risk, frequent, or problem-prone
- Develop indicators, measurable components
- Establish thresholds
- Collect and organize data
- Analyze data
- Create an action plan
- Evaluate the effectiveness of action
- Communicate relevant information

As health care expanded beyond hospitals and the Commission started accrediting health care facilities, JCAH changed their name to become the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). In 1992, JCAHO transitioned from QA to continuous quality improvement (CQI), which produced significant changes in how hospitals performed quality activities. JCAHO recommended that health care could be improved by:

- Focusing on all key activities of the organization (including direct care, governance, management, and support services)
- Coordinating efforts throughout the organization
- Using effective performance measures to collect reliable data
- Addressing processes that have direct or indirect effects on patient outcomes, including those that cross internal organizational boundaries
- Focusing primarily on opportunities to improve these processes rather than looking only for isolated "bad apples"

Quality improvement (QI) builds upon traditional quality assurance methods by emphasizing the organization and systems, focusing on "process" rather than the individual, recognizing both internal and external customers, controlling of variation, and promoting the need for objective data to analyze and improve processes. QI is also proactive and not reactive.

QI requires more data collection to identify the root causes of the process before the problem is corrected. QI also encourages the graphical display of data over time in charts, plots, and graphs.

CQI has to be driven by the top management and works best with an organization-wide approach. Education in QI is a must for all levels of the organization. For a comparison of QA, QI, and TQM see Exhibit 13-1.

TOTAL QUALITY MANAGEMENT

Quality management is an American creation of the 20th century. It was W. Edwards Deming who, for all intents and purposes, created this quality movement in an industrial model in the United States.

Deming's philosophies involve employees, customers, and top management. Management must be committed to improvement and must implement change by analyzing the collected data utilizing statistical process controls, training all employees on quality, and continually improving. This will lead to increased customer satisfaction, and improving cost-effectiveness and overall services.

Deming's 14 points build on his philosophy of TQI. He believed these steps were vital and must be practiced by management to implement quality management throughout an organization:

- Create constancy of purpose
- Adopt the new philosophy
- Cease dependence on mass inspection
- Constantly and forever improve the system
- Remove barriers
- Drive out fear
- Break down barriers between departments
- Eliminate slogans, exhortations, and targets
- Eliminate work standards, quotas, and numerical goals
- Institute modern methods of supervision, leadership
- Institute training on the job
- Institute a program of self-improvement and retraining
- End the practice of awarding business on price alone
- Put everybody to work to accomplish the transformation

Multidisciplinary teams are an important ingredient in the Deming model and can be used to effectively resolve problems and continuously improve. Everyone understands that when employees work together, operations are successful. Without an atmosphere of mutual respect, with no fear of making a mistake, management system will not work.

Proper training in quality includes more than the traditional didactic lectures. Training should encompass how quality affects actual job performance, methods to measure quality, and often, learning how to be a facilitator. Training must be a continual effort where all members of the team share knowledge and experience. Management must recognize the need to educate and retrain people, as people are assets to the organization. For a comparison of QA, QI, and TQM see Exhibit 13-1.

NHTSA LEADERSHIP GUIDE TO QUALITY IMPROVEMENT FOR EMS SYSTEMS

NHTSA developed the "Leadership Guide to Quality Improvement for EMS Systems" in 1997. This guide was written to assist EMS services in aligning their values with the needs of their customers, both the patient and the entire community, and to improve the quality of their services.

The NHTSA Leadership Guide uses the Malcolm Baldrige Quality Program as a model to guide your organization's quality improvement efforts and to evaluate your progress. The Baldrige program identifies seven key action areas or categories, which are:

- **Leadership** involves senior management leading by example to:

  - Integrate quality improvement into the entire organization
  - Initiate strategic quality planning
  - Define the mission and operational objectives clearly
  - Promote quality values
  - Empower the work force to implement quality techniques into everyday work practices

- **Information and Analysis** concerns selecting, managing, and using the data needed for effective overall improvement. The data must be meaningful, defined as data sets, rapidly accessible, operationally defined or standardized, and timely. The types of EMS data to collect could be:

  - Patient records/ambulance run forms (for example, documentation of certain information)
  - Payer and collections information (for example, turn times on account receivables)
  - Stakeholder information (for example, job satisfaction, turnover, safety, recognition issues)
  - Customer satisfaction data (for example, timeliness, professional approach, quality of care, safety)
  - Process data (for example, receiving a request for transport)

  The data must be managed by education about what data should be collected, designing procedures to collect and record the data, adopting registry software to automate data entry, defining reporting capabilities, analyzing and trending the results, sharing the data with the employees and customers, and benchmarking the data with better performers.

- **Strategic Quality Planning** involves the following components:

  - Developing long- and short-term organizational objectives, a vision statement, underlying assumptions that affect planning
  - Identifying clear goals that define the expected outcome of the QI efforts and ways to achieve those objectives
  - Identifying the key functions, key processes, or critical success factors of the system
  - Focusing on patients and stakeholders, such as
    - *Employees*
    - *Patient's family*
    - *Community*

        - *Government agencies*
        - *Payers*
        - *Referring and receiving hospitals*
        - *Hospital personnel (physicians, nurses, others)*
        - *Suppliers*
    - Developing measurable objectives or indicators to measure progress and compliance with the indicators
    - Developing and implementing action plans to bring the system into compliance
    - Measuring and evaluating the impact of the action plans and the effectiveness of the system in achieving quality standards

- **Human Resource Development and Management** involves working to develop the full potential of the EMS workforce. Human resource planning includes:

    - Redesigning work processes or jobs to increase opportunity, responsibility and decision-making
    - Addressing work process design to improve flexibility, efficiency, and delivering high-quality care
    - Addressing crew composition and self-directed responsibility
    - Ensuring effective communication processes
    - Addressing education and training of employees and forming partnerships to increase training opportunities;
    - Addressing compensation, recognition, and benefits
    - Addressing recruitment and retention strategies

- **EMS Process Management** examines how key processes are designed, managed, and improved to achieve higher performance. Process management is used to refer to the improvement of work activities and workflow across functional or departmental boundaries. EMS processes to improve may include:

    - Expanding scope of EMS practice to include prevention or primary care
    - Developing critical indicators for each key health care service
    - Managing support services to meet ongoing quality standards and drive continuous improvement
    - Managing supplier performance to include:
        - *Contracts, partnerships, long-term agreements*
        - *Effective communication with joint planning and sharing data*

    - *Use of benchmarking and comparative information*
    - *Developing customer-supplier teams*
    - *Developing incentives and recognition strategies*

- **EMS System Results** entails assessing the quality results achieved and examining the organization's success at achieving quality improvement. The performance of the organization can be measured in relation to target goals and objectives. Quality improvement activities are designed to positively affect the key drivers or performance areas that are most critical to the success of the EMS system. The key drivers or critical success indicators that are measured may include:

  - Productivity indicators to include EMS assets and resources
  - General financial performance indicators
  - Human resource indicators such as safety, job satisfaction, recruitment, retention
  - Supplier performance indicators such as service dependability and availability
  - Process results such as all turnaround times and delivery of clinical services
  - Outcome results such as defined in the "5 Ds"
    - *Death*
    - *Disability*
    - *Discomfort*
    - *Dissatisfaction*
    - *Destitution (treatment provided at lowest cost*)

- **Satisfaction of Patients and Other Stakeholders** involves ensuring the ongoing satisfaction by those internal and external to the EMS system with the services provided. Effective communication is required between patients and stakeholders involving praise, complaints, and comments. Comparing the customer satisfaction to standards or other similar systems is often helpful in identifying strategies for satisfaction improvement.

  To integrate and implement quality into an organization or system requires planning and several years to accomplish. The Baldrige categories provide a model to guide your organization's or system's quality efforts and to evaluate your progress as you proceed.

COMPONENTS OF THE QUALITY PLAN

The quality plan for your organization or system should include certain components that then become a written tool to provide an effective organizational approach to all quality activities.

Purpose

The purpose of the quality plan is to:

- Define and communicate the plan's goals and processes to all employees
- Enhance performance improvement of the service
- Describe the method for integrating the plan with employee duties and the transport service's mission and vision
- Outline the approach, process, and methods to be utilized
- Define the methods to measure and obtain compliance with regulatory and accrediting agencies

Responsibility/Accountability

The board of directors of the organization/service has the final authority and accountability for implementation of a comprehensive and integrated quality plan. The quality plan must define the organizational structure of responsibility for the quality activities. The roles of the committee or work group, which is multidisciplinary, are defined as:

- **Quality Committee**
  - Assist in designing the Quality Management (QM) plan
  - Implements the process and system for monitoring various indicators or benchmarks
  - Compiles data and trends derived from the monitoring activities
  - Makes recommendations for improvements
  - Evaluates the effectiveness and changes

- **Quality Committee Chair**
  - Directs the committee activities
  - Promotes "buy-in" from the staff on data collection and changes for improvement
  - Obtains additional training as necessary
  - Liaisons with human resources for data collection, statistical analysis, educational opportunities, etc.

- **Management**
  - Assumes an active role
  - Is ultimately accountable
  - Participates on QM committee
  - Facilitates work of the QM committee
  - Provides resources to the QM committee as needed
  - Evaluates data, trends, outcomes

- Approves various recommendations for improvements
- Liaisons with hospital QM department, risk management and legal counsel

- **Medical Director**
    - Assumes an active role
    - Reports to Medical groups
    - Responsible for medical control physicians
    - Reviews transports for appropriate utilization
    - Writes and approves medical protocols
    - Reviews appropriateness of medical care delivered
    - Supervises and participates in initial orientation and continuing education
    - Evaluates patient outcomes
    - Facilitates research from data derived from quality activities

- **Clinical Manager**
    - Assumes an active role with clinical quality activities
    - Works closely with medical director and management
    - Participates in monitoring indicators or benchmarks
    - Assists in trending data and making recommendations
    - Educates employees as needed
    - Evaluates quality activities and improvements

- **Aviation or Ground Ambulance Company**
    - Participates in quality activities
    - Monitors aviation or ground vehicle related quality indicators

- **Safety Committee Chair**
    - Integrates safety and quality issues
    - Liaisons and reports back to the safety and quality committee on safety-related issues

Reporting of quality activities occurs according to the administrative structure of the service and includes (as appropriate), but is not limited to:

- Quality committee
- Safety committee
- Management (clinical manager, director, or president)
- Quality council and safety committee at a hospital
- Board of Directors
- Contracted services management
    - Aviation operator/ground ambulance
    - Communication center personnel
    - Medical personnel

- Risk management
- Legal counsel

Mission, Vision, and Values Statements

A committee or team of employees should work together to develop the mission, vision, and values statements, which will promote employee buy-in throughout the organization. The mission statement should reflect what you do, why you do it, who you do it for, and how you do it. The vision statement should define where and what the organization or system wants to be in 3 to 5 years. Finally, the values statement should reflect the personal values of the organization and the employees.

Goals and Objectives

A committee should work together to identify common quality goals and objectives for the organization or system. These goals are important as they then provide the framework for all quality activities. These quality goals and objectives may include, but are not limited to:

- Providing a consistent organization-wide approach to process improvement
- Supporting the mission and achieving the vision by accomplishing the goals
- Continually assessing, improving, and evaluating performance related to key functions and processes, organizational priorities, and customer expectations
- Integrating customer feedback and demonstrating value to satisfy customers
- Evaluating outcomes of the service and identifying opportunities for improvement
- Promoting collaborative and multidisciplinary team activities to improve services
- Demonstrating cost effectiveness and efficiencies as an outcome of QI
- Benchmarking performance with better performers
- Complying with requirements of regulatory and accrediting agencies

Scope

The quality plan's scope focuses on all key functions and processes that result in achieving specific goals and/or outcomes and may include, but are not limited to:

- Important aspect(s) of care
- Key activities or functions
- Customer satisfaction
- Organizational performance
- Management of resources

Critical Success Factors

A successful organization will identify certain critical success factors, which are the outcomes required for the organization to succeed. The quality plan should identify these outcomes. Examples of these critical success factors or desired outcomes may include, but are not limited to:

- Safety of transport
- Internal and external customer satisfaction
- Quality patient care
- Appropriate air medical patient transports
- Efficiency of the operations
- Cost-effectiveness of the service, and
- Financial stability of the service.

Approach/Process

The quality plan must utilize a logical and simple approach to standardize the processes and quality activities. The quality committee should utilize one of these approaches with each indicator it monitors.

- Shewart and Deming developed the Planning, Doing, Checking, and Acting (PDCA) Cycle as an approach to performing continuous improvement. The PDCA Cycle can be easily utilized when performing quality improvement. See Exhibit 13-2 for a pictorial display of Deming's PDCA Cycle.
- Hospital Corporation of America's approach includes PDCA and expanded it into a 9-step process called FOCUS-PDCA, which is defined as:
    - F—Find a process to improve
    - O—Organize a team that knows the process
    - C—Clarify current knowledge of the process
    - U—Understand causes of process variation
    - S—Select the process improvement
    - P—Plan improvement and data collection
    - D—Do improvement, data collection, data analysis
    - C—Check the data for process improvement, customer outcomes, and lessons learned
    - A—Act to hold gain, to reconsider owner, to continue improvement

- American College of Emergency Physicians recommends the DEALER approach or method to standardize EMS Systems quality processes, which is:
  - D—Delineate the problems identified
  - E—Elaborate on the cause(s) of the problem
  - A—Aid the problem and develop a remedy(ies)
  - L—Lay out a plan to correct the problem
  - E—Enforce the plan of correction
  - R—Reexamine the problem

Any one of the above methods will standardize the quality processes and the organization should utilize or adapt the method/approach which will work best for them.

Methodology

Once key functions and critical success factors or outcomes the organization wants to achieve are identified, the development of quality indicators becomes easier. An indicator is defined as a quantitative measure of conformance to a standard such as patient and/or customer requirement and then a measurement of the gap between what is and what should be. An indicator measures the specific occurrence, objective event, facet of treatment, or outcome. Clinical indicators frequently measure important aspects of patient care such as high-risk, high-volume, problem-prone activities within the service and may require ongoing routine evaluation.

Medical transport organizations may include the following types of indicators in the quality plan:

- Outcome indicator: measures result of a process(s)
- Process indicator: measures an activity or process that is performed to provide care for patients
- Rate-based indicator: measures events for which a certain proportion of the events that occur are expected.
- Sentinel event indicator: measures a serious event that requires individual review for each and every occurrence of the event

Exhibit 13-3 lists examples of indicators to monitor in your quality plan. Exhibit 13-4 is a quality form that illustrates indicators, critical success factors, key functions and an action plan which can be utilized in your quality plan.

If one of your organization's critical success factors is appropriate air medical transport, then a utilization review process will need to be included as an important indicator to measure.

The Association of Air Medical Services (AAMS) and the Commission on Accreditation of Medical Transport Services (CAMTS) have both developed criteria to measure the appropriateness of specific patients to be transported. (See Exhibits 13-5–13-10 for the specific criteria).

Each air medical transport service must determine what patients are appropriate to transport based on:

- Time and distance indicators when the closest appropriate facility is too great for safe and timely transport by ground ambulance;
- The patient is time-critical and/or requires a higher specialized level of care and specialized equipment than available on the ground ambulance
- The patient is located in an area that is inaccessible to regular ground transport due to road obstacles and conditions, traffic congestion, or construction

Additionally, each transport service must develop a prospective screening process and retrospective chart audits with an associated educational peer review process to determine if the patient transport met their specific criteria.

The quality plan will have pre-established, attainable “thresholds” (or percentage) of compliance for certain indicator(s) (e.g., 95 percent threshold for successful intubations). Thresholds can be finite, predefined trends or pre-established levels of performance and are usually internally determined by the service.

Benchmarks are considered to imply an externally determined level of performance. Thresholds and benchmarks are at times used interchangeably. Performance at or above the threshold or benchmark is thought to demonstrate compliance with the standard.

Quality Tools

Improving quality can be a subjective process. Quality tools provide a scientific approach or a systematic way for committees and employees to learn about processes. Utilizing quality tools provides an approach to make decisions based on data rather than guesses; to look for root causes of problems rather than react to one part of the process; and to seek permanent solutions versus quick fixes. The committee and employees will need education and perhaps the assistance of a statistician to properly utilize quality tools.

Data Collection Tools

Collecting data is the first step in utilizing quality tools and providing a systematic approach to objectively improve processes in your organization. Checksheets or checklists provide a structured form to collect data. The forms should be designed for clarity and ease of data collection. Individual interviews or focus groups also provide methods to collect data. Typically a facilitator is utilized in this structured environment of data collection. Surveys can also be utilized to collect data. A mail survey typically returns only 4 percent unless the results of the survey are really meaningful to the person surveyed. A Likert Scale should be utilized in the surveys or questionnaires to measure the subjective data. The Likert Scale utilizes a seven-point rating scale and measures the strength of the opinion of the person completing the survey. See Exhibit 13-11 for when to utilize the various data collection tools and Exhibit 13-12 for when and what QI tools and techniques to utilize in your quality plan.

QI Improvement/Scientific Tools

The data elements should each be defined operationally. The quality or data collection committee must work on achieving consensus on the definition of each piece of data to be collected. The data must be defined as to how it will be measured, what exactly is to be measured, and what methods are utilized to collect the data.

Flow charts are utilized to provide a visual picture or graphic representation of a process. The flow chart can be utilized to communicate a standard language and understanding of the process. Symbols can be utilized to show the steps or sequences in the process. There are several types of flow charts are useful: top-down flow charts, detailed flow charts, workflow diagrams, and deployment charts.

The Fishbone Diagram or also called the Cause-and-effect Diagram is a pictorial display of the relationship between the possible causes and the effect. It is primarily used in identifying the root cause of the problem or process being studied. The head of the fish is the main process or effect under discussion, and the spine of the fish has diagonal ribs that are the causes or categories, sometimes remembered as the 5 Ps: Patrons (external customers), People (internal customers), Provisions (equipment and supplies), Places (work environment), and Procedures (policies, medical protocols, etc.). Brainstorming is an effective way to identify the causes and how they are interrelated.

Storyboards can be used to organize, prioritize, and place ideas into categories. Storyboards are also an effective way to depict and prioritize processes to improve.

Scatter diagrams are used to show relationships between two processes, whereas a dot plot shows one characteristic of a process at a time. The Scatter Diagram tells you if and how the two variables are related.

Control charts are used to depict continuous and discrete data. A control chart monitors the process by utilizing a line graph to see whether the process is in statistical control with an average line and control limit line(s). The data points, which stay within control limits, indicate most variation comes from common causes. The control chart is essentially a time plot with a range of variation built into the system.

Run chart is often called a trend or line graph. The run chart shows the direction or trend over time. The x-axis shows the time, the y axis shows the measurement scale, and the data values are shown as points connected by lines.

Pareto Diagram helps identify what category of the process is most significant. The Pareto Diagram is frequently depicted as a bar chart. The Pareto rule is that decisions to prioritize or improve should be made on the 20 percent of the problems that cause 80 percent of the troubles.

Histogram shows frequency distribution and patterns in dispersion of continuous data or discrete data sets. The histogram can be a line or bar chart and is utilized to identify trends.

A pie chart is a circular graph that illustrates the percentage of each item compared with 100 percent of the whole. A pie chart can be used to show proportions of relative importance.

The frequency chart compares the differences in quantities for discrete data. It is best used with exact whole numbers and less than 20 unique data values.

QI Team Decision Making and Advanced Tools

The nominal group technique or brainstorming is a structured technique to generate ideas and encourage creativity and involvement of employees. First, all employees present the ideas in a round-robin fashion until they are out of ideas. Then the group ranks the ideas by voting on the highest issues, which become the top priorities. Brainstorming also identifies resistance areas during the discussions.

Multivoting is a method to reduce a long list of ideas into a smaller list. Multivoting is not to be utilized if consensus is to be achieved.

Decision matrices are useful to prioritize efforts and determine where the organization's resources are to be spent.

Force field analysis, sometimes known as a gap analysis is used to identify the driving forces that restrain changes or forces in a situation. A Gap Analysis is useful when understanding is needed between different views also. An action plan can be formed from the gap between where you are and where the organization wants to be.

Planning Techniques

The Hoshin Planning Technique is utilized when the planning process needs to be broken down into general, intermediate, and detailed planning. It is a complex process that utilizes other quality techniques.

Strategic planning can be utilized to develop common goals, mission and vision statements and to operationalize action plans. Involving committees or employees in strategic planning creates buy-in towards the organization's strategic goals and action plans.

Process Design Models

Critical paths are developed to define and organize care processes for multidisciplinary teams caring for the patient. Variances to the critical path then provide information, which is analyzed to improve patient outcomes.

Clinical guidelines, sometime referred to as medical protocols, provide direction for medical personnel to follow. Deviations from medical protocols are tracked and analyzed according to patient outcome and discussed in peer review and educational sessions.

Measurement Techniques

Patient outcomes are measured by various tools related to complications, morbidity, and mortality. The Case Mix Index, TRISS, Functional status, return to work status, and quality of life are just a few of the measurements that can be performed.

Benchmarking is a strategy of examining the best practice and comparing your organization to the better performers. Benchmarking can measure comparative data such as reimbursement or lift off times. Process benchmarking can measure key functions or processes and lead to process improvement.

Recommendations and Actions

Recommendations and actions items based upon quality improvement activities will be made for each key function, process and indicator evaluated. An action plan should be developed which defines the steps to be taken, the responsible party with a timeline, and how the recommendations and changes will be evaluated.

Evaluations

All quality improvements implemented will be evaluated based on the appropriate timeframes for each improvement. Any additional data and trends to be monitored in the future should also be identified during the evaluation, along with any further recommendations and resolutions. Evaluating the recommended changes is critical after any process improvements.

Annual Review

The organization should review the quality plan annually. The review will identify the current plan's initiatives, any new or revised objectives set for the year, effectiveness in achieving objectives, planned and actual outcomes achieved, and limitations and barriers encountered.

SUMMARY

Implementation of a Quality Program

Teamwork is the essence of the quality improvement program. The QI committee must involve, educate, and integrate all employees in the quality program. The following questions may provide a checklist approach to implementing your quality program:

- Have the QI committee and leaders been identified?
- Has a structure been established for the QI committee?
- Has training been performed for the employees on the QI committee? Their role?
- Does the QI committee understand its role and boundaries?
- Has a procedure been developed to identify key functions, critical success factors, and indicators to review?
- Have the important aspects of care and service that will be monitored on an ongoing basis been identified? (These will include rate-based and sentinel effect indicators.)
- Has a procedure been developed to establish thresholds for certain indicators?

- Which data collection methodology and approach (PDCA, FOCUS-PDCA, or DEALER) will be utilized?
- Which QI data tools and statistical analysis procedure(s) will be utilized?
- Has a procedure been developed by which all affected personnel receive results, recommendations for action, and further evaluation feedback?
- Has a procedure been developed to obtain and provide feedback to the organization's personnel?
- Has a procedure been developed by which processes are acted upon, re-evaluated, and improvement is maintained?

Developing and organizing a quality plan is a "journey" at best. Establishing leadership commitment, the infrastructure, multidisciplinary committees/teams, and employees' involvement will begin the journey. Providing the employees with training and the resources to develop the plan will be the next steps. Educate the committees to look at processes to improve and limit the indicators to monitor continuously. Finally, reward the employees for their quality efforts and improvements.

The following exhibits accompany this module:

EXHIBIT 13-1: COMPARISON OF QA AND QI/TQM

Characteristic	Quality Assurance	QI and TQM
Scope	• Actions directed toward individuals • Addresses clinical issues	• Actions directed toward processes • Addresses all issues and systems
Leadership	• Middle management, clinical leaders • Individuals performing QA • QA committees • Thought quality is expensive	• All leaders and management • Top management committed to QI program • Involves QI Teams • Believes quality leads to lower costs
Goals	• Set retrospectively	• Set prospectively
People Involved	• QA Coordinator and committees • Limited involvement	• All employees "buy in" to QI • Total involvement of organization
Education	• Educated individual who performed QA	• Management and all employees educated • Employees learn useful management & problem-solving techniques
Purpose	• Problem solve individual issues • Defects are caused by employees	• Continuous improvement even if no problem was identified • Most defects are caused by the system and the process is defective
Focus	• Individual components each doing own QA—vertically focused • Inspection and audits • Structure- and outcome-oriented	• Horizontally focused—all processes in the organization can be addressed • Improve processes & then evaluate process with retrospective inspections • Process- and outcome-oriented
Customers	• Customers are patients	• Customers are everyone: patients, employees, payers, physicians, plus others, and QI is customer-driven
Requirements	• Standards set by experts and professionals	• Continuously improving standards and customer expectations
Methods	• Chart audits • Indicator with threshold monitoring • A lot of data collected but problems not necessarily resolved	• Multiple methods • Threshold becomes starting point for QI • Solves the causes of variations in the system
Outcomes	• Includes monitoring & measurement • Performance improved by individuals involved • Individuals may be disciplined or become defensive • Profit is most important outcome	• Includes monitoring & measurement • Performance improved by all employees • Reduces threat to individuals and promotes team and employee ownership in improvement • Customer satisfaction, quality, efficiency, and many other measurements are desired outcomes, plus profit
Continuing Activities	• Continuous monitoring on deviations from standards or thresholds • Follow-up on special cause deviations	• Monitor processes and continually improve standards • Follow-up on special or common-cause deviations

EXHIBIT 13-2: DEMING CONTINUOUS IMPROVEMENT CYCLE

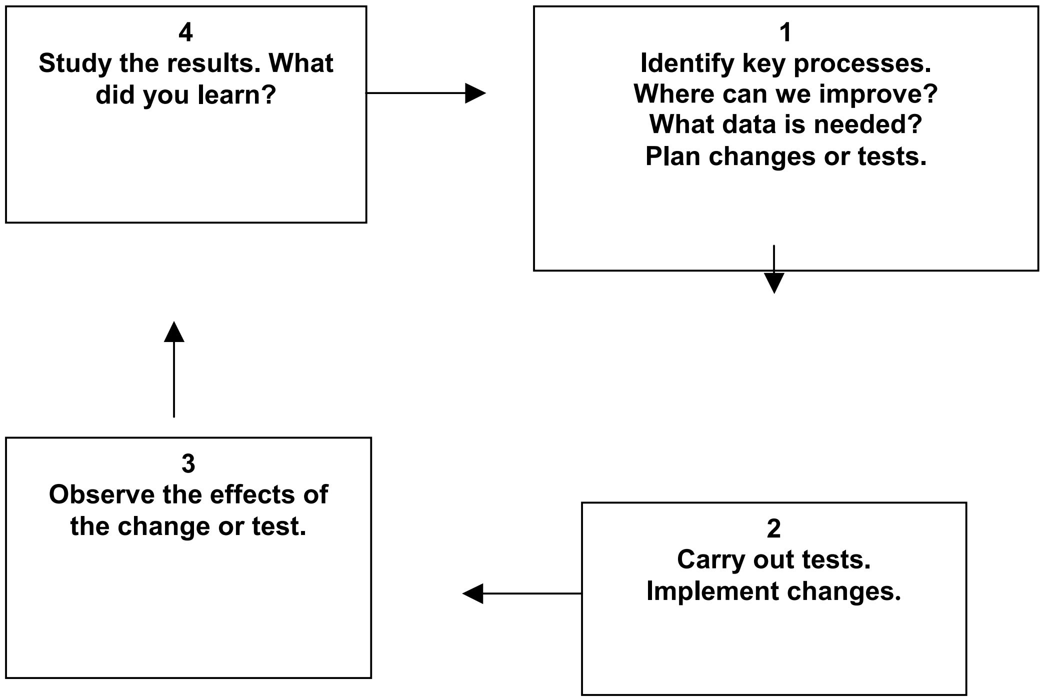


EXHIBIT 13-3: EXAMPLE LIST OF INDICATORS

- Customer Service/Satisfaction
  - Customer satisfaction surveys
  - Focus groups on customer satisfaction
  - Employee satisfaction (retention, turnover, recruitment)
  - Supplier satisfaction

- Aviation/Flight Operations
  - Safety Committee issues
  - Back-up aircraft orientation
  - Back-up aircraft requirements
  - Fuel quality
  - Aborted flights
  - Precautionary landings
  - Missed flights for maintenance
  - Missed flights for weather (what kind of weather)
  - Aborted or canceled flights for weather
  - Aborted or canceled flights for maintenance
  - Out-of-service time
  - Local area orientation
  - Specific aircraft training and hours
  - Pilot recurrent training
  - Mechanic recurrent training
  - Compliance with OSHA
  - Compliance with program policies
  - Practicing cockpit resource management techniques (e.g. flight crew discussion to abort or decline a transport)
  - Communication with ground units prior to landing aircraft
  - Annual aircraft training for medical personnel
  - Preflight and postflight debriefings attended and issues trended
  - Patient safety issues
  - Survival equipment updated
  - Performance benchmarks
  - Contract performance
  - Attendance at meetings
  - Customer satisfaction measurements

- Communication Center
  - Documentation complete
  - Response times
  - Preaccident/incident plan implementation and utilization
  - Performance benchmarks
  - Contract performance
  - Customer satisfaction measurements

- Medical
  - Patient outcome
  - Documentation complete
  - High risk and/or low-volume procedures
  - Medical (peer) review and critiques
  - Skills Maintenance, licensure, and certification
  - Invasive procedures performed
  - Medication dosages
  - Deviations from medical protocols
  - OSHA compliance

- Operational Criteria
  - Cost-effectiveness
  - Number of completed transports
  - Aborted flights for other reasons
  - Average miles (total and loaded) per transport
  - Patient diagnosis
  - Patient mix
  - Scene flights
  - Inter-hospital transports
  - Ground time
  - Time of transport
  - Patient demographic information

- Documentation
  - Chart is a medical legal record
  - Utilize standardized abbreviations
  - Chart legible, clear, and concise
  - Chart objective assessment, signs and symptoms, interventions, and response to interventions
  - Chart times, valuables, allergies, family education
  - Used for education and research

- Medical Audit/Appropriate Utilization for RW (from CAMTS Standards)
  - Patients discharged home within 24 hours
  - Transported without an IV or oxygen
  - "Scheduled transports"
  - Trauma Scores of 15 or greater
  - Interfacility where the final destination is not a higher level of care
  - Appropriate patient transfer by fixed-wing then by helicopter from airport

EXHIBIT 13-4: SAMPLE QUALITY IMPROVEMENT FORMS

Category	Indicators	Critical Success Factors (1)	Key Functions (2)	Sample Size	Frequency of reporting	Data Source	Outcome (if applicable)
1.0 Customer Satisfaction							
1.1 Availability	Availability for helicopter-requested transports	T, A	CE	Every fifth request	Quarterly	Dispatch Records	Available for 90 percent of requests
1.2 Response Times	Response times of MICU, Helicopter, or FW	T, E	CE, IM	All MICU, FW, or helicopter requests	Quarterly	Dispatch Records and Statistics	Off the ground for FW in 30 minutes
2.0 Key Activities							
2.1 Safety	Fuel quality for vehicles	CE, S	S, CE	Fuel will be sampled daily	Monthly	Fuel dipstick records	Aviation fuel quality is 100 percent
2.2 Appropriate Triage Criteria	Triage criteria utilized effectively and appropriately	CE, AP,	AP, T, A, CE	Every transport will be checked	Monthly	Dispatch and patient record	95 percent of patients transported right mode of transport
3.0 Operational Performance							
Number of transports	Number of transports	T, E, A	IM	Every request counted	Monthly	Dispatch log/computer	
4.0 Financial Performance							
4.1 Cost Effectiveness	Appropriate transports	CE, A, AP	UR, IM, CE	All helicopter transports	Monthly	Dispatch log/computer	Appropriate mode of transport used
4.2 Productivity	Paid labor hours	E, T	HR, IM, L	Paid staff hours	Monthly	Payroll hours	95 percent productivity
1.0 **Management Performance**							
5.1 Staff Turnover	Staff leaving department	E	L, HR	All employees	Annually	HR records	Less than 5 percent turnover in staff
6.0 Internal Processes							
6.1 PR Efforts	Measurement of effectiveness of PR visits	E, AP, A	CE	All PR visits	Monthly	PR records, computer log	PR visits will generate 2 percent new transports

(1) **Critical Success Factors =** Timeliness (T), Efficiency (E), Cost-effectiveness (CE), Safety (S), Availability (A), Appropriateness (AP), etc.
(2) **Functions =** Patient Care (PC), Patient Assessment (PA), Leadership (L), Utilization Review (UR), Human Resources (HR), Infection Control (IC), Information Management (IM), Customer Expectations (CE), Risk Management (M), etc.

EXHIBIT 13-5: UTILIZATION REVIEW—TRAUMA PATIENT CRITERIA

- Morbidity and mortality criteria
  - Transports within the Golden hour decreases mortality from 60 percent to 18 percent
  - 50–60 percent of traumatic deaths occur prior to reaching the hospital
  - 50 percent of all traumatic deaths occur within the first hour
  - For every 30-minute delay, mortality rate rises 300 percent

- Situational identifiers/general criteria for scene flights
  - Transportation time to the trauma center is greater than 15–20 minutes by ground ambulance or entrapment which extends the time at the scene

- Anatomical and physiological identifiers
  - Prospective criteria
    - Anatomical injuries
      - Pediatric, less than 5 years old
      - Adults, greater than 55 years old
      - Multiple system injury
        - Unstable or potentially unstable airway secondary to injuries to the face or neck that may require invasive procedures to stabilize the airway
        - Penetrating or crush injury to the head, neck, chest, abdomen, and/or pelvis
      - Significant chest trauma
        - Major chest wall injury
        - Cardiac injury
        - Widened mediastinum
        - Requirement for continuous ventilatory assistance
      - Significant orthopedic trauma
        - Unstable pelvic injury
        - Open pelvic injury
        - Two or more long bone fractures
        - Amputations or near amputations that require timely evaluation for possible re-implantation
        - Degloving or scalping injuries
        - Neurologic deficit
        - Potential neurologic deficit, secondary to a spinal cord injury
      - Major burns that may be best treated at a regional Burn Center
        - 15% body surface
        - Significant burns involving the face, hands, feet, or perineum
        - Major electrical or chemical burns
        - Inhalation injury physiological criteria
      - Abnormal vital signs
        - Pulse
        - Blood pressure
        - Respiration
        - Severe blood loss with the patient unresponsive to initial fluid resuscitation, or requiring ongoing blood transfusion to maintain a stable blood pressure
    - Objective scoring system which may be consistent with a severe head injury or multiple traumatic injuries
      - Trauma Score
      - Glasgow Coma Scale
      - Pediatric Trauma Score
    - Retrospective criteria
      - Injury Severity Score (ISS)
      - TRISS probability of survival
      - Death within 72 hours
      - Patients who required major surgery within 24 hours

EXHIBIT 13-6: UTILIZATION REVIEW—ADULT CARDIAC/MEDICAL/SURGICAL

- Cardiac criteria
  - Recent cardiac arrest (within the past 12–48 hours)
  - Patient is experiencing an acute myocardial infarction and requires therapy or diagnostic procedures not available at the referring institution
  - MI requiring intracoronary fibrolysins
  - Patient requires continuous intravenous vasoactive medications or mechanical ventricular assist to maintain a stable cardiac output
  - Cardiogenic shock requiring intra-aortic balloon pump
  - Uncontrolled life threatening dysrhythmia with or without MI
  - Patient requires continuous intravenous anti-dysrhythmia medications or a cardiac pacemaker to maintain a stable cardiac rhythm.
  - Any unstable cardiac condition requiring urgent cardiac catheterization or cardiac surgery

- Medical/surgical criteria
  - The patient has unstable vital signs represented by:
    - Respiratory Rate: < 10 or > 30
    - Heart Rate: < 50 or > 150
    - Systolic BP: < 90 or > 200 mmHg
  - The patient experienced a respiratory arrest within the past 12 hours
  - The patient has an unstable or potentially unstable airway that may require invasive procedures to stabilize the airway
  - The patient requires mechanical ventilator support or any constant positive airway pressure (CPAP)
  - Patient has an indwelling pulmonary artery catheter, intra-aortic balloon pump, arterial line, or intracranial pressure monitor
  - The patient requires specific therapy, diagnostic procedures, or intensive care not available at the referring institution for any of the following critical conditions:
    - Acute respiratory failure, not responsive to initial therapy
    - Acute deterioration in mental status
    - Acute cerebrovascular accident in evolution
    - Acute neurologic emergency
    - Severe hypothermia requiring active therapy
    - Acute hemodialysis
    - Gastrointestinal bleeding requiring angiography or other procedure
    - Severe poisonings or overdoses
    - Evidence of significant acidosis, not responsive to initial therapy
    - Status epilepticus
    - Decompression sickness with need for hyperbaric recompression
    - Life-threatening infectious process
  - The patient requires immediate transport in a critical care environment to a medical center that could perform organ transplantation or procurement
  - The patient requires urgent transport for organ salvage after having met the criteria for brain death, and whose family has consented to organ donation
  - The patient has a dissecting or leaking aneurysm and requires therapy or diagnostic procedures not available at the referring institution

EXHIBIT 13-7: UTILIZATION REVIEW—OBSTETRICAL PATIENT CRITERIA

- General criteria
  - Local facilities are inadequate for the mother and/or infant
  - The patient is pregnant, requiring urgent transport to a perinatal network for high-risk obstetrical condition(s)
  - There is adequate time to effect a safe transfer before delivery
  - The transfer will not pose a threat to the health of the woman or her unborn child

- Specific criteria: high risk obstetrical conditions
  - Placenta previa
  - Abruptio placenta
  - Eclampsia
  - Pre-eclampsia
  - Premature labor with or without rupture of membranes
  - Abnormal fetal lie
  - Uncontrolled maternal diabetes
  - Severe maternal medical illness

EXHIBIT 13-8: UTILIZATION REVIEW—PEDIATRIC PATIENT CRITERIA

- General criteria
  - The patient is experiencing or had a high risk of developing cardiac dysrhythmias or cardiac pump failure that required intervention not available at the referring hospital.
  - The patient is experiencing, or has a high risk of developing, acute respiratory failure or respiratory arrest and was unresponsive to initial therapy.
  - The patient requires invasive airway procedures prior to or during transport requiring mechanical ventilator assistance during transport.
  - The patient requires mechanical ventilator support or any constant positive airway pressure (CPAP).
  - The patient is experiencing unstable vital signs:
    - Respiratory rate: < 10 or > 60
    - Systolic BP
      - Neonate: < 60 mmHg
      - Infant < 2 y/o: < 65 mmHg
      - Child 2–5 y/o: < 70 mmHg
      - Child 6–12 y/o: < 80 mmHg
  - The patient requires continuous intravenous vasoactive medications to maintain a stable cardiac output.
  - The patient requires specific therapy, diagnostic procedures, or intensive care not available at the referring institution for any of the following critical conditions
    - Near-drowning with evidence of hypoxia or altered mental status
    - Status epilepticus
    - Acute bacterial meningitis
    - Life-threatening infectious process
    - Acute renal failure
    - Unstable toxicologic syndrome
    - Reye's syndrome
    - Hypothermia requiring active therapy
    - Acute deterioration in mental status
    - Evidence of significant acidosis not responsive to initial therapy
    - Complications of cancer and chemotherapy, including opportunistic infections with unstable vital signs
    - Decompression sickness with need for hyperbaric recompression
    - Non-traumatic surgical emergency requiring cardiothoracic, neurosurgical, or pediatric surgeon unavailable at referring institution
    - Multiple trauma

EXHIBIT 13-9: UTILIZATION REVIEW—NEONATAL PATIENT CRITERIA

- General criteria
  - The neonate cannot be adequately managed in the referring hospital
  - A specialty transport team is promptly required

- Specific medical criteria
  - Cardiac or respiratory arrest within 24 hours of request
  - Premature infant with gestational age of less than 30 weeks and complications
  - Body weight less than 1,200 grams and complications
  - Significant respiratory compromise, or the potential to develop respiratory compromise, associated with any of the following
    - Infant requiring mechanical ventilation or CPAP
    - Hyaline membrane disease
    - Persistent pulmonary hypertension
    - Supplemental oxygen more than 60% FiO2
    - Extra-pulmonary air (subcutaneous, mediastinal or intrapleural) requiring a thoracostomy tube
  - Temperature instability
  - Vasopressor drip medications or repeated volume challenges are required to maintain BP
  - Neonates with seizure activity, CHF, or disseminated intravascular coagulation
  - Surgical emergencies including
    - Diaphragmatic hernia
    - Necrotizing enterocolitis
    - Abdominal wall defect
    - Suspected volvulus
    - Congenital heart defects

EXHIBIT 13-10: UTILIZATION REVIEW—EXCLUSION CRITERIA

- Prospective Criteria
  - Terminally ill patients who are not suffering an acute *correctable* problem, such that air ambulance transport would not necessarily prolong life
  - "No Code" patients
  - Patients in full arrest at the referral institution without return of spontaneous circulation
  - Transports without an intravenous line or oxygen
  - Direct admissions to a non-critical care unit
  - Transports from the scene of an accident that do not meet trauma center criteria
  - Transports from the scene of an accident to a hospital that was not the closest, most appropriate, and available trauma center
  - Receiving hospital is not a higher level of care
  - Transport time by air ambulance will not significantly reduce the transport time:
    - From the scene of an accident to an appropriate trauma center
    - From a referring hospital to an appropriate receiving facility
  - Patients in active labor with advanced cervical dilatation
  - Any patient who cannot be safely transported in the air medical environment, which may include:
    - Prisoners
    - Patients with violent or psychotic behavior
    - Patients whose medical condition will be compromised by the air medical transport due to
      - Limited resources (equipment or personnel)
      - The air medical transport environment

- Retrospective criteria
  - Patients discharged home directly from the emergency department
  - The patient's medical condition did not require specialized care during transport
    - Medical personnel level of expertise
    - Available medical equipment
  - Monitoring capabilities
  - Special equipment
  - Medication(s)
    - The patient's medical condition was not time-critical and did not require the unique capabilities of the air ambulance
  - Speed of transport
  - Access to limited areas
    - Appropriately staffed and equipped local ground resources were available and the patient could have been safely transported by ambulance

EXHIBIT 13-11: QI DATA COLLECTION TECHNIQUES

	Questionnaire/ Survey	Interview/ Focus Group	Observation	Record audit
Uses	• To obtain factual data	• To gather data through verbal skills • To identify variables and relationships • To supplement other data collection methods	• To conduct prospective studies • To obtain data by instrumentation • To record responses to variables • To document effects of interventions	• To evaluate the care of patients • To evaluate effects of a delivery system • To evaluate Clinical Guide-lines/Standing Medical Orders • To obtain demographic data
Require-ments for use	• Concise statement of the problem • Precise wording of questions	• Trained interviewer • Topic suitable for interview • Questions clearly stated	• Data collection very specific to the study • Observer highly trained	• None
Advan-tages	• Simple to use • Easy to process • Low cost • Little time investment	• Probing into data in more depth • Data easily processed	• Can use more quantitative measurements	• Data easily obtainable • Data is useable immediately • Data can be obtained concurrently or retrospectively
Disad-vantages	• Errors in interpretation • Skill required in construct-ing tool • Objectivity required	• Labor-intensive and expensive • Validity may be affected by interviewer bias and subjectivity	• Data can be influenced • Training needed for observers	• Differences between definition of variables for which the data are available and in the study
Reliability	• Testing to determine inter- and intra-rater reliability		• High level of control for observers to remain reliable	
Validity	• Requires pretest	• Extensive training required		

EXHIBIT 13-12: QUALITY IMPROVEMENT STEPS

Determines which tools/techniques should be utilized when analyzing data:

QI Steps	Primary QI Tools	Secondary QI Tools
List and prioritize opportunities to improve	• Data Collection • Pareto Analysis • Flowcharts • Nominal Group Technique • Control Chart • Storyboards • Strategic Planning	• Graphs • Charts • Likert Chart • Multivoting • Affinity Diagram • Tree Diagram • Hoshin Planning Technique
Define improvement project and QI team	• Flowcharts • Brainstorming	• Graphs • Charts • Strategic Planning
Analyze symptoms	• Flowchart • Data Collection • Pareto Analysis • Histogram	• Graphs • Charts • Dot Plots
Formulate theories of causes	• Fishbone Diagram • Flowcharts • Nominal Group Technique	
Test theories	• Flowcharts • Data Collection • Graphs • Charts • Pareto Analysis • Histograms • Scatter Diagrams • Dot plots	• Frequency Chart
Identify root causes	• Flowcharts • Data Collection • Fishbone Diagram • Graphs • Pareto Analysis • Scatter Diagrams • Dot plots	• Histograms • Charts • Interrelationship Diagram
Consider alternative solutions	• Flowcharts • Nominal Group Technique • Fishbone Diagram	• Pie Charts • Frequency Chart
Design solutions and controls	• Flowcharts • Data Collection • Graphs • Charts • Histograms • Scatter Diagrams • Dot Plots • Cost-Benefit Analysis	• Stratification • Customer Needs Mapping • Quality Function Deployment • Decision Matrix
Address resistance to change	• Nominal Group Technique • Force Field (Gap) Analysis • Fishbone Diagram • Flowcharts	
Implementation of solutions and controls	• Flowcharts • Charts • Scatter Diagrams • Dot Plots	• Graphs • Histograms • Stratification • Customer Needs Mapping • Quality Function Deployment • Process Decision Program Chart
Check performance	• Data Collection • Flowcharts • Graphs • Pareto Analysis • Histograms	• Scatter Diagrams • Control Charts • Dot Plots • Run Chart

A. **Bibliography**:

AAMS Quality Assurance Committee. AAMS Resource Document for Air Medical Quality Assurance Programs. (Position Paper). *Journal of Air Medical Transport* 1990, 9 (9): 23–26.

AAMS Quality Assurance/Standards Committee and NFNA Special Interest Group. Pediatric, Neonatal, and Maternal Patient Care Addendum to the AAMS/NFNA Resource Document for Air Medical Quality Assurance Programs. (Position Paper). *Journal of Air Medical Transport* 1991, 10(10): 51–56.

American College of Emergency Physicians. *Continuous Quality Improvement in EMS*. Dallas, 1992.

American College of Emergency Physicians. *Policy Statement on Appropriate* Interhospital Patient Transport. June, 1997.

Association of Air Medical Services. "The Appropriate Use of Emergency Air Medical Services". *Journal of Air Medical Transport.* 1990. 9(9): 29–33.

Association of Air Medical Services. *Quality Assurance in Air Medical Transport*. Eastes, L.; Jacobson, J. (eds.). Word Perfect Publishing Co., Orem, Utah, 1990.

Association of Air Medical Services. Minimum Standards (formerly ASHBEAMS). Alexandria, VA, 1987 and updated in 1992, and 1999.

Balazs, K. T.; Thompson, C.B. "Quality Assurance and Continuous Quality Improvement Within Air Transport Programs." *Air Medical Journal.* 1996. 15:3; 104–107.

Barnoski, A.; Kovach, B.; Podmore, M.; Pastis, E.; Fallon, W.F. "Trauma Triage: Do AAMS Transport Guidelines Do It Effectively?" *Air Medical Journal.* 1998. 17 (1), 19–23.

Benson, N.H. Also, R.I.; Norton, E.G. et.al. "Air Medical Transport Utilization Review in North Carolina." *Preshospital and Disaster Medicine.* 1993. 8: 133–37.

Boyd, C.R. et. Al. "Emergency Interhospital Transport of the Major Trauma Patient: Air Versus Ground." *Journal of Trauma* 1989. 29, (6), 789–794.

Brown, M.G.; Svenson & Wallace. "Measuring Your Company Against the Baldrige Criteria." *Journal for Quality and Participation.* 1991. June, 82–88.

Bruhn, J.D.; Williams, K.A.; Aghababian, R. "True Costs of Air Medical vs. Ground Ambulance Systems." *Air Medical Journal.* 1993. August, 262–268.

Commission on Accreditation of Medical Transport Services (CAMTS) Accreditation Standards (formerly CAAMS). Anderson, SC, 1991,1993, and last updated 1997.

Coontz, D.A. "Counting on Quality Improvement." *Journal of Emergency Medical Services*. 2000. 25:7.

Czarnecki, M.T. *Benchmarking Strategies for Health Care Management*. Apsen Publishers, Gaithersburg. 1995.

Day, S., McCloskey, K., et. Al. "Pediatric Interhospital Critical Care Transport: Consensus of a National Leadership Conference." *Pediatrics.* 1991. 88:696–704.

Deming, W.E. "Out of Crisis." MIT Center of Advanced Engineering Study. Cambridge, MA. 1982.

Eastes, L. and Jacobson, J. *Quality Assurance in Air Medical Transport.* A Publication of the Association of Air Medical Services. 1990.

Eastes, L. "Implementing Quality Improvement for Air Medical Services." *The Journal of Air Medical Transport.* 1991. August; 12–14.

Falcone, R.E.; Herron, H.; Werman, H.; Bonta, M. :Air Medical Transport of the Injured Patient: Scene vs. Referring Hospital." *Air Medical Journal.* 1998. 17 (4), 161–165.

Fitch, J.J. "Make Your Service Shine." *Journal of Emergency Medical Services.* 2000; June. 25:7.

Frazer, R. "Operational Quality Assurance." *The Journal of Air Medical Transport.* 1991. March, 19–25.

Gabor, A. *The Man Who Discovered Quality*. Penguin Books, New York. 1990.

Gabram, S.G.A.; Stohler, S.; Sargent, R.K., et.al. Interhospital Transport Audit Criteria for Helicopter Emergency Medical Services. *Connecticut Medicine.* 1991. 55: 387–392.

Gabram, S.G.A.; Libby, M.C.N.; Jacobs, L.M.; et.al. "Peer Review of On-scene Air Medical Triage in Connecticut." *Connecticut Medicine.* 1994. 58: 3–12.

Gabram, S.G.A.; Young, L.; Balazs, K. "Transitioning from Quality Assurance to Continuous Quality Improvement in Air Medical Programs." *Air Medical Journal.* 1995. 14:3, 147–150.

Gaucher, E.; Coffey, R.J. *Total Quality in Healthcare—From Theory to Practice*. Jossey-Bass, Inc. San Francisco, CA, 1993.

Gearhart, P.A.; Wuerz, R., Localio, A.R. "Cost-effectiveness Analysis of Helicopter EMS for Trauma Patients. *Annals of Emergency Medicine*. 1997. October, 500.

George, S. and Weimerskirch, A.: Total Quality Management—Strategies and Techniques Proven at Today's Most Successful Companies. John Wiley & Sons, Inc., New York. 1994.

Guidelines for Perinatal Care. 3rd ed. American Academy of Pediatrics, Elk Grove Village, IL, and the American College of Obstetrics and Gynecology, Washington DC. 1992.

Harris, M. "A Breakthrough Series Update: Closing the Gap Between What We Know and What We Do." *The Quality Letter*. 1997. February: 2–12.

Harrawood, D.; Easton, K.; "EMS Measuring Stick." *Journal of Emergency Medical Services*. 2000. July, 39–45.

Holleran, R. *Flight Nursing—Principles and Practice*. Ed. 2, Mosby, St. Louis, MO. 1996.

Joint Commission on Accreditation of Healthcare Organizations. *Commission Accreditation Hospital Manual*. Oakbrook, IL. 1994.

Johnson, R.; Falcone, R.E.; Janczak, R. "Air Transport for Illness: Is it Appropriate? *Journal of Emergency Medicine.* 1993. October, 53–56.

Juran, J.M.; *Juran's Quality Control Handbook.* Ed. 4. McGraw-Hill, New York. 1988.

Kaplan, R.S.; Norton, D.P.; *The Balanced Scorecard: Translating Strategy Into Action*. Harvard Business School Press. 1996.

Loos, L; Runyan, L; Pelch, D. "Development of Pre-hospital Medical Classification Criteria." *Air Medical Journal*. 1998. 17 (1), 13–15.

Mears, P. *Quality Improvement Tools & Techniques*. McGraw-Hill, Inc. 1995.

Marszalek-Gaucher, E.; Coffey, R.J. *Transforming Healthcare Organizations—How to Achieve and Sustaining Organizational Excellence*. Jossey-Bass, Inc. San Francisco, CA. 1990.

McCloskey K.A.; Orr, R.A. "Pediatric Transport Issues in Emergency Medicine." *Emergency Medicine Clinics of North America*. 1991. 475–489.

National Association of Emergency Medical Services Physicians. "Air Medical Dispatch: Guidelines for Scene Response." *Pre-hospital and Disaster Medicine*. 1992. 7:75–76.

National Association of EMS Physicians. *Quality Management in Pre-hospital Care*. Mosby-Lifeline. St. Louis. 1993.

National Association of Flight Nurses. *Flight Nursing Core Curriculum*. 1997.

National Association for Healthcare Quality (NAHQ). *A Guide to Quality Management*. 6th Ed. 1996.

NHTSA and HRSA. *A Leadership Guide to Quality Improvement for Emergency Medical Services Systems*. 1998.

Norton, R., Wortman, E., Eastes, L.; et.al. "Appropriate Helicopter Transport of Urban Trauma Patients." *The Journal of Trauma: Injury, Infection and Critical Care*. 1996. 41: 888–891.

O'Leary, D.S., O'Leary, M.R. "From Quality Assurance to Quality Improvement: The Joint Commission on Accreditation of Healthcare Organization and Emergency Care." *Emergency Medical Clinics of North America*. 1992. 10:477–492.

Quinn, D.C. "Process Improvement and Air Medical Transport: Improving Safety." *AirMed*. 1999. Nov/Dec 30–33.

Sholtes, P.R. *The Team Handbook: How to Use Teams to Improve Quality*. Joiner Associates, Inc. Madison, WI. 1988.

Talbot, S. "Pilot Study for Predicting Appropriate Use of Air Medical Helicopters Part 1: Interfacility Transports." *Air Medical Journal*. 2000. 19 (2), 59–64.

Task Force on Interhospital Transport, American Academy of Pediatrics. *Guidelines for Air and Ground Transportation of Neonatal and Pediatric Patients*. American Academy of Pediatrics. Elk Grove Village, Illinois. 1993.

Thompson, C.B.; Balaz, K.; Goltermann, J.; Eastes, L; et al. "Intubation Quality Assurance Thresholds". *Air Medical Journal*. 1995. 14:2.

Travers, D.A.; Means, J.; Riordan, J. "Determine Appropriate Use of an Air Medical Program." *The Journal of Air Medical Transport*. 1989. October, 7–9.

Venkataraman, S.T.; Rubenstein, J.S, Orr, R.A. "Interhospital Transport, A Pediatric Perspective. Transport of the Critically Ill." *Critical Care Clinics*. 1992. (83).

Walton, M. *The Deming Management Method*. MIT, Center for Advanced Engineering Study. Cambridge, MA. 1986.

Williams, K.A.; Aghababian, R.; Shaughnessy, M. "Statewide Helicopter Utilization Review: The Massachusetts Experience." *Journal of Air Medical Transport*. 1990. 9(9): 14–23.

B. **Definitions of Keywords**:

Quality—Distinguishing characteristics that determine the value, rank, or degree of excellence or expectation. The totality of features and characteristics of a healthcare process that bear on its ability to satisfy stated or perceived needs. Or a process or outcome that consistently conforms to requirements, meets expectations, and maximizes value for the customer. For the customer, quality is getting what you were expecting; for the supplier, quality is getting it right the first time.

Quality Assurance—Distinguishing characteristics that determine the value or degree of excellence and the mechanisms to efficiently and effectively monitor and improve patient care provided by competent professionals with appropriate resources.

Continuous Quality Improvement—Approach to quality management that builds upon traditional quality assurance methods by emphasizing the organization and systems; focuses on "process" rather than the individual; recognizes both internal and external customers; controls of variation; promotes the need for objective data to analyze and improve processes.

Total Quality Management (TQM)—The management system in which all employees in all departments improve or maintain quality, cost, output, procedures, and systems to give customers a product or service which is most economical, useful, and of the best quality. A management system fostering continuously improving performance at every level of every function by focusing on maximization of customer satisfaction. Requires a commitment to an organized, systematic, collaborative, and pervasive quality program with dedicated resources. Requires rigorous process flow and techniques for statistical analysis (quality control), evaluation of all ongoing activities, methods for managing large data sets (integrated computer systems-MIS), and recognition and application of underlying psychosocial principles affecting individuals and groups within an organization. Assumes that most problems are not the result of administrative or clinical professional errors, but the inability of the structure (system) to perform adequately. Focus is on process.

Indicator—Measures of specific, measurable, objective events, occurrences, facets of treatment, etc. May be a structure (i.e., a resource), process (i.e., measures an event or activity performed directly or indirectly for patients), or outcome (i.e., a process or patient health status) of care measures used to monitor and evaluate the quality and appropriateness of important governance, management, clinical, and support functions that affect patient outcomes; professionally developed, clinically valid, and reliable aspects of health care process, clinical events complications, or outcomes for which data can be collected and compared with criteria related to the indicator. Two types of indicators are: (1) Rate-based—Events for which a certain proportion of the events that occur represent expected care; significant trends/patterns in data require ongoing investigation (i.e., medication errors, nosocomial infections, inadequate staffing, patient falls, equipment failure); and (2) Sentinel—"Serious" predictable events that require further investigation for each occurrence. Thresholds always set at 0%.

Threshold—Predetermined important single clinical event or pre-established level of performance for a practitioner, department, or organization related to specific indicator of the quality and/or appropriateness of an important aspect of care. Attainment of threshold may trigger an intensified review of a specific component of patient care or practice to determine why threshold was not reached or crossed. The term "benchmark" currently used by business to indicate ongoing process of measuring products, services, and practices.

Process—Series of ordered steps to desired outcome; activities that act upon an "input" from a "supplier" to produce an "output" from a "customer"; activities carried out by health care professionals in their care for patients (i.e., assessment, treatment planning, test ordering and interpretation, medication adjustment, performance of invasive procedures, and discharge planning); whole or totality of the service; includes the outcomes, activities, continuity, resources, and population dimensions of the service.

Utilization Review—Formal, prospective, concurrent, or retrospective critical examination of necessity, efficiency, and appropriateness of use (over-, under-, or optimum use) of resources and segments of the health care system; includes review of the appropriateness of transports, admissions, length of stay, discharge practices, and services ordered and provided on a pre-admission, concurrent, or retrospective basis.

C. **<u>Test Questions</u>**:

1. Which QA and QI components are <u>not</u> considered to be utilized for both:

   a. **Education and training are critical to all individuals in both concepts.**
   b. Both involve data collection techniques.
   c. Both involve utilizing QI tools and techniques to analyze data.
   d. Both involve evaluation processes of changes made.

2. What term can be interchanged for threshold?

   a. **Benchmark**
   b. Criteria
   c. Norm
   d. Standard

3. Critical Success Factors are defined for Medical Transport Services as:

   a. Safety
   b. Quality Patient Care
   c. Cost Effectiveness
   d. Customer Satisfaction
   e. **All of the above**

4. Which of the following QI tools should <u>not</u> be utilized to obtain input from customers?

   a. Focus Groups
   b. Brainstorming
   c. **Fishbone Diagram**
   d. Nominal Group Technique

5. Which of the following QI tools should <u>not</u> be utilized to evaluate performance?

   a. Flow Charts
   b. Pareto Analysis
   c. Scatter Diagram
   d. **Nominal Group Technique**

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Identify indicators and benchmarks for quality monitoring and management
- Identify appropriate utilization review benchmarks to be utilized in transport decision-making
- Review program-specific monitoring tools
- Attend program safety meetings and/or QI meetings
- Draft quality plan with indicators (as necessary)

F. **Patient Care Hours**: N/A

CHAPTER 5: AIR TRANSPORT CONSIDERATIONS

Module 14: Air Physiology

Module 15: Patient Assessment and Preparation

MODULE 14: AIR PHYSIOLOGY

Author: Dr. Nora Klinker, Medical College of Virginia, Richmond, VA

Reviewer: Mr. Jerry Focht, RRT, Northwest MedStar, Spokane, WA

KEYWORDS

Gas laws
Vibration
Humidity
Gravitational forces
Pressurized environments
Disorientation

OBJECTIVES

Upon completion of this module, the student should be able to:

- Describe the effects of altitude on gas volume
- Discuss the effects of altitude on oxygen availability
- Describe the effects of pressure changes on gas bubble formation
- Discuss the effects of temperature on gas volume
- Differentiate between auto-kinetic illusion, prism effect, waterfall effect, fascination, and flicker vertigo

INTRODUCTION

Several questions may come to mind when you are preparing for a patient transport. What conditions and limitations inherent in air transport will affect my patient? My crew? My equipment? Normal physiologic function occurs up to approximately 12,000 feet. From 12,000 to 50,000 feet, physiologic function becomes impaired without intervention. Beyond 50,000 feet a pressurized environment is required. Becoming familiar with the impact that altitude and flight physiology will have in both helicopter and fixed-wing aircraft is an important task for aircrew members. Understanding this impact will allow them to make treatment decisions and equipment changes to safely transport critically ill patients.

PHYSICAL GAS LAWS

Prior to working and caring for patients in the air transport environment, it's important to understand the physical gas laws: Boyles, Dalton, and Henry & Charles' laws.

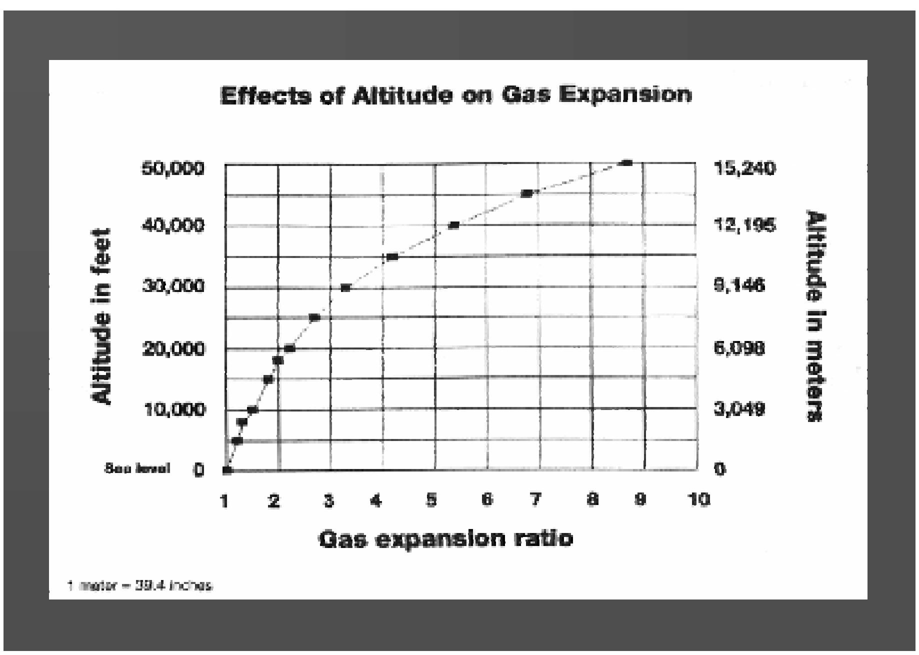
The Effects of Altitude on Gas Volume

Boyles Law $P_1V_1 = P_2V_2$

"When the temperature remains unchanged, the volume of a given mass of gas varies inversely to its pressure."

- In flight terms, as your aircraft ascends, increasing in altitude, the barometric pressure diminishes. Any gas within an enclosed space will expand. Alternatively, as the aircraft descends and barometric pressure increases, the gas will contract. Imagine a balloon inflated at sea level. At 18,000 feet this balloon will be approximately twice its sea-level volume, and at 25,000 feet, it would be approximately three times its original volume. Landing at sea level would return the balloon to its original volume.

- Clinically, it is prudent for the aircrew member to realize that any piece of equipment or body cavity containing gas will be subject to the effects of that gas' expansion with ascent and contraction upon descent. Clinical examples include barotitis media from trapped gas affects on the middle ear, barosinusitis from gas expansion in the sinuses, barodentalgia from air pockets in teeth, and gastrointestinal gas expansion.



THE EFFECTS OF ALTITUDE ON OXYGEN AVAILABILITY

Dalton's Law: $Pt = P_1 + P_2 + P_3 + \ldots P_n$

Dalton's law states "the overall pressure of a gas mixture is the sum of the individual or partial pressures of all the gases in the mixture."

- In flight terms, oxygen is "thinner" in the upper atmosphere. Why? At sea level the barometric pressure is 760 mm H_g, and the atmosphere is composed of 20.95% O_2. As altitude increases, the barometric pressure decreases, and the molecules in the atmosphere move farther apart. While oxygen still comprises 20.95% of the atmosphere, there are less oxygen particles per cubic millimeter to be utilized.

- Clinically, an increase in altitude diminishes the oxygen available to the body and can result in hypoxia. For instance, at 12,000 feet the barometric pressure decreases to 483 mm H_g. The composition of the atmosphere remains the same, and so the percentage of oxygen remains at 20.95 percent. However, the partial pressure of oxygen will decrease to 101.19 mm H_g.

  i.e.: At sea level: PO_2 = 20.95 percent x 760 mm Hg
  = 159.22 mm Hg
  At 12,000 feet: PO_2 = 20.95 percent x 483 mm Hg = 101.19 mm Hg

  With less oxygen available to breathe, hypoxia can result. One study of air medical evacuation patients showed a decrease in P_ao_2 of 20 percent in those patients flown at low altitude (3,000–3,800 feet) and a decrease of 32–35 percent in those patients flown at high altitude (6,000–7,500 feet). Up to 12,000 feet is considered the *Physiological Efficient Zone* and is the most acceptable zone for normal physiologic function. From 12,000 to 50,000 feet the barometric pressure dramatically drops from 483 to 87 mm H_g, and the temperature decreases, necessitating interventions to support normal physiologic functions. Beyond 50,000 feet, a pressurized environment is mandatory, and at 120 miles, weightlessness occurs, representing "true space".

THE EFFECTS OF PRESSURE CHANGES ON GAS BUBBLE FORMATION

Henry's Law

Henry's law states "...the quantity of gas dissolved in 1 cm^3 of a liquid is proportional to the partial pressure of the gas in contact with the liquid". A soda bottle is an example of Henry's law in effect. With the cap on a sealed soda bottle the gas is in equilibrium with the liquid. When the cap is removed, the pressure decreases within the bottle, allowing the gas bubbles within the liquid to be formed. As time goes on, the gas reaches equilibrium with the atmosphere, and the soda becomes "flat".

- In clinical terms, an example of gas solubility in a liquid is decompression sickness (a.k.a. "the bends"). As a diver ascends, the pressure is decreased on the nitrogen gas dissolved in the blood. Ascending too quickly or flying within 24 hours of a dive can result in nitrogen bubble formation in the blood, which can cause dire clinical consequences. Treatment includes 100 percent oxygen and rapid descent treatment in a hyperbaric chamber and may be necessary if the symptoms do not resolve.

Altitude restriction in air transport is a consideration in only a few rare cases. When transporting a patient with decompression sickness, altitude should be restricted to less than 1000 feet above ground level. An untreated pneumothorax is an absolute contraindication to air transport. Prior to take-off, treatment with a chest tube or temporizing one-way valve system is required. Decreased flying altitude results in increased turbulence, longer flying times, and increased fuel consumption over a decreased aircraft range, consequences which must be considered when a patient requires low altitude flight.

THE EFFECTS OF TEMPERATURE ON GAS VOLUME

Charles' Law: $\frac{V_1}{V_2} = \frac{T_1}{T_2}$

Charles' law states, "When pressure is constant the volume of gas is very nearly proportional to its absolute temperature". As the temperature increases, the volume of gas increases due to more rapid movement of molecules.

- In flight terms, at altitude the temperature is cooler, and has implications in aircraft performance.
- Clinically, temperature variations are likely to have a direct effect on patient comfort, with extremely hot or cold temperatures increasing metabolic rate, oxygen demand, and oxygen consumption. Heat also affects the volume of a gas, causing expansion as the temperature rises. For this reason, medical equipment containing gases need to be protected from extreme temperatures.

STRESSES OF FLIGHT

In addition to hypoxia, barometric pressure changes, and thermal variations, the stresses of flight include noise, vibration, humidity/dehydration, gravitational forces, third spacing, and fatigue.

Noise

Permanent or temporary hearing loss may occur for patient or provider. The longer the exposure, and the more intense the noise, the greater the potential damage. Consequences include headaches, fatigue, nausea, vertigo, stress, and reduction in task performance effectiveness. Noise may interfere in provider communications with the patient and other crew members, and impedes the ability to auscultate the lungs, heart or blood pressure. Hearing protection should be worn by patient and crew, and includes earplugs, headsets, and helmets.

Vibration

Vibration results from the aircraft motor/rotors and can be due to turbulent weather. Vibration may result in an increase in metabolic rate, fatigue, shortness of breath, motion sickness, and an inability to properly thermo-regulate. Low frequency vibration of the eye may cause visual decrements. Vibration in general is less well tolerated in the supine position due to x-axis vibrations. Neonates are most susceptible to direct injury from vibration and noise. Care must be taken with fractures, as the vibration may increase discomfort at the fracture site or from an inadequately padded and secured splint. Special consideration must be given to patients with electronic monitoring as in-flight vibration may interfere with invasive and non-invasive monitoring, and may cause dysfunction of activity-sensing pacemakers. Protection from vibration is essentially limited to isolating the individual and equipment from the aircraft by use of adequate padding.

Humidity/dehydration

Patients and crew flying at high altitude for prolonged flights will be exposed to very low humidity and may develop dehydration. Patients in a hot environment or with pre-existing dehydration may have an exacerbation of their condition, and attention should be paid to oral and IV fluid intake and urine output when appropriate. Additionally, respiratory secretions may become thick, resulting in less efficient gas exchange and contributing to hypoxia. Dehydration may be prevented through humidified oxygen and adequate fluid intake.

Gravitational Forces

Gravitational forces are most evident on ascent and descent, or when the aircraft changes speed or direction. Patient positioning during maneuvers may affect blood pooling and intracranial pressure. For example, in a cardiac patient it may be advantageous to position them with their head toward the rear of the aircraft during ascent, so that the G-forces help to pool blood in the upper part of the body. Conversely, in patients with intracranial injury or volume overload, a position with the feet toward the rear of the aircraft during ascent may pool fluids in the lower extremities and avoid a transient and potentially detrimental increase in intracranial pressure.

Third Spacing

Third Spacing is the loss of fluid from the intravascular space to the extravascular space in the tissues. This phenomenon is due to the effect of pressure changes and cellular increases in permeability resulting in fluid transitions. The effects of third spacing include edema, dehydration, tachycardia and hypotension. These affects may be complicated by other stresses of flight, including thermal variations, vibration, and gravitational force effects.

Fatigue

Fatigue is generally felt to be a culmination of all of the stresses of flight. Tactics should be taken by the aircrew to minimize the effects of flight and personal stresses to maximize effective performance, alertness and safety.

PRESSURIZED ENVIRONMENTS

In order to minimize the effects of barometric pressure changes and subsequent hypoxia, a controlled flow of compressed air can maintain a constant pressure in a fixed-wing aircraft. Typically the cabin pressure can simulate an 8,000–10,000 foot altitude while flying at an actual altitude of greater than 40,000 feet.

Malfunction of the aircraft's pressurization system or structural damage sustained by the aircraft may result in rapid decompression. The crew must understand this emergency, and be ready to respond. A loss of pressure through a large defect results in a rush of air towards the defect. Any person or equipment not adequately restrained may be blown about the cabin or through the defect due to the development of cyclonic winds. Decompression sickness, hypothermia, hypoxia and expansion of GI tract gases resulting in decreased respiratory movements and vaso-vagal syncope can result from this loss in cabin pressure. Hypoxia is the most important immediate consequence of rapid decompression. Supplemental oxygen must first be supplied to the pilot, the crew, and then the patient or passengers. Recall that gas in medical systems will rapidly expand, and any catheters, chest tubes, NG tubes, or drains should be unclamped.

Losing cabin pressure may also result in decompression sickness. This, however, is rarely a problem under 25,000 feet unless the patient has been exposed to compressed gas (i.e. scuba diving) within 24 hours of the event. The nitrogen gas bubbles can result in a decrease or blockage of blood flow to any organ system, and causes a wide variety of symptoms depending on the system affected. Treatment includes application of 100 percent oxygen and rapid descent in altitude. Unresolved symptoms will require treatment in a hyperbaric chamber.

DISORIENTATION

Pilots and crew have described disorientation phenomenon including visual illusions, fascination experiences, and spatial disorientation. These phenomenon are listed in the table below. One of the most interesting occurrences, particularly for rotorcraft personnel is “flicker vertigo”. This phenomenon can occur when a person encounters a steady light flicker between 4–20 Hz, causing uncomfortable and dangerous reactions in normal subjects. These reactions include nausea, vertigo, convulsions or unconsciousness, and susceptibility is believed to be increased when the flight member is fatigued, frustrated or in a state of mild hypoxia. Treatment is removal from the flicker stimulus and supportive measures.

DISORIENTATION PHENOMENON EXPLANATION

AUTOKINETIC ILLUSION: A fixed point of light will appear to move	Attributed to the involuntary movement of muscles that control the eye
PRISM EFFECT: Image distortion when viewing objects through a windscreen covered in rain	The surface of the water creates a prism effect, making objects appear higher or closer than they actually are
WATERFALL EFFECT: The helicopter pilot sees drops of water going down in his field of vision, causing a perception of climbing; the pilot corrects for altitude, but the aircraft lands in the water	When hovering or in slow flight at low altitudes over a surface of water, a downward wind gust from the rotor blades causes water to splash to the periphery of the blade arc and fall down under the blades
FASCINATION: The individual fails to respond adequately to clearly defined stimulus	The individual concentrates on one aspect of a situation so intently that other factors in the perceptual field are ignored or rejected, critically affecting response or performance
FLICKER VERTIGO: Flashes of light thrown on a crew member’s face at a rhythmic rate may cause unconsciousness, nausea, and vertigo	A steady light flicker at a frequency between 4–20 Hz can produce unpleasant and dangerous reactions. These reactions may include nausea, vertigo, seizures, or unconsciousness. Increased susceptibility is noted when the person is fatigued, frustrated, or hypoxic

CONFINED SPACES

A final mention should be made of the challenges of the confined space in which the crew must work. The tight quarters necessitates efficient use of space, compact equipment and conservative storage of supplies. Equipment inventory should be replaced after each transport. Advanced planning regarding patient access is also required. The ability to check a chest tube or dressing may be hampered in a tightly packaged patient, and care should be taken to plan for individual patient care needs prior to takeoff to minimize patient discomfort and facilitate the provider's access.

SUMMARY

An understanding of flight physiology and its impact on equipment, crew and the critically ill patient will allow the air medical personnel to provide optimal care during transports. Hypoxia presents a potential hazard, and barometric pressure changes may cause significant patient complications and discomfort in patients and crew. Applying the knowledge gained can minimize the effects of hypoxia and pressure changes, and optimize patient care.

A. **Bibliography**:

Blumen, I. *"Altitude and flight physiology: a reference for air medical physicians,"* in *Air medical Physician Handbook.* 1994.

CCATT Course (1998) on World Wide Web. http://brooks.af.mil/web/ah/ccat/Present, retrieved July 11, 2000, with permission.

Fromm, R. E., Jr., et al, The incidence of pacemaker dysfunction during helicopter air medical transport. *Am J Emerg Med*. 1992. 10(4): p. 333–5.

Gordon, R. S. et al., Activity-sensing permanent internal pacemaker dysfunction during helicopter aeromedical transport*. Ann Emerg Med*. 1990. 19(11): p. 1260–3.

Grissom, T., *CCATT course flight physiology: Effects of altitude on gas expansion.* 1998, United States Air Force.

Henry, J., Hypoxemia during aeromedical evacuation. *Surg Gynecol Obstet*. 1973. 136(1): p. 49–53.

Henry J.N., Kremis L.J. Cutting RT, *Surg Gynecol Obstet* 1972; 136–51.

Institute, N.A.M., *United states naval flight surgeon's manual,* Chapter 1: physiology of flight. 1991, University of Iowa.

Institute, N.A.M., *United states naval flight surgeon's manual,* Chapter 9: optamology*.* 1991, University of Iowa.

Institute, N.A.M., *United states naval flight surgeon's manual,* Chapter 3: vestibular function*.* 1991, University of Iowa.

Linde, H. J. and E. Huuss, *Medical aspects of air rescue.* Fortschr Med, 1978. 96(4): p. 139–40, 184.

Lyons, T. J. et al., G-induced loss of consciousness *accidents:* USAF experience 982–1990. *Aviat Space Environ Med*. 1992**.** 63(1): p. 60–6.

B. **Definitions of Keywords:**

Gas laws—Physical laws pertaining to the inter-dependence of temperature, altitude, gas volume and oxygen availability

Vibration—Oscillation or rapid movement resulting from the aircraft motor or rotors, and sometimes due to encountering turbulent weather

Humidity—Moisture in the air or dampness; affected by altitude, temperature and weather

Gravitational forces—Forces effected by altitude, position, aircraft ascent and decent, or changes in the speed or direction of the aircraft

Pressurized environments—A contained space such as an aircraft cabin, with a controlled flow of compressed air to maintain a constant interior pressure; this controlled flow minimizes the effects of barometric pressure changes and subsequent hypoxia

Disorientation—Phenomenon experienced by flight crew members, including visual illusions, fascination experiences, and spatial disorientation

C. **Test Questions**:

1. Which of the following is **NOT** a true statement?

   a. Normal physiologic function occurs up to 20,000 feet without intervention
   b. Between 12,000 and 50,000 feet physiologic function becomes impaired without intervention
   c. Beyond 50,000 feet, a pressurized environment is required
   d. Changes in physiologic function at altitude may impact the safety of transporting critically ill patients

2. Which of the following is NOT a proper clinical interpretation of the physical gas laws?

   a. Any piece of equipment or body cavity containing gas will be subject to the effects of that gas' expansion with ascent and contraction upon descent
   b. An increase in altitude diminishes the oxygen available to the body and can result in hypoxia
   c. Ascending too quickly or flying within 24 hours of a dive can result in nitrogen bubble formation in the blood, causing the "bends"
   d. Temperature variations have little effect on the patient's metabolic rate, oxygen demands, and oxygen consumption

3. Concerning noise as a stress factor in flight, which of the following is a true statement?

   a. **The longer the exposure and the more intense the noise, the greater the potential damage**
   b. Task performance effectiveness is not usually affected by noise
   c. Hearing protection should be worn by the crew, but is not necessary for patients
   d. Temporary hearing loss is not a risk for patient or provider

4. Concerning vibration as a stress factor in flight, which of the following is a true statement?

   a. The elderly are more susceptible than neonates to direct injury from vibration and noise
   b. Vibration is a result of the aircraft motor and rotors, and can be due to turbulent weather
   c. Vibration does not typically increase the pain at a fracture site
   d. In-flight vibration does not interfere with invasive and non-invasive electronic monitoring

5. Which of the following is not a true statement concerning physiologic stresses in flight?

   a. Patients and crew flying at high altitude for prolonged flights will be exposed to very low humidity and may develop dehydration
   b. Patient positioning during aircraft maneuvers such as take-offs and landings may affect blood pooling and intracranial pressure due to changes in gravitational forces
   c. Aircraft cabin pressures can maintain a simulated 20,000 foot altitude in order to minimize the effects of barometric pressure changes and subsequent hypoxia
   d. The loss of fluid from the intravascular space to the extravascular space during flight may cause edema, dehydration, tachycardia and hypotension

D. **Didactic Hours**: 2

E. **Skills Hours**: N/A

F. **Patient Care Hours:** N/A

MODULE 15: PATIENT ASSESSMENT AND PREPARATION

Author: Mr. Ron Bolen, RN/CEP, Duke Life Flight, Durham, NC

Reviewers: Dr. Dave Thompson, Emergency Medicine,
Upstate Medical University at Syracuse, NY
Ms. Norma Battaglia, RN, BSN, Star Mountain, Inc.

KEYWORDS

Initial patient assessment
Detailed patient assessment
Pre-flight planning
In-flight planning
Patient packaging
Transfer of care
Altitude restrictions

OBJECTIVES

Upon completion of this module, the student will be able to:

- Discuss the factors involved in pre-flight planning
- Perform a complete medical patient assessment
- Perform a complete trauma patient assessment
- Demonstrate how to properly package a trauma patient for air medical transport
- Demonstrate appropriate communication techniques, including detailed patient safety briefing, proper family support strategies, provision of verbal report on telemetry, completion of the transfer of care report, and documentation at the receiving facility

INTRODUCTION

Several critical steps must be completed before a patient can be safely transported. Omission of any of these steps could not only compromise the patient's condition, but also the safety of the flight crew. Preparatory steps include pre-flight planning, in-flight planning, initial patient assessment, documentation and consents, packaging medical and trauma patients for transport, reassessment with patient load and unload, patient safety briefing, psychological support of family and patient, reporting, and the transfer of patient responsibility to the next level of care or the receiving facility. This module will discuss the general transport preparation and en route care of the acutely ill or injured patient. Specific medical and trauma diagnoses, including related assessment and care parameters will be discussed in later modules.

PRE-FLIGHT PLANNING

Having the ability to plan and prepare for patient transfer prior to arrival on-scene can have a positive influence on patient outcome. Many things must be considered prior to the actual flight. Of course, the amount and accuracy of the information received prior to take off, as well as the urgency of the lift off time, will affect the following:

Crew Selection

The crew configuration should correlate with the patient's age, size, and anticipated diagnosis or injury. In some medical transport systems, critical care and/or specialty care patients are transported by teams specifically trained in that patient's specialty (i.e., high-risk neonatal, high-risk maternal, critical care pediatric, device-dependent cardiothoracic, etc.). When an air medical program accepts the responsibility of a particular sub-specialty of patients, every mission of that type will be staffed and equipped accordingly.

Equipment Needs

Equipment required on board the aircraft should be selected based on each air medical program's mission type and scope of practice. Critical care and/or specialty transports may require specialized equipment to complete the mission. Special equipment may include, but is not limited to, the following: infant transport incubator, child or infant car seat, mechanical ventilator, and intra-aortic balloon pump or other portable cardiac assist device.

Medication and Medical Supply Needs

The type of patient may also dictate the need for special medications or supplies such as blood products, prostaglandin E1 (PGE1), surfactant, rapid-sequence induction medications, antivenin, magnesium sulfate ($MgSO_4$), etc.

Medical Gases

The medical crew should check the amount of compressed air, oxygen, nitrous oxide and any other medical gas that may be required during transport. It is good practice to ensure enough medical gas for the administration of 100 percent FiO_2 via high-flow O_2 or mechanical ventilation for the duration of the patient transport plus 2 hours. This margin of safety will allow for increased ventilation requirements, altitude changes and transport delays. When using flow-driven mechanical ventilation or when anticipating oxygen delivery of <100 percent for neonates, it is also important to calculate compressed air requirements.

Altitude Restrictions

Possible altitude restrictions based on patient diagnosis should be discussed with the pilot prior to lift off. This will minimize any miscommunication about the ability to complete the mission. Pressure-sensitive diagnoses, such as pneumothorax, closed head injuries, increased intracranial pressure, barotrauma or diving related injuries, as well as patients already requiring 100 percent FiO_2, may need to be flown at lower altitudes when transported in a non-pressurized aircraft. When flying these patients in pressurized aircraft, the cabin pressure setting should be discussed with the pilot and monitored for the duration of the flight.

Suggested Interventions

After receiving a report from the referring facility, the flight crew or the medical control physician may be able to recommend interventions to further stabilize the patient. Focus should be on those interventions that will assure patient safety and stability while at altitude. By suggesting these interventions prior to the flight crew arrival, ground time and overall transport time may be decreased.

Coordination

The flight crew must work collaboratively with the flight coordinators or communications specialists to insure that local EMS and/or Law Enforcement providers are aware of the ground transportation and safety needs. Things that should be considered are requests for landing zone (LZ) set-up, special landing instructions or precautions, and the need for a stretcher or ground transportation from the landing site. In some uncontrolled situations, the on-board air medical crew may need to assist in securing the LZ once the aircraft has landed.

IN-FLIGHT PRE-PLANNING

Pre-arrival planning may actually shorten on-scene time. If you are responding to a scene call, you may also be able to pre-plan based on the aerial view of the accident scene.

Plan of Care

Based on the patient information received prior to transport, the medical flight crew should discuss a plan of care and anticipated interventions specific to each patient. Stabilization tasks and clinical responsibilities should also be pre-assigned.

Air-Crew Briefing

Once the pilot has accepted or denied the flight based on weather and flight conditions, a more detailed patient description can be given to the entire crew. At this time, any altitude restrictions, anticipated time delays or requests for a "hot" load should be discussed.

Environment

Warming the medical cabin prior to arrival will help maintain the patient's temperature, especially in cases of inclement weather, hypothermia related injuries, and children under the age of 3 years. Pre-warming the IV fluids and making sure that chemical heat packs, space blankets, or other patient warming devices are available will save time and offer additional temperature support.

Equipment

Having all equipment fully charged and ready for departure is imperative. Setting up equipment and testing its function (i.e., ventilator, suction, monitors, etc.) prior to arrival will also allow the flight crew to concentrate on other patient priorities. Anticipating the supply needs and opening packages or placing them on the stretcher for quick access may help to minimize on-scene time. Pre-connecting ventilator tubing, pump specific IV tubing, lead wires and electrodes, as well as placing fluid containment blankets on the stretcher, will also facilitate a quicker patient transfer.

INITIAL PATIENT ASSESSMENT

The assessment format chosen will depend on the type of patient being transported. The assessment type can be broadly classified as medical or trauma. There are questions that should be asked or considered during every patient assessment. This module will not focus on specific patient populations, such as neonates, pediatrics, or adults, but will concentrate on parameters that can be applied to all patients. Detailed patient assessments for specific populations will be discussed in later modules.

Medical Patient Assessment

Parameters that must be considered during the assessment of all patients are described below:

- **General Appearance**

  What is your initial impression of the patient as you first approach him/her? What is notable about the scene or environment? How would you describe the patient's behavior and the behavior of those around the patient? Does anything require immediate or emergent intervention? Is the patient wearing an identification band and/or a medical-alert bracelet?

- **Neurological System**

  Is the patient awake and alert? Does he/she respond to voice, or only to painful stimulus? Is he/she oriented to the month and day or confused and making incomprehensible sounds? Does the patient follow simple commands such as “Can you show me two fingers"? What is the patient's motor response? Does he/she withdraw, flex, or extend in response to painful stimulus? Are his/her pupils equal and reactive? Is there a consensual pupillary response? What is the GCS score? Is sensation intact throughout the body? Is the patient moving all extremities with purpose? Is grip strength equal? Is dorsal-plantar flexion/extension present and equal? Is the gag reflex present? Has there been any seizure activity noted? Has the patient received any paralytics or sedatives?

- **Respiratory System**

  Does the patient have spontaneous, regular, and equal respirations? What is the rhythm and rate? Has the work of breathing increased? Is there use of accessory muscles? How would you describe both the anterior and posterior breath sounds? Is the trachea in the midline position? Is there subcutaneous emphysema or crepitus upon palpation? What is the percentage of oxygen being delivered, method of delivery, and percentage of oxygen saturation? Is the patient requiring airway adjuncts? If so, what type: oro-pharyngeal, naso-pharyngeal, oral or nasal endotracheal tube, crichothyrotomy or tracheostomy? What is the adjunct size? If intubated, is the tube cuffed or uncuffed? If cuffed, is air in the cuff and pilot tube? How is adjunct secured, what method was used and if ETT used, what centimeter marking is at the gum line or in-line with the teeth? How was ETT placement confirmed? Was a CXR done, are epigastric sounds steth-audible and is there good lung compliance with bagging? How would you describe the secretions? If mechanically ventilated, what ventilator settings are being required to maintain the patient’s respiratory status (i.e., mode, tidal volume, rate, PEEP, CPAP, peak inspiratory pressures, etc.).

  Are chest tubes present? If so, what is the size of the chest tube, how was placement confirmed, what centimeter marking is at the skin line, and what method has been used to secure the tube? Is the chest tube connected to suction or water seal, and what is the amount and quality of drainage in the collection system?

- **Cardiovascular System**

  How would you describe the heart sounds, rate and patient's cardiac rhythm? How would you characterize and compare the pulses in each of the extremities? Document blood pressures on both sides and on the upper and lower extremities when possible. Has the patient experienced any syncopal episodes, diaphoresis, chest pain, pressure or discomfort? If so, note type and intensity on a pain scale of 1–10, and any radiating effects. Is any peripheral edema or JVD noted?

  What is the overall skin color and appearance: pale, pink, ruddy/plethoric, dry, hot, cool, warm, diaphoretic, cyanotic, dusky, or jaundiced? How would you describe the mucous membrane color, and what is the capillary refill time? Does the patient require cardiac assist or support devices such as a cardiac pacer, Swan-Ganz catheter, intra-aortic balloon pump, or ventricular assist device?

- **Gastro-Intestinal System**

  How would you describe the abdomen: round, flat, distended, concave/scaphoid? Is the abdomen firm, soft or tender, and are any masses detected or loops of bowel visible? Is guarding noted? Are there bowel sounds, and in which quadrants? Document, if gastric tube is present, location of gastric tube, size, how placement was verified, method used to secure gastric tube, description of and amount of secretions from gastric tube, whether tube is clamped or to suction, time of patient's last meal, and any nausea or vomiting.

- **Genito-urinary System**

  How would you describe the external genitalia? Document if exam deferred. What is the method of voiding? What is the urine color? Is there an odor? Is there sediment present, and is it cloudy? What has been the output and when was the last void? Is a Foley catheter present, and if so, what size and how is it secured?

- **Integumentary System**

  How would you describe the skin integrity and condition? Are there obvious deformities, wounds, lesions, bruising, pettichiae, swelling, edema, or crepitus? Are dressings present? Note amount and color of any drainage. What is the skin temperature and the method of assessment? Is patient wearing a hospital identification band, allergy band and/or medical alert jewelry?

- **Intravenous Access**

  Describe the appearance of the site, including catheter size, method of securing, skin condition and color. What fluid is hanging, and what is the infusion rate? Are there medications infusing, and if so, what is the concentration, solution, and dose being delivered?

Trauma Patient Assessment

The above "Medical Patient Assessment" parameters should also be considered when caring for a trauma patient. Trauma-specific parameters are described below.

- **Scene Survey**

  When approaching the scene, both the pilot and medical crew should perform a thorough scan to identify possible hazards (i.e., fuel spills, hazardous materials, fire, unstable vehicles, etc.), locate the designated LZ, and determine possible mechanism of injury. This quick scan may also yield information regarding the number of patients present and whether any were overlooked.

- **Initial Survey**

  The primary focus of this basic assessment is to determine if any life-threatening injuries are present. You may not progress to the next step until all life-threatening injuries or conditions are addressed. Note the presence or absence of a Triage Tag and the recommended disposition. This initial assessment should take no more than 2 minutes.

  - ***Airway***—Is the airway open, patent and cervical-spine immobilized? Is the modified jaw thrust required to keep the airway open? Is an oral or nasal airway present or required? Is the patient intubated or have a crichothyrotomy? If not, is one required?

  - ***Breathing***—Does the patient have spontaneous, regular, equal respirations? What are the rhythm and rate? Is breathing labored? Are accessory muscles in use, and if so, where are they noted? Is there tugging along the intercostal spaces, the supra- or sub-sternal area, or superior to the clavicles? Describe/compare the breath sounds in the anterior, posterior and mid-axillary regions. What is the oxygen delivery method, FiO2, and oxygen saturation response? Can you hear an air leak in or around the cuff? Is the trachea in midline position? Is there subcutaneous emphysema or crepitus upon palpation?

- ***Circulation***—What is the pulse rate? Is it regular? What is the estimated systolic blood pressure by cuff or using a palpable radial pulse to approximate an SBP of 80, a palpable femoral pulse to approximate an SBP of 70 and a palpable carotid pulse to approximate an SBP of 60. Compare the quality of the pulses palpated. Describe capillary refill time, mucous membranes color, skin color, skin temperature, and condition. Is any gross bleeding noted upon initial inspection? Ensure the placement of two large bore intravenous lines with an isotonic fluid infusing at a rate to maintain the SBP >90 mmHg.

- ***Disability***—The neurological exam, beginning with the AVPU (**A**lert, response to **V**erbal, response to **P**ainful stimuli, **U**nresponsive), including the GCS score (**G**lasgow **C**oma **S**cale Score) and pupillary assessment, should be done as an integral part of the initial survey once life threatening conditions have been managed. An AMPLE history (**A**llergies, **M**edications, **P**ast Medical History, **L**ast meal/last menstrual period, **E**vents leading up to accident) can also be obtained while assessing the patient. A quick motor sensory assessment should be done, noting spontaneous movement of extremities, grip strength and reflexes.

- ***Expose***—The patient must be fully exposed as part of a thorough assessment. Whenever possible, this should be accomplished prior to completely securing and loading the patient into the aircraft. This will minimize important findings being overlooked until arrival at the receiving center. Be aware that trauma or scene calls tend to attract many bystanders and media personnel, potentially jeopardizing the patient’s right to privacy.

- ***Environment***—The patient’s comfort, temperature control, and safety should be a top priority. Trauma patients are often at risk for hypothermia or hyperthermia. You must protect them from temperature changes due to convection, conduction and radiation, as well as direct exposure to elements such as the hot sun, glare, loud noises and precipitation. The change in altitude may also bring a change in ambient temperature. Use cabin heating and cooling, chemical heat packs, insulated blankets, etc. to maintain the patient's optimal temperature. Also protect your aircraft and crew from exposure to body fluids by using the appropriate fluid resistant barriers.

- ***MAST Survey***—The final step of the primary survey is a quick survey of the abdomen, pelvis, back and lower extremities. This is referred to as a MAST survey because assessment of these body areas was performed for injuries and clear these regions of any foreign objects (i.e., glass, gravel, debris, etc.), prior to the application of anti-shock trousers. Although anti-shock trousers are rarely used, assessment of these body areas should be completed. You should also palpate the abdomen, assess for rigidity, tenderness, or distention, and check the pelvis for instability and/or pain.

- ***Vital Signs***—If possible, another provider should do vital signs while the primary medical crew member is conducting the initial assessment. Vital signs, GCS, and pupillary exam should be reassessed frequently while en route.

- **Detailed Survey**

  The detailed survey is a hands-on, head-to-toe assessment that should be performed after the patient has been loaded onto the aircraft and while en route to the receiving facility. There should not be any delay in transporting the patient after the initial assessment has been completed. Altitude changes may adversely affect the patient's condition, necessitating close monitoring of the patient and his/her response to interventions. Focus on what has changed since the initial survey.

  - ***Head***—Has the patient's LOC (**L**evel **o**f **C**onsciousness) changed? What is the GCS and has there been a change of two or more points since initial evaluation? Have there been pupillary changes? Is sensation intact throughout the body? Is the patient moving all his/her extremities with purpose? Is grip strength equal, dorsal-plantar flexion/extension present and equal? Is the gag reflex present? Has the patient received any paralytics or sedatives? Are they required at this point? What has been the response to the medications administered? Are skull, facial bones and mandible intact? Are there retinal hemorrhages, broken teeth? Are mucous membranes moist and pink? Is there any ecchymosis, crepitus, blood, or fluid from ears or nose?

- ***Neck***—Note tracheal position. Is there JVD? Is there subcutaneous emphysema, crepitus, or tenderness when palpated? Are there any step offs when palpating the back of the neck? Note the type of airway adjunct, size, cuffed or uncuffed, inflated or not, patency, air leaks, position adjunct secured at, method used to secure? Method used to confirm placement, CXR, assessment of epigastric sounds, good compliance with bagging? Describe secretions from suctioning. Document ventilator settings (mode, tidal volume, rate, peep/CPAP, peak inspiratory pressures).

- ***Chest***—Does the patient have spontaneous, regular, equal respirations? What is the rhythm, depth and rate? Has work of breathing increased? Has use of accessory muscles changed? Are the breath sounds present or diminished anteriorly and posteriorly? Is there subcutaneous emphysema or crepitus upon palpation? Are chest tubes present, or need for needle thoracostomy or CT placement determined? What is the size of chest tube, how was placement confirmed, what centimeter marking is at the skin line and what method was used to secure? Is chest tube to suction or water seal? What is the amount and quality of drainage in the collection system? What are the heart sounds and patient's cardiac rhythm? Describe quality and characteristics of pulses bilaterally. Document blood pressures in both arms, skin temperature/moisture, color of mucous membranes, capillary refill. Note any chest pain/ pressure/discomfort. Is there any ecchymosis, crepitus, or subcutaneous emphysema?

- ***Abdomen***—Has the appearance of the abdomen changed? Is the abdomen round, flat, distended, obese, concave/ scaphoid, firm, soft, or any masses noted? Have bowel sounds resumed or diminished? Any guarding present, complaints of, and/or description of pain? Report of last meal. Any nausea/vomiting?

- ***Pelvis***—Note stability of pelvis. Any trauma to external genitalia? Method of voiding? Changes in urine color, odor, sediment, opacity? Foley placed, size, amount of output?

- ***Extremities***—What is the range of motion? Any gross deformities, crepitus, pain, lacerations, or abrasions noted? Check pulses, especially distal to deformities, and before/ after any manipulation/movement of extremities. Has motor/sensory response changed?

- ***Intravenous Access***—Two large bore IVs present, or need for fluid support determined? Location, type, and size? What is the appearance of the site, type of fluid infusing and rate? Any medications infusing, concentrations, solution in, doses being delivered?

- ***Integumentary System***—Is the skin intact? Describe color, temperature, condition, hydration, perfusion, wounds, drainage and dressings. Are there splints or traction present or required? Note information on hospital identification band, medical alert, and/or triage tag.

Documentation/Consents

- **Consent**—Consent for transport should be obtained from the patient or patient's representative prior to departure. It is usually the referring physician’s responsibility to explain the risks and benefits of the transport to the patient and family. A copy of this signed document should be kept as a part of the permanent transport record.
  - ***Expressed Consent***—Expressed consent is the oral or verbal permission a patient gives for the transfer after fully understanding the purpose of the consent and the risks and benefits associated with the transfer.

  - ***Implied Consent***—Implied consent is used in many emergent transfers. This consent is used when the patient is unable to give consent, but transport and treatment is the most prudent choice and one that the patient would choose if he/she were cognizant. The most common situations that dictate this type of consent are patients who are unconscious, chemically paralyzed, or sedated.

- **Documentation**—Documentation from the referring facility or first responder on-scene should accompany the patient to the receiving center. This documentation should include a scene report, copies of admission and discharge notes, pertinent labs, radiographs, and other studies done during the patient’s stay at the originating facility. This transfer of information ensures the continuity of care and prevents duplication of studies already done at the referring facility. Transfer of the patient should not be delayed while waiting for chart copies or pending study results. Pending information can be faxed directly to the receiving emergency department, and hard copies can be mailed at a later time. The air medical program can facilitate the transfer of these records by providing referring facilities with a checklist detailing the records needed. EMS records, but especially trauma records, define the baseline patient profile that is very beneficial in determining changes in patient status over time.

Packaging Patients for Transport

The manner in which a patient is packaged and loaded onto the aircraft is very important to patient comfort, but can also facilitate or hinder the ability of the flight crew to provide safe and rapid assessment and intervention. Consideration of the patient's size, equipment needs, and possible en route treatments or interventions must occur prior to placing the patient on the aircraft stretcher. The layout of the medical cabin and its limitations should guide how the patient will be prepared for transport. At minimum, the flight crew should be able to access the patient airway at all times while simultaneously accessing lines, devices, and in the case of all pregnant women, the perineum.

- **General Patient Preparation**

  All patients should have the following considerations addressed prior to and for the duration of the flight.

  - ***Patient Comfort During Transport***—Keeping the patient comfortable during the flight can be challenging. Complicating factors may include fluctuations in temperature, altitude, and ambient noise level; the method of immobilization or restraint; and the confined space of the aircraft cabin. The stresses inherent to the flight environment can be minimized and on-board safety maintained if the patient is comfortable, calm, and cooperative.

  - ***Noise***—The patient needs to be protected from the high noise levels produced by the aircraft engines. Aircraft rated headphones and/or earplugs should be used. Headsets can facilitate communication with the patient and also decrease their anxiety level.

  - ***Aircraft Stretcher/Litter***—The aircraft litter is often one of the most uncomfortable items in the air medical inventory. The firm surface required for potential cardio-pulmonary resuscitation, the lack of additional padding or pillows, and the restraint system combines to make this an uncomfortable and potentially unsafe place for the patient being transported. With some forethought, the stretcher can be manipulated to improve patient comfort and safety as well as minimize patient anxiety. There should be sufficient padding, blankets, or pillows to prevent pressure areas and to pad the voids of the lumbar region, knees, and under the head. The head of the stretcher should also be raised to the position of comfort whenever possible. These comfort measures are of particular importance when there are extended transport times.

- ***Restraints***—Safety restraints, such as seat and shoulder belts, harnesses, and five-point restraints should be used as appropriate on all patients at altitude. Combative, suicidal, or incarcerated patients may pose a threat to the safety of themselves and the crew. Unanticipated movement or noise may also distract the pilot, affecting ability to control the aircraft. In these cases, security restraints should be considered. Security restraints can be categorized as physical or chemical and should be used only per pre-determined protocol or direct order. When used with caution and discretion, restraints can be helpful to ensure patient and crew safety as well as to ensure the patency of tubes, lines, and devices.

- ***Oxygen***—An adequate oxygen source must be available on board all medical aircraft. Program mission, flight and scene times, and type of ventilation determine the amount, method of containment, and storage needed. A portable oxygen supply should be readily available for patient transfer between facilities and vehicles. A source for compressed air might also be required, depending on mission and ventilation type.

- ***Airway Adjuncts/Endotracheal Tubes***—All airway adjuncts must be secured, placement verified, and a back up available in case the airway is compromised. The patient should always be positioned so that re-intubation is possible during the flight. A BVM should be readily available as well. Because of the increased risk of airway compromise with each patient move, the airway and adjunct placement should be re-confirmed after each move (i.e., stretcher to aircraft, aircraft to ground vehicle, off-loading at facility).

- ***Linen***—The reasons for using the proper type of blanket, sheet, or protective material are to keep the patient comfortable, warm, dry, and protected from the elements as well as protecting the crew and aircraft from blood and body fluid contamination.

- ***Non-invasive BP Cuff***—Monitoring the SBP and MAP provides information regarding changes in patient perfusion, potential for hemorrhage, and changes in cerebral perfusion pressure (CPP).

- ***Pulse Oximeter***—Monitoring oxygen saturation will provide information regarding the degree of perfusion and potential hypoxemia. This reading has little value as an isolated reading, but provides good trending information that can indicate changes in overall patient condition. Oxygen saturation readings can be affected by underlying medical conditions, altitude, elevation, patient temperature, and peripheral circulation.

- ***Foley Catheter/Elimination***—The movement, increase in altitude, and expansion of gas may hasten the patient's need to defecate or void once on-board the aircraft. Because of this, patients should be given the opportunity, prior to departure, to use the bedpan, urinal, or fracture pan if they are able. A Foley catheter can be helpful to determine accurate urine output, but can also ensure the comfort of patients confined to a backboard and/or stretcher.

- ***Cables/Tubing***—Multiple invasive and non-invasive lines and cables are used to monitor and care for patients in the transport environment. All must be secure, and free from crimping, pinching, and breakage. Fluid and air levels in all tubings should be monitored for appropriateness and changes, given the effect of altitude on these substances.

- ***IVs/Infusion Devices***—The integrity of all intravenous lines must be maintained and the amount of fluids being administered should be monitored closely. Altitude, temperature, type of container, viscosity of fluid, proper syringe and tubing size as well as battery life, can affect the administration of fluids in the air medical environment.

- ***Nasogastric/Orogastric Tubes***—Due to the expansion of gas at increased altitudes, patients should have their stomach decompressed and continually vented during the flight. This is especially important for intubated patients to minimize the risk for vomiting and aspiration.

- **Trauma-Specific Patient Preparation**

  Additional patient preparation considerations, specialized equipment, supplies and interventions may be needed to appropriately care for trauma patients.

  - ***Cervical Spine Immobilization***—Proper cervical spine immobilization must be initiated and maintained on all trauma patients. To accomplish this for patients of all sizes and weights, a varied selection of cervical collars and restraint devices must be available. Specifically, pediatric sized equipment and supplies must be considered as necessary stock items. The activities and movement involved in patient loading and unloading, as well as the vibrations and turbulence of the flight environment may compromise the neutral alignment of the spine, thereby dictating frequent reassessment.

  - ***Traction Splints***—Some traction devices do not fit into the limited cabin space of smaller rotor-wing aircraft. The HARE traction splint may need to be replaced by the more compact MAST trousers or Sager splints to properly stabilize the patient's fractures during transport. If MAST trousers are used, ensure the pump and gauges are readily available, and monitor the pressures frequently.

  - ***Fluid Support***—An adequate supply of isotonic crystalloid solutions and large bore IV tubing should be readily available for rapid fluid administration, especially in the treatment of trauma related hypovolemia and shock. Because of the temperature concerns encountered on scene response calls, a fluid warmer may be a valuable piece of air medical equipment. If this specialized piece of equipment is not available, the IV tubing can be wrapped around a chemical heat pack placed close to the IV insertion site and secured with gauze.

  - ***Elements/Weather***—Especially on scene-response calls, the geography, weather, and time of year can greatly impact the patient's and crew's comfort level. Appropriate protective clothing, devices, and bedding must be available to protect all on-board from the harsh wind, sun, rain, snow, heat, and cold. Many materials and devices are available for use in specific climates or situations and should be chosen based on program mission, scope of practice, and response area. It is not uncommon to lift off from a location, fly to a destination at a much higher or lower elevation, and return to the original site. This necessitates that the flight crew be prepared to deal with patient care issues at multiple elevations, climates, and environments within the same flight.

Reassessment with Patient Load and Unload

The most critical time during the air medical transport process is the actual loading and unloading of the patient. A change in the patient condition may be missed or an invasive device may be dislodged without the crew's knowledge. The patient should be reassessed before and after each move to or from a transport vehicle. Airway, breathing, and circulation must be re-evaluated frequently during the transport. Subsequent treatments or interventions should be done based on the changes in patient status. All parameters should be assessed and compared to the baseline established prior to transport. The frequent patient transfers, multiple mechanical devices, electronic devices, multiple cables, and tubing can present a complicated patient care environment. Reassessment of these environmental issues is important to the safety and comfort of the patient. The patient support systems within the aircraft, such as medical oxygen, compressed air, portable suction, proper lighting, and battery backup, must also be checked prior to and after each flight to assure crew and patient safety.

- **Airway**

  Reassess the placement and security of any airway adjunct before and after each move.

- **Breathing**

  Because of the difficulty in accurately assessing breath sounds while in an aircraft, visual signs of increased work of breathing must be evaluated. Look at the rate, depth, and quality of respirations, including retractions, nasal flaring, mouth breathing, grunting, wheezing, and/or stridor. Pulse oximeter readings should be trended to ascertain the improvement or deterioration in oxygen saturation, especially with changes in altitude.

- **Circulation**

  Heart rate and blood pressure should be monitored frequently. Fluid administration should be sufficient to maintain the SBP at or above 90 mmHg, or appropriate for age.

- **Disability**

  The patient's neurologic status should be frequently re-evaluated. Changes in the GCS and pupillary exam must be noted and documented particularly when there are elevation changes and the potential for increased ICP.

Patient Safety Briefing

The patient safety briefing should be short and concise. Its purpose is to convey important safety information and to minimize anxiety about the transport process. Be ready to calm and reassure the patient throughout the transport, but particularly during lift-off, loading, unloading, and landing.

- **Transport Process**

  Explain the transport process to the patient and family. Answer any questions that they may have about the aircraft, flight conditions and receiving facility. Let them know that in some circumstances, a ground transport is also required from the landing site or airport to the facility.

- **Emergency Exits**

  The placement and operation of emergency exits should be explained, especially to any family members that might be going with the patient.

- **Restraints**

  Explain the purpose and need for immobilization and restraint to the patient and family. Allow the patient, especially a child, to hold a special belonging such as a blanket, memento, or a family member's hand whenever possible. This will make the restraints seem less restrictive and decrease the patient's anxiety level.

- **Communication**

  Provide the patient with an explanation of how he/she can communicate with the crew during transport. Explain the limitations and stressors of the flight environment, including the noise, vibration and visual disturbances. Providing ear protection, and whenever possible, calming music through the headset can help to calm the anxious patient. Be empathetic and supportive.

Psychological Support of Family and Patient

The need for emergent air medical transport is usually very stressful for the patient and family. It is important for the air medical crew to explain the transport process and air medical environment in a concise and thorough manner. The anxiety caused by this unanticipated event can impede the transport process if not dealt with properly. Family members, patients, and referring hospital staff members may be coping poorly with the high stress levels. Maintaining a professional demeanor and emotional composure when dealing with all involved will help manage the situation and decrease the anxiety levels.

- **Receiving Facility Information**

  Providing the family with written information, including air medical crew names and receiving facility name, address, and phone number, may minimize fear and anxiety. The receiving physician's name or that of a contact person should also be provided. Directions to the receiving facility should be detailed enough for someone who may be driving in an unfamiliar area or city.

- **Emotional Support**

  If the family has not already done so, allow them to see the patient prior to departure. Prepare the family before they see the patient by describing the condition and explaining what the patient will look like packaged and restrained. This should better prepare them for the experience of seeing their loved one ill or injured. Answer their questions to help alleviate some of their fears, while providing reassurance and emotional support. Be truthful and realistic, yet optimistic in your discussions. Be prepared to step in and ask the family to leave if they become so emotional that they endanger the patient or your crew.

Reporting/Transfer of Care

The final stage of the transport process is the actual report to the receiving facility and the transfer of care.

- **Notification**

  If you recognized during your initial assessment the need for special equipment (i.e., intra-aortic balloon pumps, ECMO, dialysis machines, etc.) that will be required upon arrival at the receiving facility, call the receiving facility prior to departure to ensure that equipment will be available upon admission.

- **In-Flight Report**

  A brief report should be provided to the receiving facility approximately 15 minutes prior to patient arrival. Report any medications the patient is currently receiving intravenously, whether any mechanical ventilation is required, and the patient's current condition. Local protocols may dictate the need to confer with a medical control physician during this report. Requests for special assistance or unloading situations (e.g., hot unload while the rotors are turning) should be made at this time. Be sure to consult the pilot regarding the unloading plan.

- **Arrival at Receiving Facility**

  The on-board air medical crew may need to assist in securing the LZ once the aircraft has landed. Ground personnel may be caught up in the need to rapidly move the patient and lose their situational awareness around the aircraft. Moving rotors, icy or slippery landing pads, and unanticipated obstacles can all endanger the patient and caregivers if not managed carefully.

- **Report to Next Level of Care**

  Ensure that all relevant health care providers are at the patient's bedside prior to giving report. A concise, yet thorough, report should include the history of the patient's present illness or injuries, important scene information, treatments received and patient response to treatment, changes in airway, breathing, circulation, GCS or pupillary response, significant past medical history, as well as any allergies. Specifically ask the attending physician and primary care nurse if they have any questions prior to the flight crew departure. Leave all copies of the patient's chart, X-rays, and CT studies at the bedside, and provide any information regarding the expected arrival of family members.

- **Documentation**

  The transport documentation can be accomplished in several different ways. Handwritten documentation, electronic notepad technology, personal data assistant, and laptop technology can all be used. If the handwritten chart is not left at the bedside, it should be completed in a timely manner so the receiving facility can review it if there are any questions. No matter how the chart is generated, it must be legible and complete. The patient transfer record is a legal document that can be used to validate and/or explain in-patient care decisions, and therefore should be concise, objective, and thorough. Observations made of the injury or accident scene are particularly important, since there is usually no other detailed record of that information.

SUMMARY

The skill and knowledge of a professional air medical flight team is the biggest contributing factor to the success of a medical mission and a positive patient outcome. A flight team that is well versed in medical and trauma assessment and care, calm and reassuring to patients and families, and objective and professional in demeanor will be an asset to any flight program. This expertise can be gained only through a solid educational foundation, adequate clinical experiences, and the benefit of an experienced flight team mentor. Although assessment skills are intrinsic to all health care providers, the expanded role of air medical flight crew carries with it an increased sense of responsibility and duty to the patient.

A. **Bibliography**:

National Association of Emergency Medical Technicians. *Basic and Advanced Pre-hospital Trauma Life Support*, 4th Edition. Mosby 1999.

National Flight Nurses Association. *Flight Nursing Core Curriculum*, 1997.

National Flight Nurses Association. *CFRN Study Guide*, 2nd edition, 1996.

Lee, Genell. *Flight Nursing Principles and Practice*. Mosby 1991.

B. **Definitions of Keywords**:

Initial patient assessment—The first brief assessment conducted to assess airway, breathing, circulation, and immediate life-threatening injuries; sometimes called a primary survey

Detailed patient assessment—The second, more comprehensive assessment of patient condition, conducted in a head-to-toe, or system-to-system manner

Pre-flight planning—Planning and preparation for the patient transfer prior to arrival on-scene

In-flight planning—Pre-arrival planning of patient care and interventions conducted en route; during a scene call, pre-planning can also be done based on the aerial view of the accident scene

Patient packaging—The process of loading, securing and immobilizing a patient prior to loading onto an aircraft or EMS vehicle. Special consideration must be given to patient's size, equipment needs, and possible en route treatments or interventions.

Transfer of care—The process of providing a patient history and status report to the next level of health care professional or facility

Altitude restrictions—Limitations placed on the type of aircraft or the acceptable altitude/pressurization for transferring patients with pressure-sensitive diagnoses, such as pneumothorax or increased intra-cranial pressure

C. **Test Questions**:

1. You are going to the scene of a motor vehicle crash. Upon arrival, you:

   a. Complete an initial patient assessment after loading the patient into the helicopter.
   b. Complete an initial patient assessment in the ambulance prior to loading the patient in the helicopter
   c. Complete both an initial and detailed patient assessment in the ambulance prior to loading the patient
   d. Complete both an initial and detailed patient assessment after loading the patient into the Helicopter

2. You receive a report about a patient with a 30 percent pneumothorax and on room air, whom you will be transporting in a non-pressurized fixed-wing aircraft. The following is included in the pre-planning portion of your transport:

   a. You must have an arterial blood gas (ABG) on the patient prior to departure
   b. You inform the pilot you must restrict the altitude of the flight to 3,000 feet
   c. **Request that a chest tube be placed prior to arrival**
   d. Request that the patient be intubated prior to arrival

3. During your initial assessment of a trauma patient, you have difficulty clearing the airway. Your next intervention is to:

    a. Continue on to the breathing component of your initial patient assessment.
    b. Remain with the airway portion of the assessment until patent airway is obtained
    c. Have an EMT continue to try to clear the airway while you complete the initial patient assessment
    d. Load the patient and continue your initial assessment in the aircraft

4. You are transporting a critical patient that requires emergent surgical services at the receiving facility. You are informed by the referring facility that it will be at least 30 minutes before copies of the radiological studies will be available. You:

    a. Load the patient and have the referring facility forward the copies when available
    b. Do not load the patient and wait for the films
    c. Request to take the originals with you and load the patient
    d. None of the above

5. Information required for a transport:

    a. Name, age, weight
    b. Weight, age, gender
    c. Weight, age, height
    d. Weight, diagnosis, name

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

Crew members may need instruction in specific skills that are not a usual part of their clinical duties. The categories of skills should include clinical skills, patient packaging, patient loading and unloading, and family interaction scenarios. The following is a partial list of these skills, and should be revised depending on program mission and scope of practice. Skills are listed by the most frequently associated discipline.

- **RN Skills**—Chest tube management, naso-gastric tube insertion, Foley catheter insertion, central line management, specialty medications

- **Paramedic Skills**—Cervical spine immobilization, securing patient to a stretcher, intubation, application and use of anti-shock trousers, traction splints, pre-hospital airway adjuncts, needle thoracostomy, and needle crichothyrotomy

- **RT Skills**—Ventilator management, intubation, detailed respiratory assessment

All equipment and supplies used for skills practice should represent the brands and types of equipment the air medical crew will be working with in their aircraft and when interfacing with ground EMS providers. At minimum, medical crew members should be familiar with aircraft specific stretcher(s), transport incubators, long-spine boards, half-boards or KED devices, cervical immobilization devices, restraints, pediatric immobilization and restraint devices, IV infusion devices, suction apparatus, monitoring equipment, pulse oximetry devices, ventilation equipment and devices, and age-specific medical supplies.

F. **Patient Care Hours**: 8, including clinic visits, hospital admissions, ED triage

CHAPTER 6: MEDICAL CONDITIONS

Module 16: Cardiovascular Patients

Module 17: Respiratory Patients

Module 18: Neurological Patients

Module 19: Toxic Exposures and Envenomations

Module 20: Metabolic, Endocrine, and Immune Suppressed Patients

Module 21: Hypothermic and Hyperthermic Patients

Module 22: Restraint and Care within a Confined Space

MODULE 16: CARDIOVASCULAR PATIENTS

Author: Dr. Cathy Carrubba, Tampa General Hospital, Tampa, FL

Reviewer: Mr. Michael Frakes, RN/CEP, LIFESTAR, Hartford, CT

KEYWORDS

Cardiovascular
Hypertension
Pulmonary embolism
Cardiac disease
Syncope
Aortic dissection
Myocardial ischemia
Deep vein thrombosis

OBJECTIVES

Upon completion of this module, the student should be able to:

- Discuss the signs and symptoms, etiology and treatment of hypertension
- Discuss the signs and symptoms, etiology and treatment for pulmonary embolus
- Discuss the signs and symptoms, etiology and treatment for aortic dissection
- List 2 of the 3 criteria identified by the World Health Organization to define an acute myocardial infarction (AMI)
- List at least 5 risk factors for deep vein thrombosis (DVT) and subsequent pulmonary embolism

INTRODUCTION

Diseases of the cardiovascular system are common in society, and are a frequent cause for air medical transport. Air medical transport crew members must be aware of the types of patients likely to be transported by their services and any specialized equipment (intra-aortic balloon pumps, LVADs, etc.) that will be encountered, and train accordingly. As always, the air medical specialist must remember that these disease entities generally do not exist in isolation, and that several disease entities may be present in any patient.

CARDIAC DISEASE OVERVIEW

Diseases of the heart can be discussed in terms of signs and symptoms (dysrythmias, chest pain, pulmonary edema, syncope), etiology (acute ischemic coronary disease), or in terms of location (myocardial, pericardial, valvular). Discussions based on signs and symptoms must include cardiac as well as noncardiac etiologies. For example, syncope has many cardiac and noncardiac etiologies. A discussion of syncope follows. The remainder of this chapter discusses specific cardiovascular entities: ischemic heart disease, pulmonary embolism, pericarditis, myocarditis, hypertension, and aortic dissection.

Syncope

Syncope is a temporary loss of consciousness due to an abrupt decrease in cerebral perfusion and glucose delivery. A disruption in glucose delivery for 5 to 10 seconds can cause complete loss of consciousness. Causes of syncope include defects in vasomotor tone and intravascular volume, cardiac pathology resulting in decreased cardiac output, hemorrhage, situational (post-tussive, defecation, micturition, swallowing, postprandial) disturbances of metabolism or endocrinopathies (hypoglycemia, Addisonian crisis, pheochromocytoma), and central nervous system causes (subarachnoid hemorrhage, carotid sinus sensitivity). Prescription medications are often implicated. There are many specific etiologies within each category listed. Cardiac etiologies can be generally divided into electrical (dysrhythmias) or mechanical. In both instances, the heart cannot maintain the perfusion pressure necessary to maintain consciousness, and syncope results.

A patient demonstrating syncope while in the care of the air medical transport team must be rapidly stabilized. Assuming a supine position to maximize blood flow to the brain is necessary, with attention paid to airway, breathing, and circulation. A search for low blood sugar and resuscitation directed at abnormalities discovered on initial patient assessment is appropriate. Careful cardiac monitoring must be continued. Attention to treatable causes, such as hypovolemia, should be initiated. Other causes, such as prescription medication reaction, should be searched for in the history and on physical exam. A patient who does not rapidly regain consciousness is not truly having a syncopal episode, but is in coma, for which an etiology should be sought (see module on neurological patients). Careful attention to the field history given by persons present at the onset of syncope, or by the ground EMS response team, may be lost if not obtained and documented by the air transport team. Although syncope is not a common reason for air transport, it is a common problem and may be part of a bigger picture.

Cardiac Dysrhythmias

The American Heart Association has recently (December 2000) revised Advanced Cardiac Life Support (ACLS) guidelines. The new guidelines show a strong commitment to evidence-based medicine, as demonstrated by the new drug classifications (example: lidocaine-indeterminant; amiodarone Class IIb for persistent V-fib.). Explicit criteria have been developed for stopping resuscitative efforts in the field, with strong recommendations for having pre-hospital personnel pronounce death in the field. New medical devices have been included (e.g., laryngeal mask airway, combitube, esophageal detector devices, end tidal CO_2 detectors, capnometers, a recommendation for pre-hospital 12 lead EKGs, etc.) The air medical specialist must be familiar with these pieces of equipment to interact effectively with caregivers from other systems.

Amiodarone has been shown to be a versatile agent in the treatment of stable and unstable tachycardias. It is the first drug of choice for tachycardias in patients with impaired heart function, narrow complex junctional tachycardias that failed to respond to adenosine and vagal stimulation, narrow complex ectopic or multifocal atrial tachycardia, and stable monomorphic ventricular tachycardia with poor cardiac function.

New fibrinolytic and anti-platelet agents are discussed, as well as low molecular weight heparin for high-risk unstable angina and nonST-elevation acute myocardial infarction. Additional drugs have been added to the lists of approved beta-blockers, calcium channel blockers, and ACE inhibitors. Early use of defibrillation or cardioversion is encouraged.

In general, the new ACLS guidelines emphasize fewer, more focused objectives, and recommend that the revised algorithms be kept handy as a reference. Another area of change is in the discussion of anti-arrhythmic medications; most can cause or cure dysrythmias. This author recommends that all air medical transport personnel review the updated ACLS material, and keep reference material handy to the work environment.

Cardiac Ischemia

Ischemic heart disease continues to be the leading cause of death among adults in the United States. Thrombolytic therapy and interventional techniques have revolutionized the care of patients with acute myocardial infarction, making timely diagnosis and therapeutics increasingly challenging. Medical therapeutics aimed at improving coronary blood flow have evolved tremendously over the past 5–10 years. It is reasonable to assume that in a society driven to seek newer and better solutions to health care problems, changes in these areas will continue to evolve rapidly. All air medical specialists will be required to keep abreast of current standards of care, maintaining competency in all therapeutics that may reasonably be delivered in the transport environment. This would include diagnostic (12 lead EKGs) as well as therapeutic interventions consistent with the mission and scope of care provided by each service. Destination decisions must take into consideration the condition of the patient and the capabilities of the receiving facilities, as well as the talents of the receiving physicians. In just 1 year, emphasis in the cardiac literature has changed from immediate thrombolytics to immediate cath lab intervention. The air medical specialist can be sure that this will continue to be hotly debated.

Cardiac ischemia manifests as a spectrum of diseases that includes angina (stable and unstable) and acute myocardial infarction. Stable angina is defined as chest pain that is transient, typically predictable and reproducible, with no change in the frequency of attacks. Unstable angina is angina at rest (symptoms last longer than 20 minutes while at rest), increasing frequency of angina, or new onset of angina. It is considered the precursor to acute myocardial infarction (AMI). According to World Health Organization criteria, AMI includes two of the following three: (1) clinical history of chest discomfort more than 20 minutes in duration, consistent with ischemia; (2) ischemic EKG changes; (3) positive myocardial enzyme tests. An AMI is caused by myocardial necrosis. Thrombus formation initiated by atherosclerotic plaques is implicated in all cardiac ischemia. Partial or complete vessel occlusion can lead to myocardial ischemia and eventual infarction. A variety of clinical presentations occur due to differences in the rate of development of thrombus, and the amount of collateral circulation present. Vasospasm may also contribute to ischemia in some instances. Reperfusion injury after spontaneous or therapeutic thrombolysis further contributes to myocardial injury. Ischemia in cocaine users appears to be from a combination of vasospasm and thrombus formation, sometimes in coronary arteries free of significant atherosclerosis. Coupled with the decreased myocardial blood flow is an increase in myocardial oxygen demand.

There is an inverse relationship between time to reperfusion and myocardial muscle salvage-time is muscle! Thus, the air medical specialist must expedite definitive care, either by rapid transport to a facility capable of advanced therapeutics, or by protocol driven diagnosis and definitive treatment (thrombolytics) in the field. Thrombolytic therapy for patients treated within 2 hours of an acute myocardial ischemic event show significantly greater benefit in terms of preservation of ventricular function and lower mortality. Many patients unfortunately do not seek care until they are outside of this window of opportunity. The National Heart, Lung and Blood Institute initiated the National Heart Attack Alert Program in

1991, with the goal of increasing public awareness, decreasing the time before reperfusion, and reducing the morbidity and mortality associated with acute myocardial infarction. Air medical specialists may wish to participate in this aspect of public education.

Patients with a history consistent with cardiac ischemia should be assumed to be having an acute myocardial infarction until proven otherwise. Recannulization may be attempted by thrombolytic therapy, or more invasively in the cardiac cath lab. Open-heart surgery, once the mainstay for reperfusion, is now for those who fail treatment or cannot be reperfused less invasively. There is considerable variation regionally on the most appropriate initial management of the acute myocardial infarction, and the air medical specialist is encouraged to keep abreast of the abilities and preferences of the receiving physicians. This is an area of rapidly changing alternatives, and likely will remain so. Though there is regional variation in patient selection for thrombolytic therapy, most protocols still generally agree that a patient with ST segment elevation on EKG, no recent surgery, no recent CNS events, and no recent arterial punctures, with history and exam consistent with acute myocardial infarction, are candidates. Age has become a softer criterion, and dependent on the immediate availability of cath lab resources, many cardiologists prefer to go straight to the cath lab and bypass the thrombolytics in favor of angioplasty and stent placement. As our ability to diagnose acute myocardial infarction improves, we may see criteria for patients with equivocal EKGs and transmural myocardial infarctions. New cardiac and thrombolytic agents are being developed rapidly. The transport specialist must stay current with changes in this area, which will be no easy task.

Management of the patient with chest pain should include monitoring of vital signs, careful history and physical exam, oxygen administration, IV access, and cardiac monitoring. Therapy is directed at the etiology. Cardiac ischemia is caused by atherosclerotic plaque rupture and platelet aggregation, with thrombus formation causing lumen occlusion, coronary artery spasm, and finally by reperfusion injury most likely due to neutrophil response, free radical formation, and calcium. To improve myocardial oxygen supply, chest pain is treated with nitroglycerin and morphine if the systolic blood pressure is > 90 mm Hg. Thrombolytic therapy may be instituted in selected patients. Beta-blockers and calcium channel blockers decrease the force of myocardial contraction and therefore of oxygen demand, and are frequently used in early stages of AMI. Cardiac ectopy and dysrhythmias are treated according to standard current ACLS guidelines. One aspirin is given for platelet inhibition. The literature suggests that GPIIb/IIIa inhibitors, either as an adjunct to PTCA or in combination with low-dose fibrinolytics, may have some clinical utility and may be seen in the transport environment. Inhibition of platelet aggregation and thrombus formation by aspirin, and antithrombins, such as heparin, help to prevent reocclusion of the coronary arteries once patency has been regained. Concomitant problems, such as hypoglycemia, hyperthermia, hypovolemia, or suspected electrolyte abnormalities, should be addressed by protocol, and treated. Other pre-hospital interventions with pharmacologic agents such as heparin and beta-blockers should be considered in appropriately selected individuals. A high index of suspicion for other causes of chest pain must be maintained (e.g., aortic dissection, pulmonary embolism, spontaneous pneumothorax, pericarditis, perforated ulcer).

Pericarditis and Pericardial Effusion

These conditions have many possible etiologies, and care of this patient after immediate stabilization will depend on determining the exact etiology when possible. These etiologies include viral infections, traumatic injury to the pericardial sac (from cardiac surgery, post-MI, or chest trauma), radiation therapy, bacterial infection, parasitic infection, amyloidosis, tumors in or around the mediastinum, sarcoid, use of anticoagulants, collagen vascular disease, dissecting aortic aneurism, as a complication of therapy with several medications, and more rarely, by local extension of bacterial disease involving the heart and heart valves. Pericarditis with an associated fibrinous effusion can be seen in end stage renal failure and dialysis patients. It is commonly estimated that 20 percent of dialysis patients have some component of pericarditis. Renal failure patients are also generally immune-compromised due to chronic illness, and a search for infectious etiologies must be made when a uremic patient presents with signs and symptoms of pericarditis or pleural effusion. Constrictive pericarditis occurs when scarring of the pericardial sack prohibits adequate filling of the heart. Symptoms can be difficult to distinguish from CHF.

Post-MI patients may also experience pericarditis, which is short lived, and responds to nonsteroidal anti-inflammatory medication. They may also experience transient pericardial effusions which are incidental findings on echo, and rarely clinically significant. The validity of “Dressler’s Syndrome”, or late post-MI pericarditis, has been questioned. In the 1950's it was very common to heparinize post-MI patients, and no other therapeutic modalities were available. Without nonsteroidal anti-inflammatory treatments, and with the possibility that early post-MI pericarditis was exacerbated by the heparin, it is likely that these patients represented prolonged early post-MI pericarditis.

Acute accumulation of pericardial effusion can be life threatening, requiring immediate percutaneous drainage. Chronic accumulation tends to be better tolerated, and can observed expectantly during transport.

Emergency pericardiocentesis, if performed blindly, should be accomplished using a unipolar lead from an EKG attached to the pericardiocentesis needle. This skill should be taught and practiced in a laboratory setting.

Acute pericarditis may present with fever, chest pain, and often an audible friction rub. Characteristic EKG changes include diffuse ST segment elevation in the first few days of the illness. After this time the EKG may evolve to T wave inversions, or may normalize. Q waves do not generally appear. Treatment of this condition is symptomatic. The transport team must be sensitive to the possibility of an AMI. When the diagnosis is in doubt, the use of thrombolytics or blood thinners should be discussed with on line medical control as these therapies may precipitate a pericardial effusion in the patient with pericarditis. Treatment of purulent pericarditis is surgical; IV antibiotics should be immediately delivered, but alone they are inadequate treatment.

Myocarditis

Myocarditis is most commonly associated with a viral infection, and symptoms are similar to viral flu like symptoms: fever, myalgias, tachycardia, and cough or cold symptoms. Vomiting and diarrhea may be present. Other more rare etiologies include Lyme disease, Chagas disease and other parasites, adriamycin toxicity, and cocaine use. Patients may present with CHF. Chest pain may or may not be present, making this entity easy to confuse with acute myocardial infarction. With severe myocardial involvement, hypotension or dysrhythmias may be present. Supportive therapy is appropriate, using standard therapies for these symptoms. Patients who continue to deteriorate or fail these supportive measures may be candidates for cardiac transplant.

Endocarditis

Endocarditis is a disease of the cardiac valve leaflets. Classically, vegetation is colonized by microorganisms. The initial damage to the valve resulting in growth of this vegetation is trauma, inflammation, or abnormal turbulence such as seen with a prosthetic valve. Common predisposing factors include previous endocarditis, valvular disease such as mitral prolapse or acquired valvular heart disease from rheumatic fever, prosthetic valves, IV drug abuse, AIDS, or intracardiac pacemaker. The symptoms associated with endocarditis are very nonspecific, making diagnosis a challenge. Typically the patient will present with fever, a heart murmur, sometimes anemia, and may or may not give a history of a prodromal acute febrile illness in the past 7 to 10 days. Empirically antibiotics are given when history and exam are suggestive of this disease process, pending specific blood culture results. With significant valvular disease, the patient may present with severe CHF. Surgery may be a necessary life saving intervention. Short of this, treatment is aimed at symptomatic relief.

Other acquired valvular heart diseases may precipitate acutely, causing the patient to deteriorate rapidly. Acute aortic or mitral regurgitation will require definitive treatment—surgical replacement; however temporization may include the use of diuretics, after load reducers, or an intra aortic balloon pump. Invasive airway management is usually necessary in these instances. Acute prosthetic valve failure has a high mortality rate, and is also a surgical emergency. Temporizing measures are aggressive attention to ABCs and treatment as in other acute valvular failures.

Hypertension

The exact definition of hypertension is variable; however in adults, it is generally agreed upon that a systolic pressure of 160 mm Hg or greater or a diastolic pressure of 95 mm Hg, is high, and requires attention. Borderline hypertension, with systolic pressure between 140 and 160 mm Hg, or diastolic between 90 and 95 mm Hg, should be rechecked within 2 weeks, and monitored closely. Proper technique in measuring blood pressures is important; too rapid deflation in the cuff will give artificially high readings.

If hypertensive blood pressure readings are obtained in an asymptomatic patient, there is need for close follow up and care, but no urgency in bringing the blood pressure to normal values immediately. In **hypertensive emergencies**, the blood pressure reduction must be accomplished within the hour. Hypertensive emergencies are abnormal elevations in blood pressure associated with the following medical emergencies: AMI; unstable angina; acute renal failure; acute CHF; acute intercranial hemorrhage; aortic dissection; head trauma; extensive burns; significant post-operative bleeding; and eclampsia, especially with fetal distress or maternal seizures.

Hypertensive Encephalopathy

Hypertensive encephalopathy also requires emergent treatment of blood pressure elevation. It is an acute medical condition resulting from cerebral ischemia secondary to vasospasm. Patients will complain of vomiting and confusion, severe headache, and drowsiness. Left untreated, increased vascular permeability results, with cerebral hemorrhages and cerebral edema. There may be focal neurological findings. Death occurs rapidly. The initial treatment is IV nitroprusside, with rapid blood pressure reduction the goal of therapy. Care must be taken not to drop blood pressure below that necessary to maintain intercranial perfusion pressure.

In a normal adult this is a mean arterial pressure of 60; however in a chronically hypertensive patient, the “set point” for cerebral perfusion pressure is likely to be higher.

Control of high blood pressure in the patient with acute stroke or intercranial hemorrhage must be approached cautiously. In many of these patients the elevated blood pressure is long standing, and reduction of blood pressure will increase cerebral ischemia because of a higher “set point” for cerebral perfusion pressure. In many patients, the elevated blood pressure is a response to the stroke itself. Treatment of blood pressure in this instance should be given only if the diastolic pressure is greater than 140 mm Hg. The goal is to reduce the pressure gradually by approximately 30 percent from pretreatment level.

Patients with hypertension and pulmonary edema will usually respond to standard therapy (nitroglycerin, oxygen, furosemide, and morphine). In most cases the elevated blood pressure is a result of the pulmonary edema. Additional hypertensive medications should be reserved for those patients in whom this initial therapy is not effective.

Hypertension with angina requires immediate lowering of blood pressure. Nitroglycerin is the first drug of choice. Other medications can be added if this is insufficient. Beta-blockers are sometimes effective. Calcium channel blockers such as nifedipine have recently fallen out of favor. The choices are vast, and will be specific to the protocols of each transport service and the preferences of the receiving physician.

Patients with hypertension and renal failure who are suffering an acute deterioration require immediate control of blood pressure with nitroprusside. Dialysis may be necessary to relieve this acute exacerbation.

The pregnant woman with severe pre-eclampsia or eclampsia should be treated immediately. The patient should be placed in the left lateral decubitus position. Hydralazine is given in 5 mg IV bolus doses every 20 minutes until the patient’s diastolic blood pressure is less than 100 mm Hg. Other medications that have been used include diazide, labetalol, and nifedipine. Calcium channel blockers should not be used in conjunction with magnesium, as this may cause profound hypotension. Beta-blockers are relatively contraindicated if asthma is also present. Nitroprusside is not recommended because of the potential for accumulation of cyanide in-utero.

Aortic Dissection

Most patients suffering aortic dissection are middle-aged hypertensive men. The chief complaint is severe pain in the area compromised by the aortic dissection. In the ascending aorta, the coronary vessels may be involved, leading to myocardial infarction. In the descending thoracic aorta or arch of the aorta, the carotid arteries may be affected. Spinal artery involvement will result in anesthesia and paraplegia below the level of involvement. Renal artery involvement might also significantly increase the hypertension. Medical treatment involves reducing arterial wall stress. Reduction of arterial pulse velocity (dV/dt) is probably more important than absolute blood pressure reduction, so control of heart rate is also important. Typically, heart rate reduction with a beta-blocker is accomplished first, followed by blood pressure reduction with nitroprusside or trimethaphan. Systolic blood pressure should be maintained between 80 and 100 mm Hg. Esmolol by itself can also be used. Liberal pain control is important and should be provided with the narcotic of choice. Patients with hypotension secondary to rupture or cardiac tamponade should be resuscitated aggressively with IV fluids and blood products. Patient transport to a facility capable of surgical intervention must be rapid.

Pulmonary Embolism

Pulmonary embolism is a disease difficult to diagnose because of its nonspecific presentation. It is thought to be fairly common but frequently missed. Several autopsy studies have shown it to be the third most common cause of death in the United States. Approximately 10 percent of patients with acute pulmonary embolism will die within an hour of the event. Of those surviving past one hour, over two thirds will be undiagnosed, and a third of those will die. The mortality rate of pulmonary embolism is 25 percent with the first episode, and 80 percent overall including recurrences. Survivors are at risk for recurrent pulmonary embolism and also for development of pulmonary hypertension, which also increases morbidity and mortality. The goals of treatment are to prevent death from the current episode, and prevent recurrence.

Pulmonary emboli are generally from thrombus formation in a distant part of the body, not in the pulmonary vasculature itself. The majority of emboli form in lower leg (calf) veins, with the exception being pelvic thrombus from gynecological surgery and in major trauma patients. Pieces of thrombus break loose and travel along the vascular tree through the right side of the heart into the pulmonary vasculature. Nonthrombotic causes of pulmonary embolism include amniotic fluid embolism (post-partum or post-abortion, or during labor); fatty embolism, associated with long bone fractures; and air embolism, primarily iatrogenic, but may also occur during the use of pressurized diving apparatus or other air powered equipment. Treatment of these nonthrombotic emboli is symptomatic primarily, and does not involve anti-thrombolytic medications.

The air medical specialist transporting a patient with known pulmonary embolism will be expected to continue standard therapy. A high index of suspicion in a patient not diagnosed with pulmonary embolism may allow the air medical transport specialist to anticipate this possibility and plan accordingly. Risk factors for deep vein thrombosis (DVT) and subsequent pulmonary embolism include AIDS, malignancy, prolonged immobility such as bed rest, indwelling venous catheters, CHF, IV drug abuse, a history of DVT in the past, collagen vascular disease, blood type A, obesity, oral contraceptives (especially high dose), postpartum period or pregnancy, trauma, venous pacemakers, varicose veins, and many different blood dyscrasias.

The angiogram is the diagnostic test of choice, but spiral CT and VQ scan may be useful. There is some literature suggesting that a normal PetCO2 and P (a-ET) CO2 gradient can exclude the diagnosis of pulmonary embolism with some reliability. Even arterial blood-oxygen testing is nonspecific, with a zero predictive value for pulmonary embolism. Calculation of the alveolar arterial oxygen gradient (A-a gradient) is a more reliable indicator of impaired gas exchange. This is the difference between a calculated value for PaO_2 and actual measured PaO_2. Though the equation appears to be complex, it can be simplified as follows:

$$\text{A-a gradient} = (\text{calculated } PaO_2) - (\text{Measured } PaO_2)$$

$$\text{A-a gradient} = [(FIO_2)(\text{Barometric pressure} - 47 \text{ mm Hg})] - [(1.25)(\text{Measured } PCO_2)] - (\text{Measured } PaO_2)$$

If the patient's blood gas is at sea level, drawn at room air, this simplifies to:

$$\text{A-a gradient} = (150 - 1.25 \times \text{Measured } PCO_2) - (\text{Measured } PCO_2)$$

The difference, or A-a gradient, should be about 10 in a normal healthy young adult, and about 20 in an elderly person. Some people prefer to use 10 plus one tenth of the patient's age in years as a "normal" value. An impaired A-a gradient is seen in many types of lung pathology, but in the appropriate setting is highly suggestive of pulmonary embolus.

Pulse oximetry is of little use in making the diagnosis of pulmonary embolism. It is rather insensitive to the changes in oxygen saturation near the physiologic range. Most patients with pulmonary embolism will have normal saturation. Other pulmonary function tests, such as end tidal CO_2 gradient, late dead space fraction, and the ratio of dead space to tidal volume, all show some promise, but there is no validation of their usefulness in clinical trials at the time of this writing. EKG changes are nonspecific ST and T wave abnormalities, and tachycardia. Chest x-rays are equally nonspecific.

DVT is so common as the source of thrombus in pulmonary embolism that finding DVT in a person suspected of having pulmonary embolism is strong evidence for the presence of embolism. Ventilation perfusion scans to demonstrate perfusion abnormalities can demonstrate areas of the lung that are ventilated and not perfused (and vice versa). This can offer strong evidence for pulmonary embolism. Spiral CT scanning has offered increased resolution and in some centers is the preferred diagnostic modality, offering rapid testing in a relatively noninvasive manner.

Treatment for pulmonary embolism includes supportive comfort measures, and therapy aimed at reducing the thrombus and preventing further embolization. Heparin has been the primary therapy for pulmonary embolism, and has been shown in multiple clinical studies to reduce the mortality to less than 10 percent. If the diagnosis of pulmonary embolism is strongly suspected, heparin should be instituted prior to completion of further diagnostic testing to avoid rapid progress of the disease. Most medical institutions have standardized heparin administration, and attention should be given to the protocol of the transporting agency for specifics in dosing. Alternatively, low molecular weight heparin can be given as an IM injection every 12 hours, and may be more convenient in the transport environment.

Thrombolytic therapy is indicated in patients with hemodynamic instability, who have exhausted their cardiopulmonary reserves, or in whom it can be anticipated that because of history or concurrent illness, recurrent pulmonary emboli are likely. This latter group of patients is at risk for cor pulmonale. The faster acting thrombolytics or a bolus with rapid infusion protocols are the treatments of choice for unstable patients. All such protocols are being constantly revised as clinical studies continue to evaluate improved therapeutic regimens. The air medical specialist is advised to be aware of the current protocols supported by the receiving facilities and physicians. Heparin therapy is generally instituted concurrently with thrombolytics. The normal contraindications to thrombolytic therapy in AMI are suggested for this disease process as well, with risk and potential benefit weighed carefully against one another. Surgical embolectomy is generally reserved for those patients with massive emboli who are hemodynamically unstable, and who are not candidates for thrombolytic therapy.

Open thoracotomy in the patient with proven massive pulmonary embolus has been reported to be successful in rare cases where it was performed early, before significant ischemia has ensued, and where saddle emboli (blocking both the right and left pulmonary vasculature) have been found. This allows open massage of these vessels, promoting clot disintegration and allowing the smaller pieces of clot to move on, providing for at least some return of circulation to the lung. It is unlikely to be successful in a patient in whom recent thrombolytic therapy has given. Standard ACLS procedures will not be effective in resuscitating the patient with pulmonary embolism.

SUMMARY

Pre-hospital care of the patient with cardiovascular disease must be based on current concepts in ACLS as well as current therapies supported by the local emergency medicine community and the air medical program medical director. Whether the disease process is acute or chronic, the air medical provider must be prepared to support the cardiovascular patient with excellent assessment skills, knowledge of treatment modalities and the subsequent response expected. The effects of altitude, distance and travel time must be considered when choosing treatment modalities and the appropriate receiving facility.

A. **Bibliography**:

American Heart Association, *2000 Handbook of Emergency Cardiovascular Care for Healthcare Providers*, December 2000.

Bell, W.R., et al: Current status of pulmonary thromboembolic disease, *Am Heart J* 103:239, 1982.

Braunwald, E. (ed): *Heart Disease: a Textbook of Cardiovascular Medicine*, ed 4, Philadelphia, 1992, WB Saunders.

Calhoun, D.A. et al: Treatment of hypertensive crisis, *N Engl J Med* 323:117, 1990.

Carson, J.L., et al: The clinical course of pulmonary embolism*, N Engl J Med* 326:1240, 1992.

Cunningham, F.G., et al: Hypertension in pregnancy, *N Engl J Med* 326:927, 1992.

Delaney, K.A: The double challenge of endocarditis, *Emerg Med* 22:53, 1990.

Freiman, D.G. et al: Frequency of pulmonary thromboembolism in man, *N Engl J Med* 272:1278, 1965.

Fuster, V., et al: The pathogenesis of coronary artery disease and the acute coronary syndromes, *N Engl J Med* 326:242, 1992.

Gilman, A.G., et al (eds): *Goodman and Gilman's the Pharmacological Basis of Therapeutics*, ed 8, New York, 1992, Pergamon Press.

Goldhaber, S.Z., et al: Risk factors for pulmonary embolism: The Framingham study, *Am J Med* 74:1023, 1983.

Harris et al: An emergency physician's guide to prosthetic heart valves; valve related complications, *Ann Emerg Med* 17:704, 1988.

Hurst, J.W., Schlant RC (eds): *The Heart*, ed 7, New York, 1990, McCraw-Hill.

Kannel, W.B., et al: Epidemiology of heart failure, *Am Heart* J 121:951, 1991.

Kaplan, N.M.: *Clinical Hypertension*, ed 5, Baltimore, 1990, Williams and Wilkins.

Kline, J.A. et al: New diagnostic tests for pulmonary embolism, *An Emer M*, Vol 35, No. 2, 2000.

Meldon, S.W.: Acute pericarditis and myocarditis; the other causes of cardiac chest pain. In Young GP (ed) *Critical Decisions in Emergency Medicine*, vol. 10, No. 11, Dallas, 1996, American College of Emergency Physicians.

Morgenthaler, T.I., et al: Clinical characteristics of fatal pulmonary embolism in a referral hospital, *Mayo Clin Proc* 70:417:1995.

Roden, D.M.: Risks and benefits of anti-arrhythmic therapy, *New England Journal of Medicine* 331:785, 1994.

B. **Definitions of Keywords**:

Cardiovascular—Pertaining to heart and blood vessels

Hypertension—Excessive pressure against the arterial walls, generally with a systolic >160 and/or diastolic >90

Pulmonary embolism—Thrombus formation involving renal or visceral veins with subsequent dislodgement and migration to the pulmonary vasculature

Cardiac disease—Sub-acute or chronic disorder of the heart

Syncope—Sudden loss of strength, loss of consciousness or fainting

Aortic dissection—Intimal tear in the aorta, resulting in hematoma formation in the medial layer and subsequent longitudinal separation of the layers of the aorta

Myocardial ischemia—Tissue damage or death within the heart muscle, secondary to the decrease of oxygenated blood or interruption of blood supply to that area

Deep vein thrombosis—Thrombus or clot formation originating in the large veins, typically in the pelvis or legs, which slows blood return and causes swelling; migration of the thrombus through the vascular system may cause a pulmonary embolus

C. **Test Questions**:

1. A sudden decrease in the perfusion pressure of the brain sufficient to impede delivery of nutrients to the brain can result in syncope within 5 to 10 seconds.

   a. True
   b. False

2. The 2000 ACLS revised guidelines recommend fewer more focused interventions in cardiopulmonary resuscitation.

   a. **True**
   b. False

3. Unstable angina is defined as chest pain at rest, increasing frequency of anginal episodes, or new onset of anginal symptoms.

   a. **True**
   b. False

4. It is estimated that at least 20 percent of dialysis patients have pericarditis.

   a. **True**
   b. False

5. Hypertensive emergencies require reduction of blood pressure over a 6-to-8 hour period of time.

   a. True
   b. **False**

D. **Didactic Hours**: 4

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

The following must be specific to the mission and scope of practice for each individual flight service:

- Review of complex dysrythmias
- Review of cardiac medications, dosages, administration techniques, indications, expected response (nitrates, beta-adrenergic blocking agents, calcium channel agonists, thrombolytics etc.)
- Review of equipment: cardiac and pressure monitoring, ventricular assist devices, intra-aortic balloon pumps; external pacers and defibrillators; total artificial heart devices; infusion pumps
- Review of invasive skills: central line placement, chest tube insertion, needle thoracostomy, pericardiocentesis

F. **Patient Care Hours**: 36

MODULE 17: RESPIRATORY PATIENTS

Author: Dr. Cathy Carrubba, Tampa General Hospital, Tampa, FL

Reviewer: Mr. Michael Frakes, RN/CEP, LIFESTAR, Hartford, CT

KEYWORDS

Dyspnea
Asthma
COPD (chronic obstructive pulmonary disease)
Emphysema
Bronchitis
Epiglottitis
Pneumonia
Pneumonitis
ARDS

OBJECTIVES

Upon completion of this module, the student should be able to:

- Discuss the signs and symptoms, etiology and treatment of epiglotitis
- Describe the triad of diseases associated with COPD
- Discuss the signs and symptoms, etiology and treatment of pneumonia
- Define ARDS
- List three different types of pleural disease

INTRODUCTION

Patients transported by air medical services may have as their primary illness a respiratory problem, or they may have concurrent illness or injury. A basic understanding of the more common respiratory disorders is presented here, with recommendations for care during transport. This section is divided into five sections: (1) a brief overview of dyspnea from any cause; (2) asthma; (3) chronic obstructive pulmonary disease (COPD); (4) pleural disease; and (5) infection. Pulmonary embolism is discussed in the section on cardiovascular disorders.

Dyspnea

Dyspnea describes an unpleasant subjective sensation of shortness of breath. The severity of dyspnea is dependent on many factors, including level of anxiety, the causative insult or stimulus, the patient's perception of danger, and other cultural and behavioral attitudes. As such it is difficult to truly correlate seriousness of disease with the severity of dyspnea. In general it is an imbalance between ventilatory demand and capacity, and can be caused by mechanisms discussed earlier, which result in inadequate respiration.

Common causes of acute dyspnea include trauma, pulmonary embolism, asthma, pneumonia, acute respiratory distress syndrome (ARDS), and acute cardiac decompensation. More chronic dyspnea is seen with COPD, chronic cardiac causes, abdominal loading problems (pregnancy, ascites, obesity, bowel obstruction), and progressive neuromuscular disorders.

Treatment approach to the dyspneic patient will depend on the etiology. A careful history and physical assessment is necessary to determine the cause and plan careful transport. A history of pregnancy, immobilization, recent surgery, prolonged travel, connective tissue disorders, or known malignancy all suggest pulmonary embolism. Sudden onset of chest pain associated with acute dyspnea would support this diagnosis, and could also suggest a cardiac ischemic event. Risk factors for cardiac disease would suggest myocardial infarction. Spontaneous pneumothorax may be present in the patient with chronic lung disease, or recent inhalation of toxins such as cocaine.

Physical exam will direct planning and intervention. Tachypnea is a nonspecific symptom seen in most forms of dyspnea. A fever would suggest infection, but can also be seen with pulmonary embolism and malignancy. Trauma should be evident from history as well as physical findings. Diminished breath sounds and hyper-resonant lungs may be found with pneumothorax. This may progress to tension pneumothorax, especially as altitude increases during transport, and must be decompressed prior to air transport. Care of trauma patients is discussed elsewhere in this text; however, the procedures for decompression of pneumothorax and tension pneumothorax remain the same for any cause. A thorough cardiac evaluation may suggest right or left sided heart failure. A careful neurological exam will detect a primary neuromuscular cause. More ancillary data may have been obtained at the referring facility (interfacility transports) and should be reviewed expediently prior to transport.

Treatment and care plan will begin with assuring the ABC's, stabilizing the oxygenation and ventilation as well as can be expediently expected prior to transport. Treatment of the underlying disease process should be initiated and continued during transport when possible. Planning should anticipate known complications of chronic illnesses, as well as the problems associated with the current episode of illness or injury. Patients with underlying lung disease will be at increased risk for iatrogenic lung trauma such as pneumothorax and tension pneumothorax. The air medical crew must be prepared to decompress these emergently during transport. Written protocols concerning appropriate intervention should include emergent needle decompression, followed by definitive drainage either during transport, or upon arrival at the receiving facility.

Asthma

Asthma is a variable or reversible airflow obstruction defined by the American Thoracic Society as a clinical syndrome characterized by increased responsiveness of the tracheobronchial tree to a variety of stimuli. There are an estimated 15 million persons suffering from this disease in the United States. Morbidity and mortality have appeared to stabilize in the 1990's, after a dramatic increase in the 1980s stimulated increased physician and patient education and closer monitoring of therapy.

Patients suffering from asthma experience hyper-reactivity to broncho-constricting stimuli. Postmortem exams show hyper-inflated lungs, with airways plugged by inflammatory cells and mucous plugs. There is also thickening of the basement membrane of the airways, with increased submucosal inflammatory cells and connective tissue, as well as hypertrophic and hyperplastic smooth muscle. Stabilization involves initial care guided by ABCs. Further treatment is directed towards relaxing smooth muscle, clearing obstruction from mucous plugs, and limiting or reversing inflammation. Risk for asthma-related death includes a history of prior intubations for asthma, hospitalization once in the past month or twice in the past year, current use of or recent cessation of corticosteroids, and psyche or social problems prohibiting adequate access to care.

Symptoms associated with a severe exacerbation of asthma include cough, dyspnea with a sense of chest wall muscle constriction, with the patient sitting forward using accessory muscles to aid in respiration. Wheezing is generally present, but may not be present in the most severe cases where maximal respiratory effort produces very little airflow. Cyanosis is uncommon, as the hemoglobin/oxygen dissociation curve is shifted leftward due to the respiratory alkalosis. An alteration in mental status indicates a severe attack mandating aggressive airway intervention. Pulsus paradoxus (systolic BP drops by 10 mm Hg or more during inspiration) is present in approximately 50 percent of all severe exacerbations. If present, it will generally disappear as airflow improves.

All that wheezes is not asthma. There are many common, and uncommon, causes of wheezing:

- Congestive heart failure—or cardiac asthma, seen primarily in older patients and patients with cardiac valve disease
- Noncardiogenic pulmonary edema (narcotic overdose, high altitude pulmonary edema)
- Acute exacerbations of chronic obstructive pulmonary disease
- Endobronchial disease (foreign body, neoplasm, airway stenosis)
- Pulmonary embolism
- Allergic reactions
- Less common causes: Gastroesophageal reflux, Addison's disease, invasive parasitic infections, eosinophliac pneumonia, and aspergillosis

Treatment of the critically-ill patient with asthma must be immediately initiated. The patient in respiratory failure (apnea, coma, or rapidly deteriorating respiratory status) will require endotracheal intubation with ventilatory support, sedation, and muscle paralysis. In the emergency department setting this can be accomplished with rapid sequence induction (RSI) or using Ketamine. Ketamine has the advantage of bronchodilation, but does increase salivation and has some hemodynamic effects. In the transport environment, RSI is more multipurpose and generally available. The ventilation of this patient should provide adequate oxygenation while minimizing high airway pressures and avoiding iatrogenic barotrauma and hypotension. An increased inspiratory:expiratory ratio will be needed. For this reason, ventilator settings should reflect a tidal volume of no more than 6–7 cc/kg, with a high FIO2, and low ventilator rates to prevent "stacking" of ventilations. "Permissive hypercapnea" is gaining widespread clinical acceptance.

Because the obstruction to ventilation is not in the upper airway, endotracheal intubation alone will not solve acute respiratory problems. Pharmacologic treatment aimed at reducing bronchoconstriction includes beta-agonist inhalation therapy, corticosteroids, anticholinergic nebulizers, and oxygen sufficient to maintain the oxygen saturation at 92 percent or above. Continued sedation and muscle paralysis is appropriate, either with continued ketamine or neuromuscular blocking agents such as vecuronium.

If aggressive therapeutics do not work to improve the condition of the intubated asthmatic, general anesthesia is then employed to definitively relax the airways. In any patient that deteriorates suddenly, pneumothorax must be considered. In the event that cardiopulmonary arrest occurs, bilateral chest tube placement is necessary.

Pharmacology for Reactive Airways

Treatment for asthma is a combination of adrenergic agents, corticosteroids, anticholinergic drugs, methylzanthines, and, perhaps, magnesium.
The most commonly used **adrenergic agents** are:

- Albuterol (most common); given 2.5 mg/3 cc, X 3 every 15 minutes, or continuously over 1 hour, during acute stabilization. Available in IV form in countries other than USA. Beta-2 agonist, given by wet nebulization (via mouthpiece or mask, or in line through endotracheal tube).
- Terbutaline sulfate, 0.25 mg given subcutaneously; may be repeated in 30 minutes. An infusion can also be given. Beta-2 agonist, given subcutaneously; also available po for nonemergent use.
- Epinephrine 1:1000; 0.2 to 0.5 ml, subcutaneously every 15–30 minutes X 3. Alpha and beta effects; more unpleasant side effects. Useful in allergic reactions.

The **corticosteroid** for IV therapy of acute asthma is methlprednisolone. The recommended dose is 125 mg IV (adult). Improvement is generally noted 3 hours after administration, and peaks at 6 to 10 hours. Oral therapy with prednisone appears to be equally effective, and can be used if the patient can swallow and has no difficulty absorbing the medication from the GI tract. The recommended dose is 60 mg po for (adult). Inhaled corticosteroids are not of benefit in acute exacerbations of asthma.

Anticholinergic drugs are thought to block reflex bronchoconstriction by overriding parasympathetic nervous system smooth muscle constriction. The most commonly used is Atrovent (ipratropium bromide), which is preferred because it appears to have the least side effects of all available agents. It is used as an addition to the beta-2 agonist in the same nebulizer, and should be employed as a first line of treatment for patients with severe obstruction (0.25–0.50 mg added to 2.5 mg of albuterol).

Methylzanthines (theophylline and aminopylline) are of no use in the acute asthma attack, but may contribute to a more rapid overall improvement in the hospitalized patient. For this reason the transport team may be required to continue an infusion in progress. Dosages are generally calculated based on patient's measured serum concentration. The loading dose is generally 5–6 mg/kg given over 20 minutes IV, with a maintenance infusion based on ideal body weight of 0.5 mg/kg/hr. This is adjusted up to 0.9 mg/kg/hr in smokers and in COPD, and adjusted down to 0.25–0.45 mg/kg/hr in adults over 50, with CHF, or with liver dysfunction. Theophylline has many adverse side effects, drug interactions, and a very narrow therapeutic window. For this reason, if it has not been started at the referring facility, it may be best not to begin this prior to transport. Written protocol should define the use of methylzanthines during air transport.

Although magnesium has not been found to be advantageous in treating asthma exacerbations in general, the subgroup of asthmatics who are very ill seem to benefit from a dose of 2–3 grams IV. The mechanism for this improvement is not clear.

Chronic Obstructive Pulmonary Disease (COPD)

COPD is actually a triad of co-existent diseases: reactive airways (with bronchoconstriction and mucous plugs); airway collapse (emphysema—the "pink puffer"); and inflammation (bronchitis—the "blue bloater"). It is thought to affect 25 percent of the adult population, accounting for significant morbidity and mortality in 10 percent of the adult population. It must be considered as a possible chronic illness in adult patients transported for any reason. In the adult patient with dyspnea, one or more of these component parts may be exacerbated.

It is a common misconception that increasing the oxygen delivery to a patient with COPD will depress the hypoxic drive to breathe. This has not been found to be true; only those patients who are obtunded with decreased respirations prior to intervention will be at risk for worsening respiration; in this instance the chemoreceptors that respond to decreased oxygen are not functioning. This patient will require aggressive airway management. In all other patients the goal is to correct hypoxia, delivering oxygen adequate to maintain oxygen saturation at 90–92 percent.

Patients with a large bronchitic component to their COPD (the "blue bloaters") are often misdiagnosed as cardiac patients; they frequently have mixed cardiac and pulmonary disease. They tend to be polycythemic from chronic hypoxia, appear cyanotic, and suffer episodes of acute pulmonary failure and cor pulmonale. The peripheral edema (water retention) causes weight gain. The inflamed bronchial surfaces are edematous, and damaged, making them more susceptible to infection.

Therapy for COPD is directed towards correcting hypoxia, reduction of bronchoconstriction and mucous plugs, treatment of inflammation, and improving ventilation. Life threatening ventilatory failure is recognized by mental status changes including lethargy and confusion, and by an inability to speak. This will rapidly deteriorate to coma and apnea. Immediate intubation is necessary, utilizing RSI unless the patient is too exhausted to resist. Tidal volume is generally set at 6–7 cc/kg, rate 15–18/min (adult), FIO2 100 percent. An increased I:E ratio is also required.

Frequent suctioning and careful monitoring of peak flow pressures are necessary. Sedation and paralysis should be continued. A high suspicion for barotrauma during flight is encouraged.

For less severe patients, noninvasive techniques include continuous positive airway pressure (CPAP). This is technically difficult to provide in the air medical environment, requiring high-pressure oxygen delivery that may be difficult to maintain on oxygen reserves typically present in aircraft. This patient will need aggressive pharmacologic therapy and diligent observation during transport, and may require intubation and sedation electively prior to transport if there is concern that the stress of flight may worsen the patient's condition.

Pharmacologic therapy is similar to that described for asthma. In-line beta agonists mixed with Atrovent are the first line therapy in the intubated patient, as are corticosteroids. Methylzanthines should be continued if already in progress. In addition, IV antibiotics should be considered.

Pleural Disease

Nontraumatic diseases of the pleura include spontaneous pneumothorax, iatrogenic pneumothorax, tension pneumothorax, pleural effusion, and pleuritis.

Spontaneous pneumothorax is generally discussed as primary or secondary. Primary disease occurs in young, tall, thin men, usually as the result of a ruptured congenital bleb. It is commonly recurrent. Secondary disease is usually found in males greater than 50 years of age, secondary to chronic disease states such as COPD, asthma, infection (predominantly TB worldwide), HIV patients with pneumocystis, neoplasm, interstitial lung disease, or cystic fibrosis (more common in neonates). Nonpulmonary causes are rare, and include drug abuse, esophageal rupture, and, rarely in women, endometriosis.

Iatrogenic pneumothorax may be more common than primary or secondary. These are caused during central line placement, needle aspiration, mechanical ventilation with barotrauma, thoracentesis, biopsy, intercostal nerve block, NG tube insertion and CPR.

The severity of the symptoms in nontraumatic pneumothorax is generally related to the size of the air leak. Symptoms include sudden onset of chest pain, dyspnea, and cough. Tachycardia and tachypnea may also be present. Changes in lung sounds are challenging to appreciate in the air medical environment. With COPD, the occurrence of a pneumothorax will be hard to assess because baseline breath sounds are often very decreased. The air medical specialist must have a high index of suspicion.

The complication of most concern to the air medical transport team is tension pneumothorax, which is more likely to occur at altitude as trapped air expands. Patients will become increasingly dyspneic and agitated. As the mediastinal shift occurs, the trachea will shift away from the affected side. Heart sounds may be noted to shift as well. Cardiac output will decrease, jugular venous distention will increase, and the pulse will become rapid and thready. Blood pressure will fall, resulting in hypotension. Immediate decompression is lifesaving. Emergent needle decompression is standard, using a long 14-gauge or 16-gauge needle in the anterior mid-clavicular line at approximately the 2nd intercostal space. A rush of air may be detected, and the patient should improve clinically as the tension is released.

Treatment of pneumothorax is the same from whatever cause, and is discussed in the sections on trauma contained in this text. Some authors believe that small catheter decompression of nontraumatic pneumothoraces is appropriate and sufficient; however, there is scant evidence in the literature comparing chest tube vs. small-bore catheter outcomes in these patients. The decision is generally made by the medical director concerning appropriate drainage equipment, and should be defined by written protocol for the flight team.

Pleural effusion is defined as increased fluid in the pleural space. Common causes include CHF, malignancy, bacterial pneumonia, pulmonary embolism, TB, and intra-abdominal processes such as pancreatitis and sub-phrenic abscess. The signs and symptoms are usually due to the underlying cause, and treatment is directed towards the causative disease. Large pleural effusions may limit expansion of lungs, requiring adjustments in tidal volumes and pressure in patients on ventilators.

Pleuritis is inflammation of the pleura. The chief complaint is severe pain. Infection is the leading cause, though those etiologies listed above for effusions can also cause pleuritis. The treatment of choice is pain relief, and therapy directed at any known causes. Nonsteroidal anti-inflammatories are generally used as the first-line therapy. These are not routinely available in air medical transport. If pain is severe, and there are not contraindications, the patient may be made more comfortable with IV narcotic analgesia during transport.

Infectious Disease of the Respiratory System

Infections of the respiratory tract can be generally divided into those of the upper airway and pneumonia. Safe transport of these patients may require early endotracheal intubation prior to liftoff. Written protocol should describe the general approach to airway control in patients with upper airway obstruction due to infection. Airway capture by the most experienced medical personnel available is advocated; in many instances this may be the air medical crew.

Upper airway infections are a very common problem. Those that can cause airway obstruction are of significance to the air medical transport team. These tend to progress rapidly, and can become life threatening. They must be treated aggressively.

Epiglottitis is a cellulitis of the submucosal tissue of the supraglottic structures. These loose tissues can swell tremendously, increasing the work of breathing, and can lead to rapid deterioration and respiratory failure due to exhaustion and obstruction. Compared to other infections of the upper airway, it is relatively uncommon. In adults more than children, associated epiglottic abscesses may develop. Most commonly, this cellulitis is caused by Haemophilus Influenzae. With the advent of H. flu immunization, epiglottitis is becoming more a disease of adults than of children. The onset of the disease may be several hours or several days, with the shorter onset in patients likely to require invasive airway control. Pain and dysphagia are common complaints. The air medical crew should be alerted to impending obstruction by respiratory difficulty, drooling, aphonia, and stridor. The patient will assume the typical sniffing position to optimize airway patency, and should not be agitated or laid flat. The air medical crew must be prepared at all times to establish an airway. Direct visualization for intubation is necessary. Immediate cricothyroidotomy is necessary to establish a surgical airway if endotracheal intubation cannot be accomplished. Blind intubation attempts are to be avoided. Whenever possible, definitive airway control should be performed prior to transport. Most texts advocate airway control under controlled conditions in the operating room with anesthesia and ENT in attendance. When this is not possible, the most experienced practitioner available should intervene. In many instances this will be the air medical crew specialist. Other resuscitative measures (IV fluids, antibiotics) should be continued during transport. Once endotracheal intubation is accomplished, sedation should be continued. Unless there is concomitant lung injury, ventilator settings should support normal ventilation: 6–7 cc/kg tidal volume, rate of 12–15/minute (adult), and percentage of inspired oxygen sufficient to maintain pulse oximetry above 90 percent. While it may be safe to observe stable patients without respiratory distress in the ICU without intubation, the limitations of continuous airway monitoring in the air medical environment add tremendous risk to this approach to patient care. Endotracheal intubation prior to transport is generally accepted as conservative preparation prior to transport.

Pharyngitis, tonsillitis, and laryngitis are common upper respiratory tract infections. Symptoms include fever, pain and difficulty swallowing.

Patients may present with hoarseness or aphonia, and should be evaluated for epiglottis. Most are transmitted through contact with respiratory secretions, and air medical crew must exercise protective precautions to avoid contamination. These infections tend to be localized and uncomplicated, but may rarely cause sufficient swelling to threaten airway patency. Peri-tonsillar abscess is the most common severe sequelae, and the most common adult deep head and neck infection. This can result in pharyngeal obstruction of the airway. Other complications include spread of infection to other deep facial planes of the head and neck, spread to the mediastinum or central nervous system, and systemic sequelae of sepsis and dehydration.

Infections of the deep facial planes of the lower face and neck have decreased dramatically as dental hygiene has improved and with appropriate antibiotic therapy. They tend to lie in the midline, and can rapidly occlude the airway. They can spread easily to the mediastinum. They begin as cellulitis of local structures, and the confining fascia promotes abscess formation. Patients are in danger of rapid fatal decompensation from airway compromise, and require airway capture under direct visualization. Trismus and distortion of the airway are common problems. Cricothyroidotomy may be necessary to secure the airway rapidly. Neuromuscular blockade is not recommended; muscle laxity may in this instance worsen the degree of airway obstruction. Blind intubation is not recommended.

Ludwig's angina involves the neck and floor of the mouth. It begins as a cellulitis in the sub-mandibular space, most commonly as sequelae of dental disease, but can be seen in mandible fractures and lacerations to the mouth, as well as with malignancies, infections of the salivary glands, peri-tonsillar abscesses, and sepsis. The resultant edema frequently results in airway obstruction requiring immediate intervention. The most common cause of death is airway obstruction, which may occur suddenly. Airway distortion, trismus, and laryngospasm may impair-airway capture. Cricothyroidotomy is then the airway of choice.

Other, less common infections of the upper respiratory tract that may compromise the airway include retropharyngeal abscess (seen most commonly in young children), and peripharyngeal space abscesses. Intubation in these can be complicated by trismus, abscess rupture with aspiration, and distortion of normal anatomy. If endotracheal intubation is not possible, emergent cricothyroidotomy is necessary.

Pneumonia is the leading cause of death from infectious disease, especially seen in immuno-compromised individuals and in the elderly. As in all patient transports, care is directed towards ensuring adequate oxygenation and ventilation. Supplemental oxygen should be given to all patients sufficient to maintain pulse oximetry at or above 90 percent. Concurrent lung disease such as asthma or COPD may require the use of bronchodilators during transport. Suspicion for communicable diseases such as TB should result in appropriate protection usage by the air medical crew. In the patient with the diagnosis of pneumonia, the indications for aggressive airway control remain the same as previously discussed. Continuation of antibiotic therapy and interventions directed at maintaining other body systems should be continued (e.g. IV fluid therapy, temperature control, etc.).

Aspiration of gastric acid and stomach contents can also cause pneumonitis, with resultant hypoxia and respiratory distress. The full extent of alveolar damage may not manifest for several hours, during which inflammation and respiratory dysfunction evolve. Transport priorities remain the same—ABCs. Constant surveillance to prevent aspiration and a high index of suspicion in patients at risk are necessary for safe transport of these patients. Patients at risk include those with neurological deficits from injury, illness, or intoxication. Prevention of aspiration may require endotracheal intubation. Treatment of patients who have aspirated is to maintain oxygenation equal to or greater than 90 percent (pulse oximetry), and vigorous pulmonary hygiene.

Acute respiratory distress syndrome (ARDS) is a noncardiac pulmonary edema that can result from a variety of direct and indirect insults to the alveolar surface. Direct injury can result from inhaled irritants or aspiration. Indirect causes include damage to the alveoli from circulating mediators of inflammation associated with sepsis, drugs, severe trauma, DIC, or infectious pneumonia. Respiratory failure can develop rapidly, and mortality is high. These patients all require mechanical ventilation and sedation, with a high PEEP to maintain adequate oxygenation. Permissive hypercapnea (as described above in asthma discussion) has been suggested, reducing tidal volume and increasing respiratory rates. In some patients, prolonging inspiratory time has been helpful, as has positioning patients so that air movement is re-directed to less affected areas may be helpful (e.g., lateral decubitus position with less affected segments raised). Fluid restriction is recommended if the patient's condition permits. Iatrogenic barotrauma is common, and the air medical crew must be vigilant for pneumothorax during transport.

SUMMARY

Respiratory emergencies frequently require air medical transport, yet they are rarely an isolated diagnosis in the adult patient. Maintaining a patent airway and adequate ventilation are imperative skills for the air medical provider. Competency in the insertion of advanced airway adjuncts and the administration of appropriate supportive medications must be maintained and updated frequently. Care of adult, pediatric, and special needs patients requires individualized assessment and treatment, yet the over-riding principles of airway maintenance, adequate ventilation and perfusion support remain the same.

The following exhibits accompany this module:

Exhibit 17-1: Airway Intervention Skills
Exhibit 17-2: Pharmacological Adjuncts to Intubation

EXHIBIT 17-1: AIRWAY INTERVENTION SKILLS

Intervention	Indications	Contraindications
Bag-valve mask	1) To augment inadequate ventilatory effort	1) Failure to clear oral foreign body prior to applying positive pressure B.V.M.
Nasopharyngeal airway	1) To relieve upper airway obstruction, in conjunction with B.V.M. (tolerated by conscious patient)	1) Multiple nasal fractures or total obstruction of nasal passage for any reason
Oropharyngeal airway	1) To relieve upper airway obstruction, in conjunction with B.V.M.	1) Intact gag reflex
Esophageal Obturator Airway (EOA) and Esophageal Gastric Tube Airway (EGTA)	1) Rapid airway control when endotracheal intubation is delayed or not practical. 2) Can be placed by pre-hospital care providers not trained in endotracheal intubation. 3) Can be placed with head in neutral position (trauma).	1) Not well tolerated in awake patients 2) Not generally used in patients less than 15 years old 3) Esophageal injury or known disease 4) Relatively contraindicated where there is excessive bleeding or oral secretions—does not protect the airway
Pharyngeal-Tracheal Lumen Airway (PTLA) and Combitube	1) Offer improved ventilation over EOA/EGTA, with same relative indications and advantages.	1) Same as EOA/EGTA
Tracheal Intubation Oral Nasal Retrograde Tactile oral	1) Offers maximal control over ventilation and oxygenation. 2) To protect against aspiration, hypoxia, and hypercarbia in the unconscious or severely compromised patient. 3) To provide improved tracheal and bronchial suctioning.	1) Poorly tolerated in awake patient. 2) Requires expertise to be effectively executed
Cricothyroidotomy	1) Any situation in which tracheal intubation must be secured, but nonsurgical procedures cannot be successfully performed.	1) Serious damage or fracture to the cricoid cartilage or larynx.
Tracheostomy (Consider omitting this section—air medical intervention probably limited to cricothyroidotomy)	1) Same as cricothyroidotomy. 2) Fracture of larynx or cricoid cartilage.	1) Time consuming and difficult to perform. Has been replaced by cricothyroidotomy.
Laryngeal Mask Airway/Intubating Laryngeal Mask Airway	Inability to intubate using traditional means.	1) Does not secure airway as completely as tracheal intubatoin. 2) Requires multiple sizes and special training.
Percutaneous Transtracheal Catheter Ventilation	1) Any situation in whom ventilation and oxygenation is necessary, and in whom one cannot easily secure endotracheal intubation. 2) Requires less skill than other procedures to perform. 3) Useful in C-spine injuries where there is difficulty visualizing the airway.	1) Does not safeguard against aspiration. 2) May be less efficacious in ventilation (allowing for retained CO_2) 3) Requires oxygen source supply of 50 psi—not always available in transport vehicles

EXHIBIT 17-2: PHARMACOLOGICAL ADJUNCTS TO INTUBATION

Drug	Dosage	Potential adverse effects
Fentanyl	10–20 ug/kg when used alone for intubating; 2–3 ug/kg when used with a paralytic agent.	Rigidity of skeletal muscle following rapid infusion of very large doses. Seizures—very rare. Respiratory depression, most commonly when given with other CNS depressants.
Midazolam	0.02–0.04 mg/kg, given in 1 mg boluses, up to 0.1 mg/kg when used alone for intubating.	Respiratory depression, especially when given too rapidly; hypotension.
Succinylcholine	1.5 mg/kg IV; given over 10–30 seconds; onset 0.5 to 1 minute; duration 6–10 minutes (IV), rarely given IM, onset 2–3 minutes (IM); duration 15–20 minutes (IM).	Muscle fasciculation; hyperkalemia, stimulation of autonomic ganglia, malignant hyperthermia, prolonged apnea, histamine release, increased intracranial pressure. In combination with other drugs (aminoglycosides, lidocaine, procainamide, terbutaline, verapamil) prolongs neuromuscular blockade.
Pancuronium	0.1mg/kg IV; given over 10–30 seconds; onset 0.5 to 3 minutes; duration 25–60 minutes.	Increased heart rate, blood pressure, and cardiac output (vagolytic); histamine release; prolonged paralysis in myasthenia gravis and kidney disease. In combination with other drugs (aminoglycosides, clindamycin, lincomycin, polymyxins, quinidine, succinylcholine, tetracycline) enhances neuromuscular blockade and prolongs effects.
Vecuronium	0.1 mg/kg IV; given over 10–30 seconds; onset 0.5 to 3 minutes; duration 25–40 minutes. When given immediately after succinylcholine, dosing should be adjusted to 0.04–0.06 mg/Kg IV. Infusion rate 1 mcg/kg/min IV to maintain neuromuscular blockade.	Relatively free of adverse effects. Hypotension, flushing, tachycardia, or bradycardia can occur. As noted with agents listed above, various antibiotics and other neuromuscular agents given or present at the time of use enhance neuromuscular blockade and prolong effects.
Rocuronium	0.6 to 1.2 mg/kg IV; given over 10 to 30 seconds; onset 1 minute, maximum blockade in 3 minutes; duration 30 minutes.	(My data on Rocuronium suggests that it is relatively free of adverse effects, is hemodynamically neutral, and does not promote bronchospasm.).May cause arrhythmias, bronchospasm, hypertension or hypotension. Relatively contraindicated in obesity and when severe bronchospasm is already present. Interacts similarly to other neuromuscular blocking agents (as noted above) with aminoglycosides bacitracin, magnesium salts, polymyxins, quinidine and vancomycin.
Etomidate	Dosage: 0.3 mg/kg IV push; Onset < 1 minute, Duration < 5 minutes	Potential adverse effects: Myoclonus, possibility of transient respiratory depression, pain on injection
Ketamine	Dosage: 1–2 mg/kg IV	Potential adverse effects: Increased salivation, hallucinations, especially on emergence and worse in children, increased ICP, tachycardia, hypertension. Does have the advantage of bronchodilation

A. **Bibliography**:

Balmes, J.R., Barnhart S: Evaluation of respiratory impairment/disability. In Murray JF, Nadel, J (eds), *Textbook of respiratory medicine*, ed. 2, Philadelphia, 1994, WB Saunders.

Baum, G., Wolinsky E. (eds): *Textbook of pulmonary diseases*, ed 5, New York, 1994, Little, Brown

Byrnes, T.A., et al, Pneumothorax in patients with acquired immunodeficiency syndrome, *J Thorac Cardiovasc Surg* 98:546, 1990.

George R.B. et al (eds): *Chest medicine: essentials of pulmonary and critical care medicine*, ed. 3, Baltimore, 1995, Williams and Wilkins.

Gleeson K., Reynolds H.: Life-threatening pneumonia, *Clin Chest Med* 15:581, 1994.

Kelly, M.A., Abbahl, S.: Massive pulmonary embolism, *Clin Chest Med* 15(3):547, 1994.

Light, R.W., *Pleural Diseases*, ed. 2, Philadelphia, 1990, Lea and Febiger.

Manning, H.L., Schwartzstein, RM: Pathophysiology of dyspnea, *N Engl J* Med, 333(23):1547, 1995.

Isselbacher, K.J. et al (eds): *Harrison's principles of internal medicine*, ed 13, New York, 1994, McGraw-Hill.

Rosen, P., et al (eds): *Emergency medicine CD/Online*, 1998, Mosby.

Sepkowitz, K.A. et al, Pneumothorax in AIDS, *Ann Intern Med* 114:45, 1991.

Staub, N. C.: Control of breathing. In Berne, RM, Levy MN (eds) *Physiology,* ed. 3, St. Louis, 1993, Mosby.

Talbot-Stern, J., et al, Catheter aspiration for simple pneumothorax, J. *Emerg Med* 4(6);437, 1986.

Teitelbaum, J., Borel C: Respiratory dysfunction in Guillain-Barre syndrome, *Clin Chest Med* 15:705, 1994.

B. **Definitions of Keywords**:

Dyspnea—Shortness of breath

Asthma—Variable or reversible airflow obstruction characterized by increased responsiveness of the tracheobronchial tree to a variety of stimuli

COPD (chronic obstructive pulmonary disease)—Triad of co-existent diseases: reactive airways, airway collapse, and inflammation

Emphysema—Airway collapse, patient often referred to as the "pink puffer"; often associated with COPD

Bronchitis—Airway inflamation

Epiglottitls—A cellulitis of the submucosal tissue of the supra-glottic structures

Pneumonia—Infectious process involving all or part of the lung and bronchial tree

Pneumonitis—Alveolar damage and inflammation leading to respiratory dysfunction

ARDS—Noncardiac pulmonary edema resulting from a variety of direct and indirect insults to the alveolar surface.

C. **<u>Test Questions</u>**:

1. Air transport is requested from a small rural hospital with no ICU and limited subspecialty support for a 26-year-old female with chief complaint of dyspnea. The patient has a history of asthma, and has had progressive increased difficulty in breathing over the past 2 days. She is febrile at 102 degrees Fahrenheit, heart rate 120, respiratory rate 36/minute, and blood pressure 150/80. Upon arrival at the referring facility, the air medical crew finds the patient slumped down in the bed, with a nebulized, bronchodilator treatment in progress. The patient is confused and unable to answer questions appropriately. A correct immediate assumption is:

    a. The patient is psychotic, and in need of anti-psychotic medication
    b. **The patient is hypoxic and requires aggressive airway evaluation and management**
    c. The patient is hypotensive and requires aggressive fluid resuscitation
    d. The patient is experiencing an allergic reaction to medications given in the emergency department

2. In caring for the patient above, the air medical crew's first action will be:

   a. Request a blood gas to determine need for intubation
   b. **Physical assessment of airway, breathing, and circulation**
   a. Review the patient's chart to determine what mistakes the referring facility has made to cause this decompensation by the patient
   b. Request a chest x-ray to evaluate the need for intubation

3. Auscultation of the chest in the patient described above reveals rhonchi in the posterior right base, with mild expiratory wheezing in that area only. Lung sounds are harsh and velcro-like on the left, but no wheezing is appreciated. Examination of the skin reveals multiple tract marks from IV drug abuse in the antecubital areas of both arms. The patient's pulse oximetry reads 85 percent. Examination of the chest x-ray reveals a dense infiltrate in the right lower lung field, and diffuse patchy infiltrates in all lung fields. A likely etiology of hypoxia in this patient is:

   a. Pneumonia from infection
   b. Pneumonitis from IV drug abuse
   c. Pneumocystis pneumonia or diffuse TB as a result of immunocompromise
   d. **All of the above**

4. Intubation of a decompensated 20-year-old asthmatic prior to the arrival of the flight team is described as traumatic. The flight crew finds the patient to have diffuse wheezing bilaterally, poor tidal volume, and depressed mental status. No sedation has been given. In-line bronchodilator therapy has been continuous in the ER. Care during transport should include:

   a. Neuromuscular blocking agent and sedation
   b. Controlled hypoventilation (permissive hypercapnea)
   c. Continuous in-line bronchodilator therapy with Atrovent and Albuterol
   d. **All of the above**

5. In an acutely decompensated patient with COPD, which of the following is true?

   a. It is contraindicated to give increased oxygen delivery to a patient with COPD in acute decompensation, because it will depress the respiratory drive
   b. **Delivering sufficient oxygen to maintain saturation levels of 90–92 percent is required**
   c. Intubation is contraindicated, as these patients are difficult to wean from the ventilator
   d. IV antibiotics are not indicated

D. **<u>Didactic hours</u>**: 4

E. **<u>Skills Hours</u>**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- In-depth respiratory assessment; lung sounds
- CXR interpretation; insertion of advance airway adjuncts
- Mechanical ventilation management; arterial and capillary blood gas interpretation
- Pulse oximetry
- Continuous CO2 monitoring
- Specialized ventilation and treatment modalities as per program medical direction, mission and scope of practice

F. **<u>Patient Care Hours</u>**: 8

MODULE 18: NEUROLOGICAL PATIENTS

Author: Dr. Cathy Carrubba, Tampa General Hospital, Tampa, FL

Reviewer: Ms. Marialice Gulledge, RN, Medical Center Air, Carolinas Medical Center, Charlotte, NC

KEYWORDS

Vertigo
Ischemic stroke
Hemorrhagic stroke
Embolic stroke
Coma

OBJECTIVES

Upon completion of this module, the student should be able to:

- Discuss the symptoms of delirium, dementia, headache, vertigo and coma
- Describe the pathophysiology of stroke and related therapies
- Discuss the signs and symptoms associated with infectious diseases of the central nervous system (CNS)
- List the most common causes of seizures in the adult patient
- Compare the various treatment options, evaluation tools and pharmaco-therapeutics used for CNS disorders

INTRODUCTION

The critically-ill or injured patient transported by air medical services may have a neurologic disorder as the primary reason for transport or as a co-morbid disease process. It is frustrating that in many neurologic diseases, our ability to diagnose exceeds our ability to treat. Recent research in stroke therapies is an exciting area of rapid change, and one where the necessary timeliness of therapy may increase the need for air medical transport of these patients to facilities capable of rapid diagnosis and treatment.

This module will discuss the symptoms of delirium, dementia, headache, vertigo and coma, as well as stroke, infectious diseases of the central nervous system, and seizures. The air medical specialist should have a basic understanding of neurologic evaluation as part of the initial and detailed assessments of all patients, as well as an understanding of appropriate treatment modalities.

SELECTED SYMPTOM COMPLEXES OF CENTRAL NERVOUS SYSTEM DISORDERS

Patients transported will frequently have neurologic symptoms as a part of their disease process. Some symptoms may be treated by the air medical crew to provide a more comfortable transport. Other symptoms should alert the medical personnel of another pending problem, but symptom-specific treatment may be precluded by overall patient condition.

Headache

Headache is a common complaint in many individuals suffering injury or illness. It is generally caused by aggravation of a pain sensitive structure. All extracranial structures (muscles, nerves, vessels, skin) and the major arteries and veins that penetrate the skull have pain fibers. Most of the intracranial contents do not contain pain fibers. Processes limited to these intracranial contents are not likely to cause pain. Common causes that the air medical specialist may encounter include acute vascular disorders (traumatic or spontaneous), infection, and hypertension. Toxins, metabolic abnormalities, muscle tension from stress, and idiopathic migraine cephalgia may also be causative. Assessment of ABCs and evaluation for life threatening etiologies will direct care towards the cause. Severe headache with mental status change and fever should alert the air medical specialist to the possibility of CNS infection as the cause, and protective personal equipment should include protection from inhaled respiratory secretions. Pain control need not be withheld if the cause of the pain is understood. After cause-specific care has been given (e.g. blood pressure control in hypertensive crisis), narcotic analgesics may be given for further pain control. Fentanyl is an excellent choice in this instance, as it is potent and short acting, has few side effects, and is completely reversible with naloxone. Dosage is 2–3 micrograms per kilogram of normal body weight. Care must be taken to evaluate for respiratory depression, especially in patients that have other medications on board that may also depress respiratory drive.

Vertigo

Vertigo is a less common but extremely debilitating symptom. It is a sensation of motion or spatial disorientation, usually associated with severe nausea and vomiting, diaphoresis, and often with nystagmus. There are CNS and peripheral causes. Peripheral causes involve disruption of the normal vestibular apparatus function in the inner ear. There is no accompanying change in mental status, and it is frequently postural, with any change in head position causing exacerbation of symptoms. Peripherally caused vertigo is most often caused by infection involving the inner ear, though certain drugs (alcohol, several antibiotics, barbiturates, phenytoin, and salicylates) can also cause these symptoms, and may cause temporary intoxication with mental status change related to the drug. Centrally caused vertigo will generally be accompanied by focal neurologic findings on exam, and may be associated with mental status changes. Causes include cerebellar hemorrhage, vertebrobasillar artery insufficiency (especially in the elderly), or a mass in the middle ear or cerebellopontine angle, or vertigo may be post-traumatic due to a perilymphatic fistula. The treatment of vertigo is the same for both causes. IV diazepam (2–10 mg IV) is effective if the patient's condition permits. Meclizine (25 mg po), benadryl (25 mg po or IV) droperidol (2.5 mg IM or IV), and phenergan (25 mg po or IV), are all useful alternatives. Transdermal scopolamine patches are effective if available. All of these medications will cause drowsiness.

Global Cognitive Impairment

Global cognitive impairment can be seen in patients with acute delirium, or in chronic dementia. Clouding of consciousness is common to both. Distinction between the two can be difficult without sufficient history of the patient's cognitive abilities prior to illness or injury. In general, delirium is an acute phenomenon, with sudden or rapid onset, which lasts hours or days, and is accompanied by autonomic manifestations, which may include fever, hypertension, tachycardia, or diaphoresis. There may be motor restlessness, visual hallucinations, and disorientation. Delirium tremens (alcohol withdrawal) is an example of delirium. Dementia is a chronic CNS abnormality, usually irreversible, with no autonomic symptoms. Differentiating between the two may be difficult in the context of other serious injury of illness. The presence of dementia does not preclude symptoms from delirium. The air medical specialist will direct care towards the cause of delirium. These include hypoxia, hypoglycemia, drugs and exogenous toxins (tricyclic antidepressants, tranquilizers, narcotics, alcohol), hypothermia, hyperthermia, electrolyte abnormalities, aberrations in metabolism (liver failure, renal failure), acute head trauma, burns, and other CNS diseases, as discussed further in this module. After attention to evaluation and stabilization of ABCs, it is important to check blood glucose levels and temperature on all patients with delirium, as these are immediately treatable causes.

Coma

Coma is a state where purposeful response cannot be elicited, and the patient cannot be aroused. There are many etiologies, for which a careful search must be made. Though the patient is unable to give a good history, information from family, friends or EMS personnel may be critical to determining the cause. The medical history, environment that the patient was found in, and any toxins or drugs noted in the environment may point to the etiology. CNS pathology would be suggested by a patient with focal neurologic findings, a history of trauma, hypertension, abnormal respiratory patterns, or abnormal posturing to stimulus. Fever, hypotension, or physical evidence for drug abuse (tract marks, drugs found at the scene) would indicate nonCNS pathology. Hypoglycemia must be identified immediately, and treated, to prevent additional damage to the CNS. Routine use of D50 is not recommended unless blood sugar testing reveals a serum glucose of less than 70; dextrose may be damaging to the ischemic tissue in a stroke patient. The medical flight crew should have the ability to immediately test for blood sugar. Hyper- or hypothermia should be recognized and treated as well. The air medical specialist will begin with attention to the ABCs, with care then directed towards the suspected etiologic agent. If sepsis is suspected, antibiotics should not be withheld in an unstable patient. Naloxone may be indicated in patients where etiology is unclear. Consideration should be given to C-spine immobilization when trauma cannot be ruled out as a cause. Thiamine, 100 mg IV, should be given to prevent Wernicke's encephalopathy in patients with suspected malnutrition or alcoholism. If the patient does not respond to these measures, airway capture is necessary for control and protection.

INFECTIONS OF THE CENTRAL NERVOUS SYSTEM

Infections of the CNS include meningitis, encephalitis, and abscess formation. The etiology of these infections has changed over time with aggressive use of antibiotics, and with recent increases in immuno-compromising disorders such as AIDS. Though our understanding of these diseases and ability to diagnose and understand the pathogenesis have improved, morbidity and mortality remain high.

Meningitis is an infection of the membranes surrounding the brain and spinal cord. It can be caused by bacterial or viral pathogens, usually by nasopharyngeal colonization with invasion of the mucosa. Encephalitis is inflammation of the brain, usually caused by viruses. Viruses can enter through the skin, by insect vector, or through the respiratory, GI or GU tract. Abscess formation can be within the parenchyma, or in the subdural or epidural spaces of the brain and spinal cord. It is most commonly associated with contiguous infection of sinuses or other local structures, IV drug abuse, cranial trauma, neurosurgical procedures, or remote systemic infections (metastatic seeding). There is an increasing incidence of CNS abscesses among immuno-compromised individuals, especially with HIV.

The classic signs and symptoms in meningitis include fever, headache, nuchal rigidity, photophobia, malaise, lethargy, altered level of consciousness, vomiting, chills, and seizures. However, immuno-suppressed individuals may present with more subtle findings, making diagnosis in these individuals more challenging. Although petechiae and purpura are associated with meningococcal meningitis, they can also be present in meningitis caused by other bacteria or viruses. Vascular collapse and shock can be present in bacterial meningitis of several etiologies. Patients with encephalitis can have the same symptoms of meningeal irritation, but will also have a more profound alteration in level of consciousness. Focal neurologic deficits and seizures are more common with encephalitis. CNS abscess can have findings associated with both meningitis and encephalitis, and can be very difficult to distinguish. Spinal cord abscess causes cord compression, and symptoms will reflect the level and extend of this compression.

Care During Transport

The care needed by a patient with suspected CNS infection begins with evaluation of ABCs. In the awake, alert patient, IV access, oxygen by nasal cannula, and frequent re-evaluation may be sufficient. Hypoxemia should be avoided. If bacterial etiology is suspected, IV antibiotics should be started as soon as possible, and continued during flight. Antibiotics should not be delayed pending CT results or if an LP was unsuccessful. Broad-spectrum coverage with a third generation cephalosporin can be initiated, and further therapy can be refined when a causative organism has been identified. The choice of antibiotics will depend on prevalence of organisms in the area, drug resistance, and the availability of agents. The decision concerning which antibiotic to use will rest with the referring and receiving physicians. This information should be sought prior to flight if it is anticipated that the referring institution will not be able to provide antibiotics in a timely manner. Referring facilities should be encouraged to begin antibiotic coverage as soon as contact has been made if bacterial CNS infection is suspected.

The use of steroids in bacterial meningitis is controversial, and should be guided by the preferences of the referring and receiving physicians, and defined in written protocol for the medical flight crew.

The treatment of viral encephalitis and viral meningitis is symptomatic. With the exception of varicella and HSV, no specific therapies are available. Acyclovir is the agent of choice for HSV infection (10mg/kg every 8 hours).

In a patient with mental status changes, aggressive airway management may become necessary. Seizure activity may require pharmacological intervention. Hypotension should be treated aggressively with IV crystalloids and vasopressors when necessary. If alcoholism is suspected, IV thiamine (100 mg) should be given. Careful attention to blood sugar is necessary. Cardiac monitoring is necessary. Co-morbid disease should be suspected, especially in the elderly or debilitated, and treated appropriately. Signs of increased intracranial pressure should be managed with hyperventilation. Mannitol may be useful if shock is not present. Attention to volume status is necessary when using osmotic agents.

Infection Control for the Air medical Crew

Self-protection is necessary for the air medical specialist. Avoiding contact with respiratory secretions involves diligent use of protective gear. Post-exposure prophylaxis for meningococcal and H. Influenza meningitis may be necessary if aggressive airway control was needed during transport. Written policies concerning post-exposure prophylaxis should be reviewed and updated frequently by the flight program.

SEIZURES

Seizure is the clinically observed response to abnormal cortical neuronal activity. Seizures are either primary or secondary. Primary seizures or epilepsy involves recurrent seizure activity with consistent provocation. Secondary seizures occur in response to provocation by certain environmental, toxic or pathophysiological stresses. They are also called reactive seizures, and patients who experience these do not have epilepsy. It is estimated that the incidence of epilepsy is less than 1 percent in the general population, but approximately 10 percent of the population may have a seizure within their lifetime.

Seizure activity can be partial or generalized. Generalized seizures have also been described as convulsions, which are rhythmic muscle contractions involving the entire body, with loss of consciousness, followed by a confusional state termed the post-ictal state. Partial seizures are focal in nature, and usually involve only one of the cerebral hemispheres. Focal tonic-clonic muscle contractions may occur, or absence seizures may occur, which show disturbances of consciousness without major motor activity (though repetitive automatic motions or eye blinking may be noted). Partial seizures may generalize to involve both cerebral hemispheres.

In children, primary epilepsy usually begins before the age of 6 months, and has a strong genetic tendency. It accounts for greater than half of all childhood seizures reported. Febrile seizures are the most common presenting single seizure, and tend not to be recurrent. Other causes in childhood include CNS infection, trauma, AV malformations, metabolic abnormalities (such as hypoglycemia or hyperosmolar states, hypoxia, pyridoxine deficiency), neoplasm (primary or metastatic), toxins, drug intoxication or withdrawal, VP shunt malfunction, dialysis, post-immunization reactions (most commonly pertussis and measles vaccines, though this is a rare cause of seizures), and cerebral palsy.

In adults, primary epilepsy normally originated in childhood or young adulthood. An adult with a first seizure must be assumed to have one of various etiologies, including metabolic encephalopathies, infections of the CNS, CNS lesions (traumatic, congenital, neoplasm, ischemic), intoxication with drugs or alcohol, or withdrawal from drugs or alcohol.

Status epilepticus describes an event where serial seizures occur without an intervening return to normal mental status, or when seizure activity persists for 30 minutes or more. It is more common in young children than in adults. Causes for status can be divided according to age. In adults, noncompliance or withdrawal of seizure medication is most common. In infants, it can be caused by infection, congenital abnormalities, birth trauma, or as the presenting sign of idiopathic epilepsy. In young adults, it is most commonly associated with ethanol intoxication or withdrawal, drugs or other toxins, and head trauma. In older adults, it is associated with ethanol withdrawal, tumors, head trauma, cardiovascular disorders, and neuro-degenerative diseases. Mortality in adults from status epilepticus is reported to be between 10 percent and 25 percent; in children it is 4 percent. Approximately one third of infants (less than a year of age) have significant neurologic sequelae as an outcome of status epilepticus (mental retardation, neurological defects epilepsy). The leading cause of death in pediatrics with status epilepticus is hypoxia.

Seizure activity has systemic manifestations of concern to the air medical crew. Sympathetic stimulation induces tachypnea, tachycardia, hypertension, elevated body temperature, and hyperglycemia. Prolonged seizure activity can cause lactic acidosis, skeletal muscle damage, and rarely rhabdomyolysis (which places the patient at increased risk for renal failure). Autonomic discharges may also cause urinary or fecal incontinence, vomiting, and tongue biting, with risk for impairment of airway from aspiration of blood and vomitus. Anatomically, the large tongue of the infant or young child and smaller airways makes them at increased risk for airway obstruction. Because of their small glycogen stores, the initial hyperglycemia seen in seizures may shift to hypoglycemia in prolonged seizures in children.

Most seizures cease spontaneously. The timing of damage to neurons is controversial in current literature, but is thought to occur by 30 minutes of seizure activity, primarily due to hypoxia, acidosis, electrolyte abnormalities, shock, cardiac dysrhythmias, and pulmonary aspiration or pulmonary edema. Appropriate management of status epilepticus begins with the ABCs of resuscitation. Patients should be positioned to maximize ventilation, minimize aspiration, and protect from physical injury. Turning the head or the entire body to the side is common positioning. High flow oxygen should be delivered by mask, maintaining pulse oximetry at 90 percent or above. No objects should be placed in the patient’s mouth; a nasopharyngeal airway may be helpful, especially in children. The air medical crew must be ready to aggressively control the airway if necessary.

Care During Transport

It may be necessary to use neuromuscular blocking agents (RSI) to secure the airway in actively seizing patients. The absence of tonic-clonic muscle activity does not equate to lack of seizure activity when these agents are used. Short acting neuromuscular blocking agents are preferred for this reason, and their administration should be accompanied by ongoing and aggressive anti-convulsant therapy as described later in this section. Indications for endotracheal intubation include desaturation on pulse oximetry, inability to maintain the airway with bag valve mask (BVM), and suspicion of intracranial mass lesion. Pharmacological agents that manage seizure activity will also depress respirations. Monitoring should include pulse, blood pressure, respiratory rate, pulse oximetry, and temperature. Hyperthermia should be treated aggressively with antipyretics and external cooling devices. Blood sugar determination (especially in children) should be accomplished rapidly, and an IV should be placed for delivery of appropriate medications. Intraosseous needles may be placed in small children; blood for electrolyte testing, toxicology and medication levels can be taken from this line.

Pharmacological Agents

Medications for treatment of status epilepticus include barbiturates, phenytoin, and benzodiazepines. Most patients in status epilepticus will respond to a single antiepileptic medication. Benzodiazepines are the first line of therapy, because they are generally potent and effective. They rapidly diffuse into the CNS, and have a short duration of activity. They can cause significant hypotension and respiratory depression, and impair level of consciousness in all patients, sometimes requiring subsequent mechanical ventilation. Commonly used drugs include diazepam and lorazepam. Lorazepam is generally the first drug of choice because it works within 2–3 minutes, causes the least respiratory depression and hypotension of the group, and controls seizures for 2–3 hours. If IV access is not obtained, diazepam is used because it can be given rectally. Rectal lorazepam is not as well absorbed. Midazolam can be given IV or IM. Phenytoin is the second-line drug for treatment of status epilepticus. A lower success rate of seizure termination is seen in patients with toxic, metabolic, or anoxic etiologies. Onset of action is 10–30 minutes. It must be given over 15–30 minutes, with careful monitoring of cardiovascular status. Fosphenytoin has been recently made available, and appears to have fewer cardiovascular complications.

Phenobarbital is now used as a third-line treatment for status epilepticus, primarily because of the significant side effects (apnea, hypotension, impaired consciousness), but also because onset of action is at least 30 minutes. Side effects are much more pronounced when benzodiazepines are also on board.

Status epilepticus refractory is most commonly treated with increased doses of phenobarbital (no upper level), or induction of a barbiturate coma with short acting pentobarbital. Lidocaine and chloral hydrate have also been described anecdotally as useful in refractory status. Treatment directed towards correction of any underlying toxic or metabolic provocation should accompany the therapeutic medications discussed above. Correction of hypoglycemia must be immediate. Electrolyte disorders are discussed further in the module on endocrine and electrolyte abnormalities. Very few antidotes for toxic ingestions causing seizures exist. Isoniazid ingestion can be treated with IV pyridoxine (1 mg of pyridoxine for each mg of Isoniazid ingested). If all else fails, patients have been induced using general anesthesia with some limited success in control of status epilepticus. The air medical crew will not generally have these agents available in the flight environment.

STROKE

Stroke is an acute disruption of circulation to the brain causing neurologic impairment. Onset may be sudden, or in a stuttering pattern, and may cause permanent or transient neurological deficits. Occlusion of vasculature and hemorrhage into the brain or subarachnoid space, can both cause disruption of blood flow. Recent advances in the treatment of stroke are designed to increase blood flow and limit damage to neurons. Advances in effective treatment for stroke are occurring rapidly. Rapid recognition of stroke, with acute intervention in selected patients, requires that patients arrive at a facility capable of evaluating and instituting these modalities in a timely manner. Air medical transport will play an increasingly important role in delivering these patients to institutions capable of rapid evaluation and treatment, minimizing out-of-hospital time.

Ischemic Stroke

Ischemic stroke can be caused by thrombus formation in cerebral vessels, or by embolism. Thrombus formation is usually a result of clot formation in an area of ulcerated atherosclerotic plaque. Other less common causes of thrombus include any condition that predisposes the blood to sludging, such as sickle cell anemia, polycythemia vera, and protein C deficiency. Cerebral artery dissection can result from trauma, collagen vascular disease, and arteritis. Rarely, prolonged vasoconstriction from migraine syndromes can cause stroke.

Embolic Stroke

Embolic stroke results most commonly from cardiogenic emboli. Valvular heart disease (especially common in mitral stenosis), prosthetic valves, and bacterial endocarditis can be sources of embolization. An MI may result in formation of mural thrombus in the hypokinetic ventricle. A silent MI is often found in patients with embolic stroke. Atrial thrombi can occur in patients with atrial fibrillation. It is estimated that fully one third of all patients with chronic atrial fibrillation will develop an ischemic stroke within their lifetime. Cardiomyopathy and congestive heart failure (CHF) also predispose a patient to development of mural thrombi. Fragmented thrombus from other diseased arteries can also result in embolus.

Hemorrhagic Stroke

Hemorrhagic strokes can be intracerebral or subarachnoid. Intracerebral hemorrhage (ICH) is present in 10 percent of all acute strokes, and has a high mortality rate. It is generally associated with history of hypertension or arteriovenous malformations (AVMs). ICH is seen mostly in older patients, with co-morbid diseases contributing to the high mortality rate. ICH in younger patients is generally seen from AVMs, or with sudden increases in blood pressure from cocaine or other stimulants. Oral anticoagulants and brain neoplasms have also been implicated.

A subarachnoid hemorrhage (SAH) is most commonly caused by bleeding from an arteriovenous malformation (AVM), or the rupture of an aneurysm. Aneurysms are thought to occur in approximately 6 percent of the general population, usually at the bifurcation of arteries. They tend to rupture with increased blood pressure or stress (e.g. during Valsalva maneuver, sexual intercourse, or labor). Some are congenital, and some result from turbulent flow at a point of structural weakness. SAH occurs more frequently in younger patients, and has very high mortality rate.

Differential Presentation of Stroke

Ischemic strokes usually present with focal deficit. Headache, vomiting and unconsciousness are uncommon, unless there is brain stem involvement. Patients with hemorrhagic stroke may have focal neurological deficits, vomiting, and depressed level of consciousness. Headache is common in ICH, and is a hallmark of SAH, where patients may have described the worst headache of my life. Meningeal irritation may develop as blood spreads through the subarachnoid spaces. Patients with hemorrhagic stroke can progress rapidly to stupor or coma.

Care During Transport

In the transport environment, it is important to assess the patient rapidly and transport quickly to a definitive care center, where CT scanning is immediately available and neurologic interventions can be accomplished in a timely manner. Differentiation between ischemic and hemorrhagic infarction is crucial in determining subsequent therapeutic interventions. Most ischemic strokes will not be visualized on CT in the acute phase. Hemorrhagic strokes will visualize in 90 percent of cases. In addition, the CT will identify other processes such as tumor, subdural hematoma, epidural hematoma, and abscess. The role of Magnetic Resonance Imaging (MRI) continues to evolve, and may assist in separating subgroups of ischemic stroke into those with higher probability of responding to specific therapeutic interventions such as thrombolytic therapy. As this evolves, further refinement of destination criteria for these patients will be necessary.

Documentation of baseline neurological examination is necessary to monitor change and has profound implications on therapeutic interventions. There are various methods for documenting a baseline neurological assessment. One of the most commonly used in the pre-hospital environment is the Cincinnati Stroke Scale. It has the added advantage of being fairly accurately obtained in the transport environment. It is primarily used to aid in determining if the presenting symptoms are consistent with stroke. The NIH Stroke Scale is a more detailed neurological assessment, which can be fairly rapidly employed, but may be difficult to execute in flight due to limitations imposed by the environment (noise, difficulty with detailed communications). It offers the advantage of more clearly documenting baseline and any change from the baseline presentation. The numeric score allows more accurate trending of patient symptoms. Transport of an acute stroke should not be delayed for purposes of extensive documentation. However, documentation of worsening symptoms has implications for subsequent therapy. Resolution of symptoms may signal the occurrence of a sentinel event such as a Transient Ischemic Attack (TIA) or Reversible Ischemic Neurological Deficit (RIND), which require admission for further evaluation.

Transport Considerations In Ischemic Stroke

Treatment of the patient with symptoms consistent with ischemic stroke during transport begins with assessing ABCs. These patients can usually maintain airway patency unless there is significant edema causing midline shift of the cerebral hemisphere involved. Oxygen should be administered to maintain pulse oximetry at 90 percent saturation. The head of the bed should be slightly elevated. IV access should be obtained. Dehydration may contribute to decreased blood flow in the ischemic area and should be treated. Over hydration should be avoided to prevent worsening of edema. Blood glucose determination should be made immediately, and glucose containing solutions should be withheld unless hypoglycemia is present. Elevated blood glucose levels may worsen an ischemic event. Cardiac monitoring is necessary. Any signs of systemic disease should be looked for. Signs of trauma to the head should be noted. Pupillary size, reactivity, and extra-ocular muscle movement should be noted. Abnormalities in evaluation of these cranial nerves suggest brain stem involvement. Airway compromise can accompany brain stem dysfunction and necessitates readiness for more aggressive airway management. Severe hypertension, defined as a diastolic blood pressure exceeding 140 mmHg, should be treated with nitroprusside, which allows careful titration. Aim for a 10–20 percent blood pressure reduction over the course of an hour. Hypertensive patients with a mean arterial pressure of greater than 130 mmHg should also have blood pressure reduction. Nitroprusside or labetalol may be used. Blood pressures lower than 220/120, or a mean arterial pressure less than 130 mmHg in patients with ischemic stroke, should not be treated, as this may reduce cerebral perfusion to the borderline ischemic areas. Blood pressure measurements should be verified with a repeat measurement in 5 minutes before treatment is begun. It is important to note that hypertension is managed more aggressively in patients with ischemic stroke who are candidates for fibrinolytic therapy. Blood pressure in these patients should be reduced to and maintained at a level no higher than 185/110.

Sublingual nifidipine has fallen into disfavor because of its ability to reduce blood pressure precipitously, worsening ischemia. Calcium channel blockers and other agents proposed theoretically to reduce damage to cells and protect ischemic but viable cells are currently under study. At the time of this writing none are currently recommended routinely; however, neuroprotective pharmacology is an active area of research and these recommendations may change dramatically in the near future. Air medical services that transport these types of patients will need to remain current in this rapidly changing area of pharmacological intervention.

Various conflicting studies concerning the risk and benefit of thrombolytic agents exist. The Year 2000 guidelines for the management of patients with acute ischemic stroke published by the Stroke Council of the American Heart Association recommend the use of thrombolytic therapy. Currently, the recommendation is to consider thrombolytic agents within a 3-hour window of onset of symptoms in patients without serious contraindications to use of these agents. There are various agents available, and more are appearing almost daily. TPA represents the first FDA-approved therapy for acute ischemic stroke and is most commonly used. The recommended dose is 0.9 mg/kg up to a maximum of 90 mg, 10 percent of which is given in a bolus, and the remainder infused over

1 hour. This area of research is also rapidly evolving, and undoubtedly will change dramatically in the future. At the time of this writing, several new thrombolytic agents have recently been approved or are close to approval by the FDA for this use. Side effects of thrombolytic therapy include bleeding, seizures, allergic reactions, and worsening of symptoms. Care must be taken to accurately and frequently document the neurological exam.

It will be necessary for the air medical specialist to become familiar with the thrombolytic therapy used by the receiving institution(s) served by the transport service. It is recommended that written references be kept aboard the aircraft if pharmacology is likely to vary significantly. The air medical crew may be asked to continue thrombolytic therapy started at the referring institution, or rarely, to begin thrombolytic therapy. Thorough understanding of the dosage and infusion rate is necessary. It is prudent to always check the medications mixed by another health care professional and to be sure that clear labeling and instructions are presented upon assuming care for this patient.

Transport Considerations in Hemorrhagic Stroke

Treatment of hemorrhagic stroke involves supportive care with particular attention to airway. Because of the propensity of these patients to worsen significantly, aggressive airway management may be necessary. This should be done in a manner that is least likely to increase intracranial pressure. Adding Lidocaine IV (1 mg/kg) to the RSI protocol is thought to help avoid an intercranial pressure spike. Pre-treatment with etomidate may also have protective qualities. Oxygen should be delivered to all patients by the most appropriate route. IV access should be established. Optimal blood pressure management is generally accomplished using nitroprusside, because it can be rapidly titrated and will not affect mental status. Optimal blood pressure in patients with ICH is controversial. Hypotension will decrease cerebral blood flow; hypertension will increase intracranial pressure. Either one can worsen the patients condition. Current recommendations are to maintain blood pressure no higher than 180/105, with consideration given to the patient’s pre-morbid blood pressure. Constant pressure monitoring and titration in the air-transport environment is necessary if nitroprusside is used during transport. Monitoring by invasive arterial lines is optimal, if available.

While calcium channel blockers remain under investigation for patients with ischemic stroke, they are now approved for clinical use in patients with subarachnoid hemorrhage, where vasospasm is a major complication. Nimodipine, 60 mg po, is generally given within the first 48 hours.

Other Causes of Focal Neurologic Findings

Other entities can present with altered mental status and focal neurologic findings. These include tumors and abscesses and air-embolism. Air embolism should be suspected in patients that have experienced atmospheric pressure changes (scuba diving, decompression at altitude), or in whom medical procedures have been performed that might allow air to escape into the vascular system. Treatment for this would involve transport to a facility with a hyperbaric chamber. Other entities that can mimic stroke include giant cell arteritis, collagen vascular diseases, hypoglycemia, Wernicke's encephalopathy, hypertensive encephalopathy, atypical migraine, Meniere's disease, acute glaucoma, meningitis, and encephalitis.

SUMMARY

A neurologic disorder may be the primary reason for an air medical transport, or it may be a component of a multisystem illness or injury. New treatment modalities are being added each year to the acceptable and recommended regimes already utilized by critical care and emergency providers. The timely transport of these patients to facilities capable of rapid diagnosis and treatment is imperative to maximize the patient outcome. The air medical crew should have a basic understanding of neurologic evaluation as part of the initial and detailed assessments of all patients, as well as an understanding of appropriate treatment modalities.

The following exhibits accompany this module:

Exhibit 18-1: Medications Commonly Used for the Treatment of Status Epilepticus
Exhibit 18-2: Cincinnati Stroke Scale
Exhibit 18-3: NIH Stroke Scale
Exhibit 18-4: Inclusion and Exclusion Criteria for Use of Thrombolytic Therapy in Ischemic Stroke

EXHIBIT 18-1: MEDICATIONS COMMONLY USED FOR THE TREATMENT OF STATUS EPILEPTICUS

Medication	Dose	Side effects
Lorazepam (onset of action 1–3 minutes)	0.05–0.10 mg/KG IV (may be given intraosseous). Maximum dose: 10 mg	Hypotension (less severe than with diazepam)
Diazepam (onset of action 1–3 minutes IV; slightly longer PR)	0.2 mg/kg IV or intraosseous; 0.5 mg/kg PR (per rectum) Maximum dose: 4 mg	Respiratory depression Hypotension
Midazolam (onset of action 1–5 minutes)	0.05–0.20 mg/kg IV, IM or intraosseous. Maximum dose: 5 mg	Apnea Hypotension
Phenytoin (onset of action 20–30 minutes)	20 mg/kg IV, IM or intraosseous. Maximum dose: 1,000 mg	Hypotension Cardiac dysrhythmias
Phenobarbital (onset of action 10–20 minutes IV, 2 hours IM)	20 mg/kg IV, IM or intraosseous. No upper limit maximum dose.	Respiratory depression
Pentobarbital (infusion titrated by EEG activity)	5 mg/kg IV loading dose; 3–5 mg/kg/hr infusion	Myocardial depression Respiratory depression Hypotension (may require inotropic support)

EXHIBIT 18-2: CINCINNATI STROKE SCALE—
(One or more abnormal finding(s) suggests stroke)

NOTE: In an unconscious patient, provide a central painful stimulus (sternal rub or pinch trapezius) to evaluate the symmetry of the facial grimace. Pinch the medial aspect of each extremity to evaluate the symmetry of abduction from painful stimuli.

Action	Normal Response	Abnormal Response
Facial droop—have the patient smile or show teeth.	Both sides of the face move equally or not at all	One side of the face droops
Motor weakness—arm drift. Close eyes, extend arms, palms up.	Arms remain extended equally, or drift equally, or do not move at all	One arm drifts down when compared with the other
Speech impairment—repeat the phrase “you can teach an old dog new tricks”	Phrase is repeated clearly and correctly	Words are slurred (dysarthria) or abnormal (aphasia) or no speech

EXHIBIT 18-3: NIH STROKE SCALE

1.a. Level of consciousness	Alert Drowsy Stuporous Coma	0 1 2 3
1.b. LOC questions	Answers both correctly Answers one correctly Incorrect	0 1 2
1.c. LOC commands	Obeys both correctly Obeys one correctly	0 1
2. Best gaze	Normal Partial gaze palsy Forced deviation	0 1 2
3. Best visual field	No visual field loss Partial hemianopsia Complete hemianopsia Bilateral hemianopsia	0 1 2 3
4. Facial palsy	Normal Minor Partial Complete	0 1 2 3
5. Best motor—arm Right arm _____ Left arm _____	No drift Drift Cannot resist gravity No effort against gravity No movement Untestable (limb amputated, joint fused)	0 1 2 3 4 9
6. Best motor—leg Right leg _____ Left leg _____	No drift Drift Cannot resist gravity No effort against gravity No movement Untestable (limb amputated, joint fused)	0 1 2 3 4 9
7. Limb ataxia	No ataxia Present in one limb Present in two limbs	0 1 2
8. Sensory	Normal Partial loss Severe loss	0 1 2
9. Best language	No apasia Mild to moderate aphasia Severe aphasia Mute	0 1 2 3
10. Dysarthria	Normal articulation Mild to moderate dysarthria Near to unintelligible or worse Intubated or other physical barrier	0 1 2 9
11. Extinction or inattention	Normal Partial neglect Complete neglect	0 1 2
12. Change from previous exam	Same Better Worse	S B W
13. Change from baseline	Same Better Worse	S B W

EXHIBIT 18-4: INCLUSION AND EXCLUSION CRITERIA FOR USE OF THROMBOLYTIC THERAPY IN ISCHEMIC STROKE

Inclusion Criteria:

Age 18 years or older
Clinical diagnosis of ischemic stroke causing a measurable neurological deficit
Time of symptom onset well established to be less than 180 minutes before treatment begins

Exclusion Criteria:

Evidence of intracranial hemorrhage on noncontrast head CT
Only minor or rapidly improving stroke symptoms
High clinical suspicion of subarachnoid hemorrhage even with normal CT
Active internal bleeding (e.g. GI bleeding, urinary tract bleeding within the past 21 days)
Known bleeding diathesis, including low platelet count, anticoagulant therapy, high PT/PTT
Within 3 months of intracranial surgery, serious head trauma, or previous stroke
Within 14 days of major surgery or serious trauma
Recent arterial puncture at noncompressible site
Lumbar puncture within 7 days
History of ICH, AVM, or aneurysm (CNS)
Recent acute MI
Witnessed seizure at stroke onset
On repeated measurements, systolic pressure > 185 mmHg or diastolic pressure > 110 mmHg at time of treatment, requiring aggressive treatment to reduce blood pressure to within these limits

Taken from Advanced Cardiac Life Support, 1997–1999, Emergency Cardiovascular Care Programs, American Heart Association.

A. **Bibliography**:

Advanced Cardiac Life Support, 1997–99, American Heart Association, Emergency Cardiovascular Care Programs.

Adams, H.P., et al: Guidelines for Thrombolytic Therapy for Acute Stroke: American Heart Association Medical/Scientific Statement; *Stroke*, 27;1711–18, 1996.

Albers, G.W., et al: Antithrombotic Thrombolytic Therapy for Ischemic Stroke, *Chest*, 114:683S–698S, 1998 Supplement.

Albers, G.W.: Expanding the Window to Thrombolytic Therapy in Acute Stroke: The Potential Role of Acute MRI for Patient Selection; *Stroke*, 30(10): 2230–2237, 1999.

Bale, J.F., Viral Encephalitis, *Med Clin N Am*, 77:25, 1993.

Chalela, J.A., et al: Safety of Air Medical Transportation after Tissue Plasminogen Activator Administration in Acute Ischemic Stroke, Stroke 30(11): 2366–68, 1999.

Conroy, M.B., et al: Helicopter Transfer Offers a Potential Benefit to Patients with Acute Stroke, *Stroke*, 30(12): 2580–2584, 1999.

Engle, J. et al: Overview of Seizures, *Emerg Med Clin North Am*, 12:895, 1994.

Hoffman, R.S., et al: The Poisoned Patient with Altered Consciousness, *JAMA* 274: 562, 1995.

Kothari, R.U., et al: Cincinnati Prehospital Stroke Scale: Reproducibility and Validity, *Ann Emerg Med*, 33(4):374–378, 1999.

Kieburtz, K., et al: Neurologic Manifestations of HIV, *Neuro Clin* 7:447, 1989.

Kunisaki, T.A., et al: Drug and Toxin Induced Seizures, *Emerg Med Clin N Am* 12:1027, 1994.

Lambert H.P. ed: *Infectious of the Central Nervous System*, Philadelphia, BC Decker, 1991.

Lipowski, Z.J.: Delirium: *Acute Confusional States*, Oxford Univ. Press, NY, 1990.

Marler, J.R., et al, eds.: *Proceedings of a National Symposium on Rapid Identification and Treatment of Acute Stroke*, The National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesday, Maryland, 1997.

Pellegrino, T.R.: An Emergency Department Approach to First Time Seizures, Emerg Med Clin North *Am*, 12:925, 1994.

Raskin N.H.: Headache, In Harrison's Principles of Internal Medicine, ed 13, New York, McGraw-Hill, 1994.

Rosen, P., et al, eds: *Emergency Medicine, Concepts and Clinical Practice*, ed 3, St. Louis, Mosby 1992.

Rosen, P. et al, eds: *Emergency Medicine CD/Online*, Mosby 1999.

Samuels, M.A.: The Evaluation of Comatose Patients, *Hosp Pract* 28: 165, 1993.

Scheld, W.M.: Bacterial Meningitis and Brain Abscess, in *Harrison's Principles of Internal Medicine*, New York, McGraw-Hill, 1994.

Shepherd, S.M.: Management of Status Epilepticus, Emerg Med Clin North Am 12:941, 1994.

Vining, E.P.: Pediatric Seizures, *Emerg Med Clin North Am* 12:973, 1994.

Shelton, M.M. et al: Bacterial Meningitis: An Update, *Neurol Clin* 8:605, 1990.

B. **Keywords**:

Vertigo—Sensation of motion or spatial disorientation, usually associated with severe nausea and vomiting, diaphoresis, and nystagmus

Ischemic stroke—Caused by thrombus formation in cerebral vessels, or by embolism

Hemorrhagic stroke—Caused by bleeding in the intracerebral or subarachnoid spaces

Embolic stroke—Results most commonly from cardiogenic emboli

Coma—A state where purposeful response cannot be elicited, and the patient cannot be aroused

A. **Test Questions**:

1. A 40-year-old female is involved in a motor vehicle accident. There is minimal damage to the car other than the side door is bent and extrication is in progress. The first responders have not yet done a patient assessment. Seatbelt is on, airbag is deployed, and no evidence of head trauma is noted. The patient is comatose. The first action by the air medical crew is:

   a. Test blood sugar
   b. **Assess and secure ABCs**
   c. Give narcan sublingually
   d. None of the above

2. The above patient's initial vital signs are: HR 140, RR 25, and BP 100/70. She is moved onto a long spine board, and assessment continues. Airway appears to be patent, with adequate tidal volume and respiratory effort. Pulse oximetry on room air shows 92 percent. The next appropriate step by the flight crew is:

   a. **Test blood sugar**
   b. Assess and secure ABCs
   c. Give D50 IV followed by narcan
   d. Complete a secondary survey

3. A 25-year-old patient is seen at a rural ER, 5 days after an MVC in which he sustained a closed skull fracture. His mother states that he had a persistent runny nose over the past 5 days, and today complained of headache, neck pain, and photophobia. He is found to be confused, hallucinating visually, with a temperature of 102 degrees Fahrenheit. His pulse is 125, respiratory rate is 25, and blood pressure is 150/90. The most likely cause of this delirium is:

   a. Meningitis from an undiagnosed cribiform plexis injury
   b. A subdural hematoma
   c. **A thrombotic stroke**
   d. None of the above

4. The patient above is prepared for transport. He is uncooperative, and resists physical restraint on the transport gurney. His pulse oximetry reading shows 80 percent. He will not allow a nasal cannula or oxygen mask to be placed. The air medical specialist should consider:

   a. **RSI with aggressive airway capture**
   b. Mild sedation with Fentanyl for the headache pain
   c. Thrombolytic therapy for the thrombolytic stroke symptoms
   d. Heavy sedation, and delivery of IV antibiotics immediately

5. A patient transport is requested for a 65-year-old hypertensive female with mental status changes. Attempts to lower the patient's blood pressure with po medication at the referring facility have been unsuccessful. You find the patient sitting upright in a hospital bed, talking pleasantly with the nurses. She does not recognize her daughter at the bedside, who states she has a history of Alzheimer's. Vital signs show a heart rate of 90, a respiratory rate of 16, a normal temperature, and a blood pressure of 190/110. After assessing and stabilizing ABCs, you immediately:

   a. **Talk to the daughter to establish any change in mental status from baseline**
   b. Immediately hang Nipride to reduce the blood pressure, using standard titration
   c. Consider canceling the transfer, informing the referring staff that the patient is demented, not delirious
   d. Call the on-call physician, or receiving physician, to discuss the case prior to transport

D. **Didactic Hours**: 4

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Blood glucose testing
- Review of GCS
- Review of Cincinnati Stroke Scale

- Review of NIH Stroke Scale
- ICP monitoring

F. **Patient Care Hours**: 36

MODULE 19: TOXIC EXPOSURES AND ENVENOMATIONS

Author: Dr. Cathy Carrubba, Tampa General Hospital, Tampa, FL

Reviewer: Ms. Marialice Gulledge, RN, Medical Center Air,
Carolinas Medical Center, Charlotte, NC

KEYWORDS

Envenomation
Toxidrome
Anticholinergic syndrome
Sympathomimetic syndrome
Opiate/Sedative syndrome
Cholinergic syndrome
Serotonin syndrome
Hymenoptera
Nematocyst

OBJECTIVES

Upon completion of this module, the student will be able to:

- Explain “toxidrome” and list three examples
- Differentiate between anticholinergic, sympathomimetic, and serotonin syndromes
- Discuss the prevalence and causes of venomous animal exposure deaths in the United States
- Compare the signs and symptoms of a black widow spider bite, brown recluse spider bite, and a scorpion sting
- Describe the signs, symptoms, and treatment related to a nematocyst exposure

INTRODUCTION

The air medical specialist may be expected to transport patients for whom toxic overdoses, either intentional or accidental, are the primary complaint. Other patients for whom trauma or illness is the primary complaint may additionally have toxins as a complication. The most common example of this is the motor vehicle accident victim intoxicated by ethanol. Other common drug abuse may also contribute to a confusing presentation. This chapter will discuss the general approach to the patient with a toxic exposure. Envenomation from stings and bites will be discussed.

INITIAL MANAGEMENT OF THE TOXIC EXPOSURE

Prior to patient management, scene safety and the safety of health care personnel must be evaluated. Contamination or risk to health care providers of exposure to the same contaminate must be avoided. Many flight programs will not transport patients with dermal contamination if this puts the flight crew at risk.

Without exception, the basic ABCs of resuscitation are the appropriate starting place for patient management. Most poisoned patients will require only supportive care. There are a few instances, such as cyanide poisoning or digitalis overdose, where an antidote or specific therapy is available. In many instances, the history of ingestion or exposure may not be apparent, and careful collection of history will be necessary to determine the exact nature of the exposure. The transporting caregiver should gather all available information possible without delaying transport. Often a pill found in a pocket or a bottle found in the car will provide enough information to guide further care. In a suicidal patient in whom an intentional overdose is suspected, the history obtained from the patient may not be reliable.

An unconscious patient must always be evaluated for hypoglycemia. Low blood sugar should be verified prior to administration of concentrated glucose solutions. There is some evidence that an elevated blood sugar in cerebral ischemia may do more harm than good. In appropriate settings, consider that body packing may be present. Heroin, amphetamines and cocaine have all been transported in this manner. A careful examination should include vital signs (including temperature), and a typical neurologic exam must be performed. Careful evaluation for unsuspected trauma must be included. Evaluation of the pupils is routine, but is fairly nonspecific. Examination for evidence of parenteral drug abuse should include evaluation of not only the antecubital fossae, but less usual places such as under the tongue or on the dorsum of the feet. Any unusual odor on the patient's breath should be noted. A fruity odor would suggest acetone, hydrocarbons such as chloroform, or ethanol. Cyanide is often likened to the odor of bitter almonds. An odor of garlic may indicate organophosphates, selenium, arsenic, or DMSO.

In patients for whom an adequate history cannot be obtained, it may be useful to identify the presence of a toxidrome—a constellation of physical findings that may help to narrow the diagnosis and direct care. The most common of these are the sympathomimetic syndrome, the opiate/sedative syndrome, the anticholinergic syndrome, and the cholinergic syndrome.

The Anticholinergic Syndrome includes elevated temperature, tachycardia, dry flushed skin, urinary retention, decreased bowel sounds, dilated pupils, and delirium, and may deteriorate to seizures and cardiac dysrythmias. Drugs commonly implicated include smooth muscle relaxants, antipsychotic agents, antidepressants, antispasmodic agents, mydriatics, antiparkinson medications, atropine and scopolamine. In addition, certain species of mushrooms as well as jimson weed will cause these symptoms.

The Sympathomimetic Syndrome

The sympathomimetic syndrome includes tachycardia, elevated temperature, diaphoresis, pilo-erection, hyper-reflexia, mydriasis, delusions with paranoia, and may also deteriorate into hypotension, seizures and dysrhythmias. Cocaine and amphetamines are often implicated, as well as common components of weight loss medications such as ephedrine and phenylpropanolamine.

The Opiate/Sedative Syndrome

The opiate/sedative syndrome describes respiratory depression, hypotension, miosis, bradycardia, low body temperature, decreased bowel sounds, hypo-reflexia, pulmonary edema, and in some instances seizures (propoxyphene). Opiates, ethanol, barbiturates, and benzodiazepines are the most common causes.

Cholinergic Syndrome

Cholinergic syndrome is characterized by CNS depression, salivation, lacrimation, urinary and fecal incontinence, confusion, abdominal cramping, vomiting, diarrhea, miosis, and seizures. Pulmonary edema may be present. Bradycardia or tachycardia can be seen. Insecticide poisoning is the most common etiology. There are several mushroom species that can also cause this syndrome. The Tokyo subway mass exposure to sarin illustrated this constellation of symptoms. Appropriate therapy includes atropine and cholinesterase regenerators.

Serotonin Syndrome

More recently the serotonin syndrome has been described. It is difficult clinically to distinguish from thyroid storm, cocaine intoxication, or neuroleptic malignant syndrome. Symptoms include elevated body temperature, agitations, hyper-reflexia, ataxia, and lack of coordination, altered mental status, diaphoresis, and diarrhea. Correct diagnosis will be dependent on a careful history of possible exposures. Drug interactions can also be responsible, occurring between monoamine oxidase inhibitors and the new class of serotonin re-uptake inhibitors used for depression (Prozac, Zoloft, Paxil, Effexor, Anafranil).

There are very few specific antidotes, but these include naloxone for opiate overdose, bicarbonate for tricyclic antidepressant overdose, flumazenil for benzodiazepine overdose, glucagon for beta-blocker and calcium channel blocker overdose, and calcium for calcium channel blocker overdose. Physostigmine is used for anticholinergic delirium that progresses to seizures or dysrhythmias. Ethanol is the treatment of choice for methanol and ethylene glycol intoxication. Atropine and protopam and used for organophosphate and carbamate toxicity. Pyridoxine is used in isoniazid and hydrazide toxicity. Digoxin-specific FAB fragments are the treatment of choice for toxic digitalis glycoside poisoning. N-acetyl cystine is used in acetaminophen toxicity. A cyanide poison kit contains sodium nitrite and sodium thiosulfate. Deferoxamine is used in iron toxicity. EDTA and DMSA are used in lead poisoning. BAL and D-Penicillamine are used in arsenic, mercury and lead poisoning. Methylene blue is used in methemoglobinemia. Folate or leucovorin may be helpful in methanol intoxication. The use of cyproheptadine in Serotonin Syndrome is controversial. Recommended doses for these medications are listed in Exhibit 19-1.

Specific antidotes for envenomation include crotalidae antivenin for pit viper bite (rattlesnake) and latrodectus antivenin for black widow spider bite. Both of these have been implicated in anaphylaxis. Unless the patient displays serious symptomatology, these antivenins should not be used. It is common to test the patient with a small amount of subcutaneous antivenin prior to using it. This should only be done in patients in whom the antivenin will be used; the test itself will induce an allergic reaction, putting the patient at risk for anaphylaxis for future episodes where antivenin may be necessary.

Gastrointestinal decontamination is generally not necessary in flight. The exception to this would be alkali or acid ingestion. Acid ingestion is best NOT neutralized or diluted, but pumped out via NG tube immediately. Alkali can be safely neutralized by intake of milk. Po administration of charcoal may be useful in some instances, where gag reflex is intact. In the awake, alert patient with no other signs or symptoms, this may be all that is needed. Most ingested medications or chemicals will bind to the charcoal, preventing further systemic absorption. Ipecac and lavage appear to offer no advantage in the treatment of overdose or accidental ingestion unless it is sure to have occurred within 45 minutes of presentation. Whole bowel irrigation may be considered for sustained release formulations of medications, as well as for lithium ingestion. This is not easily accomplished in the air medical environment.

Further treatment of the patient is generally symptomatic, with frequent re-evaluation of ABCs.

VENOMOUS ANIMAL BITES AND EXPOSURES

Fatalities due to animal or insect bites are primarily caused by venomous snakes worldwide, and are most prevalent in temperate agricultural areas where people are likely to go barefooted. Insect bites with subsequent anaphylaxis account for 50 percent of venomous animal exposure deaths in the United States, where snakes cause 30 percent and spiders less than 15 percent. Cobra bites are increasing in incidence, probably reflecting an increase in exotic snake exposures, as well as the lethality of its venom. Of those deaths caused by insect bites, the majority are bees, with wasps following closely, then yellow jackets, and spiders. In the U.S., most morbidity and mortality from spider bites historically has been from black widow bites; however, brown recluse spider bites may be under-reported. In fact, all insect bites are grossly under reported, because most victims do not seek medical attention. Statistics other than mortality tend to be rather meaningless for this reason.

Pit vipers are the most common venomous snakes in the United States, and can be found in all states except Hawaii and Alaska. They account for greater than 90 percent of all snakebites in the U.S. In other countries Elapidae are more common. These snakes include mambas, kraits, cobras, and coral snakes. Identification of venomous snakes, especially live ones, should be done by an expert in the field. Envenomation from careless handling of dead snakes has been reported. Although coral snakes are more easily identified from a distance by color and pattern (red next to yellow, kill a fellow), pit vipers may be difficult to identify without handling. Direct, close observation of the characteristic heat-sensing organ, which appears as a pit between the nostril and the eye, is the most reliable physical characteristic. Imported exotic snakes are much more difficult to identify. However, in most instances a handler/owner who is bitten can positively identify the species.

The patient's response to envenomation depends on the properties of the venom itself and the individual’s response to this venom. Dependent on the content in the particular venom, the reaction may be limited to local reaction or become systemic. Local symptoms are generally related to breakdown of local tissue by enzymes contained in the venom. Phospholipase A, a potent enzyme that breaks down cell and organelle membranes, has been found in all venoms from snakes studied thus far. Other smaller proteins in the snake venom are absorbed and cause systemic effects on the CNS, and potentially on all other organ systems.

Variations in venom content, the site of envenomation, and the general health condition of the patient all contribute to variable outcome. The severity of the snakebite is determined by observing the clinical response. Pit viper bites are generally associated with local and immediate pain, probably related to the amount of venom injected. Local edema generally follows, and swelling may become pronounced. Compartment syndromes, though theoretically possible, have not been described even associated with tremendous swelling. Local hemorrhage causes petechiae and ecchymosis. Necrosis of the tissue usually develops later and may be limited if adequate antivenin is used in a timely manner. General weakness, nausea and vomiting, low-grade fevers, muscle fasciculations, and hypotension may be systemic manifestations of pit viper envenomation. Death from pit viper envenomation is usually associated with hemorrhage and hypotension, leading to shock and multiple organ failure. An allergic reaction mounted by the host may also contribute to this process of cell membrane lysis.

With coral snakes and other exotic snakes, there may be no local pain and minimal local swelling. This venom contains a compound that blocks neuromuscular transmission and directly affects cardiac and skeletal muscle. Ptosis will generally be the first sign of envenomation. Other symptoms include slurred speech, drowsiness, vertigo, difficulty swallowing, increased salivation, and proximal muscle weakness. Respiratory failure accounts for most deaths reported from this cause.

Any snakebite should be considered a timely medical emergency and transport to a facility capable of evaluating and treating this injury should be facilitated. The treatment that is provided in the first 6 to 8 hours has the most impact on the eventual outcome. During transport, the patient should be kept as still and calm as possible to limit spread of the venom. If signs of envenomation are already present, a constricting bandage should be applied proximal to the bite, tight enough to impede venous and lymph flow, but not arterial blood flow. In coral snake bites (and other elapidae bites) the Australian technique of binding the bite site to collapse superficial veins and lymphatics has been very effective. This technique has not been studied for pit viper bites. Most texts still recommend suction of a bite wound with appropriate equipment only if performed within 15 minutes of the bite. Incising the area is no longer recommended. Icing the area seems to have no benefit and may further damage the locally compromised area. The involved extremity should be kept at or below the level of the heart. The patient should be kept NPO. If the snake cannot be accurately identified, it should be safely secured, and brought to the treating facility with the victim, if possible. IV access should be established and vital signs monitored carefully. Baseline blood specimens should be collected as soon as possible, to aid in monitoring systemic effects of the venom. Circumferential measures at the site of the bite and 5 inches proximal should be made and periodically repeated. This will aid in determining the spread and the exact effect of the venom. If the venom has already caused local and systemic symptoms, aggressive cardio-respiratory support may be necessary. Hypotension from hemorrhage and third-space loss can be severe.

If the bite is from a pit viper, and of sufficient severity, antivenin should be obtained. In the U.S. pit viper antivenin comes with detailed instructions that describe how to grade the envenomation, how to test for horse serum allergy, and provide a detailed protocol is provided for antivenin administration. The amount of antivenin given correlates with the severity of symptoms, which are graded from "0" (no signs of envenomation) to "5" (severe envenomation). Do not test for horse serum allergy unless the decision is made to use the antivenin. This test alone will cause the patient to develop a reaction to subsequent use of horse serum antivenin in the future, regardless of whether antivenin is given with this incident or not. Patients who sustain pit viper bites are likely to be at risk of repeat bites due to chosen environment. In general, children will require a larger initial dose of anti-venom than adults because of smaller body mass.

The current recommendations for use of antivenin for coral snake bites indicates that all victims should be treated prior to development of symptoms. Symptoms develop very rapidly, and once symptoms appear they may be difficult to reverse with antivenin. The antivenin is given by IV infusion, with 3–5 vials mixed in 300 to 500 cc of normal saline.

If the envenomation cannot be positively identified, local wound care and supportive care must be instituted. The symptom complex and environment may suggest a particular etiology, however delivery of antivenin should be discussed with on line physician control or with a poison control center or toxicologist.

Drug therapy for snake envenomation will doubtless change dramatically in the next 5–10 years. Currently there are clinical tests being conducted with active immunization against certain indigenous snakes in areas where this envenomation is a common cause of morbidity and mortality. Lab tests to differentiate between venoms are in development. Efforts to purify antivenin to make it less allergenic are underway.

INSECT ENVENOMATION

Generally, human envenomation of man by an insect is defensive, or made by mistake. Humans are too large to be prey. Because insects can be found in all inhabited environments, these unplanned confrontations are common. Insect venoms are rarely fatal; more often a resultant allergic reaction is the cause of associated morbidity and mortality.

Bees, Wasps and Ants

Hymenoptera species are frequently implicated; this includes bees, hornets, yellow jackets, wasps and ants. Treatment of these is dependent on the degree of reaction to the sting. One sting in a sensitive individual can precipitate anaphylaxis. Many stings from multiple insects in a colony can cause toxin levels sufficient to harm the circulatory and renal system. One sting on the neck in an otherwise nonsensitized individual can produce local swelling sufficient to impair ventilation. All stings are accompanied by local pain and swelling to some degree. An ice bag wrapped in a towel applied to the sting area can provide local relief. Persons known to be allergic to these stings should be encouraged to carry epi-pen self-administration kits. Treatment may involve aggressive resuscitation with careful attention to ABCs. If the venom apparatus is still stuck to the patient, it should be removed by lifting the apparatus away from the skin without squeezing the sac, which may still be injecting venom. If the reaction is limited to local urticaria, subcutaneous epinephrine (1:1000) and benedryl (25 mg) may be adequate treatment. Respiratory symptoms, if mild, can be treated as in asthma. Further deterioration may require invasive ventilatory support, and IV fluids and vasopressors. There are no specific antivenins for hymenoptera stings.

Spider and Scorpion Bites

There are approximately 20,000 species of venomous spiders in the world, and 1,400 venomous scorpion species. Of these, only a small percentage cause human illness. The best known of these is the **black widow spider**, whose venom contains a potent neurotoxin. Classically, a small pinprick bite may not even been noted by the victim. Local swelling occurs and is followed within the hour by cramping muscle pain in the area of the bite, which then generalizes. Lower extremity bites will cause spasm of the abdominal wall muscles, with this board-like abdomen mimicking an acute surgical abdomen. Other symptoms include nausea, vomiting, headache, shortness of breath, profuse sweating, generalized weakness, difficulty in speaking and swallowing, and usually hypertension. There may be EKG changes similar to digitalis changes. Adults with concomitant diseases are at great risk with the additional burden on cardiovascular and cerebrovascular systems. With supportive care, most adults will have resolution of symptoms within a few days. Children, because of their small body mass, may be fatally bitten. Symptomatic children or symptomatic adults with other underlying illnesses should be given antivenin. This is a horse serum product, and requires prior testing for sensitivity. Information for use of this antivenin is given in detail on the packaging. Adults with symptoms who are otherwise uncompromised often have relief of symptoms with IV infusion of 10 ml of a 10 percent CaCl solution, given slowly over 30 minutes. Other symptoms can be treated according to standard accepted treatment methodologies.

The **brown recluse spider** causes morbidity primarily through local tissue destruction; systemic manifestations of envenomation appear to be caused by allergic reactions, and vary from one victim to another. Local tissue destruction is ischemic in nature, caused by severe vasoconstriction. Systemic symptoms include anaphylaxis, as well as fever, petechiae, nausea and vomiting, and weakness. Hemolysis and shock with organ failure are signs of severe envenomation. Fatalities are more common in young children. Care is supportive in nature. Antivenin is under development, but not yet available in the U.S. It is available in Brazil for a particular species of brown recluse found there.

Treatment for the bites of other venomous spiders is primarily supportive. There is antivenin available for some rare species, primarily in the areas where these species are endemic. In general, antivenin is not available outside of these regions.

Scorpions are endemic to many parts of the world. In general, species that cause large local reaction in their victims tend to be less dangerous than those that cause systemic reactions. Children are at greater risk due to smaller body mass. Local symptoms include swelling and pain. Systemic systems include sensory changes in the area of the sting, nausea, vomiting, muscle spasms, high fever, salivation and sweating, blurred vision, hypertension, syncope, seizures, cardiac dysrhythmia, and sometimes, respiratory arrest. Symptoms progress variably, sometimes in as little as 30 minutes, sometimes over 24 hours. Antivenin is available for severe systemic symptoms and should be given in this instance. Symptomatic care is otherwise sufficient. Invasive airway management may be necessary.

Many other insects can cause local reactions or anaphylaxis in susceptible individuals. These patients are treated according to accepted medical therapies consistent with their symptoms.

VENOMOUS MARINE SPECIES

As the number of people participating in water sports has increased, so too has the number of toxic envenomations from marine wild life. Venom can be delivered by bites, stings or by nematocysts. The effect of these venoms on the victim is determined by the content of the venom, the amount of toxin, and the individuals response based on pre-existing illness or sensitivity. If a severe allergic reaction occurs, it must be treated aggressively, with wound care according to the type of venom delivery apparatus that is involved.

Nematocysts

Nematocyst injuries from jellyfish, Portuguese man of war, coral, anemones, and several others are the most common marine envenomation. Symptoms include severe pain in the area of exposure with raised erythematous lesions. With large numbers of nematocysts, systemic symptoms may develop including nausea, vomiting, chest pain, shortness of breath, muscle spasms, diarrhea, convulsions and respiratory arrest. Anaphylaxis is the most common cause of death. Treatment consists of symptomatic therapy, after removal of the victim from water to prevent drowning. Removal of the nematocysts with sea water should be accomplished. Using fresh water or friction (rubbing) may cause the nematocysts to discharge, worsening the symptoms. Vinegar poured over the wound will immobilize the remaining nematocysts. These can then be removed by covering them with talcum powder or shaving cream, which will stick to the denatured nematocysts. The complex can then be safely scraped away. Nematocysts should be removed prior to transport; delay will worsen the local damage.

Stingers or Fish Spines

Puncture wounds from stingers or fish spines are treated by removal of the stinger or spine if possible. Sea urchin spines are especially fragile and tend to break off in the wound. Other marine animals that deliver venom in this manner include crown-of-thorns starfish, stingrays, stonefish, lionfish, zebrafish, cone shells, and bloodworms. Venom from these injuries is usually heat labile, so hot water or hot packs should be applied to denature it. This often provides significant pain relief as well. Symptomatic care is given, including close attention to ABCs in case of anaphylaxis. Wound care includes removal of the foreign body, if present, and prevention of further damage by infection.

Bites by marine animals are not commonly venomous, with a few notable exceptions. The blue-banded octopus, found in the south Pacific area has resulted in adult fatalities. There is no known antivenin. Treatment is supportive.

SUMMARY

During air transport, the ABCs of resuscitation are the appropriate starting point for management of patients suffering from poisoning and envenomations. Most such patients will require only supportive care during transport. Before transporting patients who have been poisoned, scene safety and safety of health care personnel should be evaluated. Envenomated patients should generally be kept as still and quiet as possible to limit spread of the venom. Air-transport crews should be familiar with toxidromes and with symptoms of envenomation by local venomous snakes, insects, and marine life.

Accompanying this module is Exhibit 19-1: Dosage of Specific Antidotes.

EXHIBIT 19-1: DOSAGE OF SPECIFIC ANTIDOTES

Crotalidae antivenin	Minimum dose is 5 vials, infused in normal saline. Rate is dependent upon patient's tolerance
Latrodectus antivenin	One vial given slowly IV
Folate	50 mg IV every 4 hours while symptomatic
Cyproheptadine	4 mg PO (does not come in a parental formulation). Cyproheptadine may cause anticholinergic findings.
Methylene blue	1–2 mg/Kg IV (adult) (one 10 cc vial = 10 percent solution = 100 mg)
BAL	3–5 mg/kg IM
EDTA	75 mg/kg/day, by continuous IV infusion
Sodium nitrite	Adult: 10 ml of 3 percent solution (one ampule = 300 mg) Pediatrics : 0.33 ml/kg; given slowly IV
Sodium Thiosulfate	Adult: 12.5 gm (1 ampule) IV (50 ml of a 25 percent solution) Pediatrics: 1.65 ml/kg
N-acetyl cystine	140 mg/kg po; then 70 mg/kg q 4 hours
Digoxin specific FAB	dose is based on serum digoxin concentration or amount ingested if known; 10–20 vials are given if patient is in v-fib.
Thiamine	100 mg IV
Protopam	Adult: Loading dose is 1–2 gm IV Pediatric: loading dose 35–50 mg/kg
Atropine	Adult: 1–2 mg IV; titrate to drying of pulmonary secretions Pediatric: 0.03 mg/kg
Ethanol	Loading dose 10 ml/kg; maintenance drip 0.15 ml/kg/hr of 10 percent solution
Glucagon	5–10 mg IV, then infusion of same dose over an hour
Calcium	Adults: 1 gm CaCl IV slowly over 2–5 minutes Pediatrics: 20–30 mg/kg/dose
Flumazenil	0.2 mg, then 0.3 mg, then 0.5 mg, up to 5 mg.
Bicarbonate	Adult: 1–2 vials (44–88 mEq) IV push Pediatrics: 1–2 mEq/kg IV push

A. **Bibliography**:

General Toxicology

Doyon, S., et al: Reappraisal of the “coma cocktail”, *Emerg Med Clin North Am* 12:301, 1994.

Goldfrank L.: Teaching the recognition of odors, *Ann Emerg Med* 11:684, 1982.

Kulig, K.: Initial management of ingestion of toxic substances, *N Engl J Med* 326:1677, 1992.

Rosen, P. et al (eds.) *Emergency Medicine, concepts and clinical practice*, CD ROM, Mosby, 1999.

Suzuki, T., et al: Sarin poisoning in a Tokyo subway, *Lancet* 345:980, 1995.

Tueth, M.J.: The serotonin syndrome in the emergency department, *Ann Emerg Med* 22:1369, 1993.

Envenomation

Auerbach, P.S., Geehr, EC (eds) *Management of wilderness and environmental emergencies*, St. Louis, 1989, Mosby.

Biner, L.S.: Acute arthropod envenomation, *Med Toxicol* 4:163, 1989.

Blackmam, J.R. et al: Venomous snakebite: past, present and future options, *J Am Board Fam Pract* 5:3899, 1992.

Gold, B.S., et al: Snake venom poisoning in the United States: a review of therapeutic practice, *South Med J*. 87:579, 1994.

Levitz, T.L. et al, 1993 Report of the American Association of Poison Control Centers Toxic Exposure Surveillance System, *Am J Emerg Med* 12:546, 1994.

Auerbach, P.S. Marine envenomation, *N Engl J Med* 325:486, 1991.

B. **Definitions of Keywords**:

Envenomation—Topical or parenteral application of toxins produced by specialized glands and tissues of animals and insects

Toxidrome—Constellation of physical findings that may help to narrow the diagnosis and direct care

Anticholinergic syndrome—Includes elevated temperature, tachycardia, dry flushed skin, urinary retention, decreased bowel sounds, dilated pupils, delirium, and may deteriorate to seizures and cardiac dysrhythmias

Sympathomimetic syndrome—Includes tachycardia, elevated temperature, diaphoresis, pilo-erection, hyper-reflexia, mydriasis, delusions with paranoia, and may also deteriorate into hypotension, seizures and dysrhythmias

Opiate/Sedative syndrome—Describes respiratory depression, hypotension, miosis, bradycardia, low body temperature, decreased bowel sounds, hyporeflexia, pulmonary edema, and in some instances seizures (propoxyphene)

Cholinergic syndrome—Characterized by CNS depression, salivation, lacrimation, urinary and fecal incontinence, confusion, abdominal cramping, vomiting and diarrhea, miosis, and seizures

Serotonin syndrome—Includes elevated body temperature, agitations, hyper-reflexia, ataxia, and lack of coordination, altered mental status, diaphoresis, and diarrhea

Hymenoptera—Species that includes bees, hornets, yellow jackets, wasps and ants

Nematocysts—Stinging cells that when disturbed eject a barbed thread and poison

C. **Test Questions**:

1. Most poisoned patients will require only supportive care.

   True
   False

2. Organophosphate poisoning is relatively benign, and can be watched expectantly with minimal intervention.

   True
   False

3. You are called to care for and transport a patient who was involved in a motor vehicle crash. Though no apparent injuries have been found, the patient continues to be tachycardic, diaphoretic, paranoid and delusional. On physical examination, his HR is 130/minute, BP is 150/80, respiratory rate is 20/minute, and oral temperature is normal. Further history reveals that this young man was returning from a nightclub in Harbor City. There is no evidence for IV drug abuse. His physical exam is remarkable only for diaphoresis. Lungs are clear. The most likely etiology of this constellation of symptoms is:

   a. Recent alcohol ingestion
   b. Recent cocaine use
   c. Recent opiate ingestion
   d. SVT

4. The above-mentioned patient seizes. The seizure is generalized; lasting approximately 2 minutes, then recurs approximately 10 minutes later. Vital signs are unchanged. Correct therapy is:

   a. Opiate analgesia
   b. Benzodiazepine of choice
   c. A loading dose of 1 gm of Dilantin, given slowly IV
   d. Nitroprusside drip
   e. Amiodarone, 150 mg IV over 5 minutes

5. In the above-mentioned patient, the most important initial intervention by the flight crew is:

   a. Invasive airway intervention
   b. A careful history and physical examination
   c. Thorough gastric decontamination
   d. Administration of antipsychotic medication

D. **Didactic Hours**: 2

E. **Skills Hours**: N/A

F. **Patient Care Hours**: N/A

MODULE 20: METABOLIC, ENDOCRINE, AND IMMUNE SUPPRESSED PATIENTS

Author: Ms. Carol A. Faedtke, RN, BSN, CEN, Chief Flight Nurse, Christiana Care/LifeNet, Newark, Delaware

Co-author: Dr. Jennifer Michalek-Spencer, Emergency Medicine, Upstate Medical University, Syracuse, NY

Reviewer: Dr. Debra Perina, University of Virginia, Pegasus Flight Operations, Charlottesville, VA

KEYWORDS

Diabetic ketoacidosis
Hyperosmolar hyperglycemia nonketotic coma
Adrenal crisis
Thyrotoxicosis
Myxedema coma
Syndrome of inappropriate antidiuretic hormone
Pneumocystis carinii

OBJECTIVES

Upon completion of this module, the student should be able to:

- Explain how altitude affects dehydration and fluid displacement
- Understand the effect of electrolyte imbalances on body functions
- Recognize and treat specific electrolyte imbalances
- Describe the functions of the endocrine system
- Recognize and treat specific endocrine emergencies
- Discuss the importance of body substance isolation and the immune suppressed patient

INTRODUCTION

Water, water, everywhere is usually the case in a healthy adult. Fluid accounts for approximately 60 percent of a person's total body weight and along with electrolytes, is the mainstay of homeostasis. Any condition that results in too much or too little of fluid or concentrations of electrolytes can affect the overall function of the body's multiple systems.

The endocrine system serves as the regulatory control mechanism for metabolic, renal, and neural functions. Disturbances within the endocrine system can have catastrophic effects if not identified and treated promptly.

FLUID MANAGEMENT

Caring for a patient at altitude can be very challenging. It is well known that a patient's oxygen requirements change when the aircraft, whether pressurized or not, climbs to cruising altitude. A lesser-known effect of altitude is the need for external humidification, as there is a loss of normal air humidification in a pressurized cabin due to the recycling of air. The patient compartment of a nonpressurized aircraft may also be more susceptible to temperature changes and changes in humidity. Patients who are diaphoretic or dehydrated are at an increased risk for greater fluid volume deficits under these circumstances. Consequently, supplemental intravenous fluids may be required to compensate for the insensible water loss resulting from the environmental factors at altitude.

Dehydration/Hypovolemia

- **Cause**: Many factors can contribute to dehydration, such as diarrhea, vomiting, profuse diaphoresis, tachypnea, renal and endocrine disorders, a prolonged decrease in oral intake, trauma, burns, and hemorrhage. A loss of water is almost always associated with a loss of sodium. Patients who are diaphoretic or dehydrated are at an increased risk for greater fluid volume deficits. Therefore medical crew members should be aware of the need to provide supplemental intravenous fluids to make up for the insensible loss that occurs due to environmental factors encountered on-scene and during air transport.

- **Signs and Symptoms**: Presenting symptoms of dehydration can include thirst, poor skin turgor, decreased urine output with an increase in urine specific gravity, fever, tachycardia, or a change in mental status that can range from delirium to coma.

- **Treatment**: Correction of dehydration involves replenishment of water and sodium losses with .9 percent NS or .45 percent saline in conjunction with monitoring serum electrolytes. Rates and quantities of fluid replacement are determined by the patient's overall circulatory and renal functions.

Hypervolemia

- **Cause**: Hypervolemia may occur as a result of cardiac pump failure, renal disease, endocrine disorders, shock, and excessive intravenous therapy.

- **Signs and Symptoms**: Patient presentation may include sudden weight gain, muscle cramps, pulmonary and peripheral edema, and changes in mental status that may result in confusion, hallucinations, seizures, and/or coma.

- **Treatment**: Treatment begins with fluid restriction and diuresis and continues with close monitoring of respiratory, cardiac, and renal status.

FLUID MANAGEMENT SUMMARY

In all but a few specific disease entities or traumatic injuries, maintaining the patient in a “normo-volemic” state will improve morbidity and decrease mortality. Adequate tissue perfusion depends on adequate circulating blood volume and proper oxygenation. Treatment should be aimed at returning the patient to a normo-volemic state. Once circulating blood volume is stabilized, treatment can more specifically focus on the management of any electrolyte imbalances.

INTRODUCTION TO ELECTROLYTES

Each electrolyte has one or more specific functions within the body. An increase or decrease in the concentration of electrolytes within the cells of the body can have serious side effects. Three of the most important electrolytes are Sodium (Na^+), Potassium (K^+), and Calcium (Ca^{++}).

Sodium has four primary functions: (1) the creation and maintenance of normal fluid osmolality; (2) enhancing cell permeability; (3) facilitating the conduction and transmission of electrochemical impulses; (4) the regulation of acid-base balance.

Potassium is necessary for the proper transmission of nerve impulses, the maintenance of a normal cardiac rhythm, as well as skeletal and smooth muscle contraction.

Calcium is a necessary component of bones and teeth and is a co-factor in blood clotting. It is also necessary for hormone secretion, cell membrane stability, and permeability and muscle contraction.

Specific Electrolytes Abnormalities

Hypernatremia

- **Definition**: Hypernatremia occurs when serum sodium levels are greater than 145 meq/L.

- **Cause**: Conditions that can lead to hypernatremia are: decreased body water resulting from poor fluid intake, osmotic diuresis, diabetes insipidus, vomiting, diarrhea, fever, heat stroke, high environmental temperatures, thyrotoxicosis, drugs and dialysis. Renal dysfunction, acidosis, and ingestion of seawater can also cause hypernatremia.

- **Signs and Symptoms**: Patient presentation may include: dry, thick mucous membranes; dry, flushed skin; oliguria; thirst; elevated temperature; and tachycardia. Irritability and restlessness occur with serum osmolarity greater than 350. Ataxia, tremors, and muscular rigidity; occur at an osmolarity above 375. Lethargy, weakness, coma, and seizures may be seen when the osmolarity approaches 400.

- **Treatment**: The correction of hypernatremia focuses on restoring normal fluid volumes and osmolality. Initial administration of intravenous NS may be required to correct any hypotension. Further treatment is based on the underlying cause of the hypernatremic state.

  Normal saline should first be used to correct any perfusion deficit. Then switch to 0.5 percent N.S. after urine output reaches 0.5 mL/kg/h. Avoid lowering sodium more than 10 meq/L per day.

  Total body water deficit = Total body water X (1-measured Na/ desired Na).

  Children with Na> 180 may benefit from peritoneal dialysis.

Hyponatremia

- **Definition**: Hyponatremia occurs when there is a deficit of sodium in the extracellular fluid. It is defined as a lab reading of less than 136 meq/L.

- **Cause**: Conditions that can lead to hyponatremia include: excessive infusion of electrolyte-free solutions, renal dysfunction, SIADH, cirrhosis, CHF, and hyperglycemia. Potent diuretic therapy, adrenal insufficiency, diaphoresis, and third-space sequestration from burns, peritonitis, or pancreatitis can also be a cause of hyponatremia. Severe malnutrition, water intoxication, drugs, Myxedema, Addison's disease, and Sheehan's syndrome can also result in a decrease in circulating sodium.

- **Signs and Symptoms**: Depending on the severity of the underlying condition, the patient's signs and symptoms may range from anorexia, nausea, vomiting, weakness and confusion. With severe deficits seizures, coma, and even death can occur.

- **Treatment**: Volume or perfusion deficits should first be corrected with normal saline.

  Sodium deficit is calculated as follows: Wt in kg X 0.6 X (140-measured sodium). In severe hyponatremia (Na < 120 meq/l with CNS changes), hypertonic saline [3 percent (513 meq/L)] can be used and given at a rate of 25 to 100 mL/h. Hyponatremia should not be corrected faster than 0.5 to 1 meq/L per hour. Central Pontine Myelinolysis can result from the rapid correction of sodium deficit. In hypervolemic/euvolemic patients with hyponatremia, fluids should be restricted to 500 to 1500 ml/day.

  Signs of fluid overload and changes in neurological status must be carefully monitored while determining the underlying cause of the hyponatremia and starting appropriate treatment.

Hyperkalemia

- **Definition**: Hyperkalemia is a serum potassium greater than 5.5 meq/L.

- **Cause**: Precipitating illnesses or injuries that can lead to hyperkalemia include acute or chronic renal failure, missed renal dialysis, adrenal insufficiency, metabolic acidosis, insulin deficiency, GI bleeding, digitalis intoxication and excessive ingestion of K+. Hyperkalemia can also result from burns, massive crush injuries, hemolysis, and rhabdomyolysis.

- **Signs and Symptoms**: Presenting symptoms may include weakness, paresthesias, areflexia, muscle twitching, cramps, seizures or paralysis. There is usually no change in level of consciousness. The patient may complain of nausea, vomiting, or diarrhea. The most significant findings are those that affect the cardiovascular system.

  At a serum K+ level of 6.5 to 7.5 meq/L, EKG changes can be seen and may include peaked T-waves, shortened QT intervals, and prolonged PR intervals. At 7.5 to 8.0 meq/L, the P-wave flattens and disappears and the QRS widens. With levels above 8 meq/L the QRS degrades into a sine wave, and ventricular fibrillation, ventricular standstill, and complete heart block may occur.

- **Treatment**: Temporary treatment for hyperkalemia includes the administration of glucose, insulin, and sodium bicarbonate IV to drive potassium into the cells. Kayexalate or renal dialysis should be considered for follow-up, permanent treatments.

  Cardiac status and serum K+ levels should be monitored frequently. Calcium chloride or gluconate preparations are used in symptomatic cases with evidence of cardiac toxicity to stabilize the cardiac membranes and neutralize the neuromuscular effects.

  - 10 to 20 ml of 10 percent calcium gluconate or 5 ml of 10 percent calcium chloride
  - Shifting of K+ into cells can be accomplished with insulin, bicarbonate, or B agonists
    - 10 units of regular insulin is given with 1 ampule of D50
    - 1 to 2 ampules of sodium bicarbonate can be given
    - Nebulized albuterol also facilitates cellular shift
  - Kayexalate is used subacutely for increased potassium excretion; Administer 15 to 30 grams by mouth

Hypokalemia

- **Definition**: Hypokalemia occurs when the serum potassium level falls below 3.5 meq/L.

- **Cause**: An increased loss of potassium can result from diuretics, vomiting, diarrhea, intestinal obstruction, GI suction, fistulas, liver disease, renal insufficiency, renal tubular acidosis, nephritis, osmotic diuresis, hypercalcemia, alkalosis, diabetic ketoacidosis, hyper-aldosteronism, Cushing's syndrome, or steroid therapy.

- **Signs and Symptoms**: Patient presentation can include muscle cramps, muscle weakness sometimes progressing to paralysis, hyporeflexia, ileus, metabolic acidosis and glucose intolerance. Worsening digoxin toxicity, T-wave flattening, U-waves, ST segment depression, prolonged QT intervals and ventricular dysrythmias, including PACs, PVCs, sinus bradycardia, PAT, AV blocks, AV dissociation, junctional dysrhythmias, and VT may also be seen. Mental status changes may range from drowsiness to coma. In severe cases respiratory muscle weakness may result in respiratory failure.

- **Treatment**: Cardiac monitoring and serial potassium levels are recommended.

Potassium chloride replacement must be considered; although, IV potassium is very irritating to the veins and should be infused slowly in diluted solutions through a secure large-bore peripheral IV or central line.

Potassium administration:

- Oral replacement is suggested for the asymptomatic patient, use KCL 20 to 40 meq/L
- Replacement at 20 meq/hr will raise serum potassium by 0.25 meq/L
- IV infusion, 10–40 meq/hr. Dose not to exceed 40 meq/100 cc over 1 hr. Consider means of administration—peripheral line (10 meq/hr maximum) vs. central line.
- Follow-up concentrations of 40–80 meq/L with a maximum 24-hr dose of 200–400 meq

Hypercalcemia

- **Definition**: Hypercalcemia is identified by a Ca++ level>10.5 meq/L or an ionized level >2.7 meq/L.

- **Causes**: Hypercalcemia may be caused by malignancies such as lung and kidney myeloma, parathyroidism, adrenal insufficiency, hyperthyroidism, sarcoidosis, tuberculosis, histoplasmosis, hypervitaminosis of D and A, thiazide diuretics, elevated lithium concentrations, or Padgett's disease.

- **Signs and Symptoms**: Hypercalcemia may present as malaise, weakness, confusion, hyporeflexia, bone pain, fractures, nausea, vomiting, abdominal pain, or dysrhythmias including QT interval shortening.

- **Treatment**: Any underlying dehydration must be treated with N.S. Calcitonin 0.5 to 4 IU/ kg IV over 24-hr or IM q6 with 100 mg hydrocortisone is recommended. In addition, IV furosemide should be considered if the patient is in a normo-volemic state. If dehydrated, lasix is deferred until proper rehydration with normal saline has occurred. Concurrent hypokalemia or hypo-magnesemia must be treated as well. Invasive monitoring may be required.

Hypocalcemia

- **Definition**: Hypocalcemia is defined as a Ca++ level < 8.5 or ionized level < 2.0.

- **Causes**: The underlying cause of hypocalcemia may be sepsis, pancreatitis, shock, renal failure, hypo-parathyroidism, phosphate overload, Vitamin D deficiency, or drugs such as cimetidine.

- **Signs and Symptoms**: Hypocalcemic patients may present with paresthesias, cramps, weakness, confusion, or seizures. Increased reflexes may also be seen, such as Chvostek's sign (tapping over 7^{th} cranial nerve at the zygoma results in facial twitch) and Trousseau's sign (carpal spasm when BP cuff is inflated above systolic BP for more than 3 min). Cardiac effects include prolonged QT intervals and heart blocks. Cardiac arrest can occur with levels above 20 meq/L.

- **Treatment**: Asymptomatic patients can be given Vitamin D along with calcium gluconate, 1–4 g/d PO divided q6h.

  Urgent or symptomatic patients are given IV Calcium chloride or gluconate, 10 ml of a 10 percent solution slow IV.

ELECTROLYTE SUMMARY

All critically ill or injured patients are prone to fluid volume difficulties. This often results in shifts in electrolytes. The transport team needs to be aware of the signs, symptoms and conditions that result from this system-wide imbalance. Prompt recognition and treatment of any fluid or electrolyte abnormality will improve patient outcome and prevent further complications.

ENDOCRINE INTRODUCTION

The endocrine system serves as the regulatory control mechanism for multiple body systems that control metabolic, renal, and neural functions. Disturbances within the endocrine system can have catastrophic effects if not identified and treated promptly.

Common endocrine emergencies to be discussed here are diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic nonketotic coma (HHNK), hypoglycemia, adrenal crisis, thyroid storm, myxedema coma, and syndrome of inappropriate antidiuretic hormone (SIADH).

Diabetic Ketoacidosis

- **Definition**: DKA is a potentially life-threatening condition that occurs primarily in patients with insulin-dependent diabetes mellitus. It accounts for approximately 10 percent of the diabetic-related deaths in the United States. It is defined by the following lab indicators: Glu > 250 mg/dl, HCO3 < 20 meq/L, and the presence of ketones.

- **Causes**: Precipitating factors of DKA are infection, illness or trauma, noncompliance with diabetes treatment regime, situational stressors, and drug therapies for other illnesses. DKA may also be the initial presentation for the patient with undiagnosed diabetes mellitus.

- **Signs and Symptoms**: The onset of DKA can take from several hours to several days. Initial complaints may include polyuria, polydipsia, fatigue, and weakness. As the illness progresses, glyconeogenesis leads to severe hyperglycemia and osmotic diuresis. A cascade of excessive loss of water, sodium, and potassium leads to hypovolemia. The physiology resulting in DKA is the unavailability of insulin, which prevents the body from metabolizing glucose. This eventually leads to the body using fats and muscle proteins for energy and results in a state of ketoacidosis.

  The patient in ketoacidosis usually presents moderate to severe distress with nausea, vomiting, decreased appetite, and abdominal pain. The skin is usually flushed, hot and dry. As the ketoacidosis worsens, Kussmal's respirations may be noted, as well as a fruity or acetone smell to the breath. The patient's mental status may vary from lethargy to confusion. The patient may be hypotensive and tachycardic, with dysrhythmias occurring that are indicative of electrolyte imbalances.

- **Treatment**: Treatment for the patient in DKA focuses on the correction and control of hyperglycemia, dehydration, electrolyte disturbances, and metabolic acidosis. The patient in DKA needs to be monitored closely for potential complications associated with hypoglycemia, hypokalemia, dysrhythmias, and cerebral edema. Treatment considerations may include:

  - Airway; oxygen therapy; IV therapy; intake, output, and cardiac monitoring
  - Control/reduction of nausea, vomiting, pain, stress, and anxiety

- Strict and frequent serum glucose monitoring
- Initial fluid replacement volumes vary with age. 0.9 percent NS until intravascular volume is restored; continue 0.45 percent saline to provide free water for intracellular volume replacement. Volume replacement must proceed more slowly in children due to the potential to precipitate cerebral edema if volume is replaced too quickly.
- Dextrose may be added to the fluid replacement once serum glucose reaches 250–300 mg/dl to provide fuel until the patient is able to eat (Sheehy)
- Insulin: constant infusion of 0.1 units/ kg/hr or regular insulin will stop ketosis; a loading dose of 0.1 units/kg IV bolus is optional. Insulin preparations should always be given IV in a patient with DKA, as SQ absorption is irratic secondary to the patient's poor perfusional state
- When blood sugar approaches 250 mg/dl, slow IV fluids and switch to D51/2 NS
- Continue to monitor blood sugars hourly and electrolytes q 2–4 hours
- Sodium bicarbonate is not recommended unless severe acidosis is present. This is secondary to the fact that CNE edema may be worsened with bicarbonate, particularly in children
- Potassium replacement is recommended when serum levels are < 5.0 meq/L
- Phosphorus replacement should begin when serum levels are < 1.0 mg/dl

Hyperosmolar Hyperglycemic Nonketotic Coma

- **Definition**: (HHNK) is a condition that is more common in non-insulin-dependent (Type II) diabetics. The difference between DKA and HHNK lies in the fact that the Type II diabetic produces enough insulin to avoid the ketoacidosis, but not enough to prevent the profound hyperglycemia, dehydration, and hyperosmolality. HHNK is usually associated with elderly patients who have preexisting cardiac and/or renal disease.

- **Causes**: HHNK often presents after the stress of illness, trauma, or surgery results in an increased glucose level. Symptoms may be slow to develop, taking several days to weeks to manifest themselves. Infections, new onset diabetes, noncompliance, and other stressors similar to DKA can also produce HHNK.

As in DKA, the increased serum glucose acts as an osmotic diuretic and produces severe dehydration and associated electrolyte loss. Patient presentation may vary depending on the length of illness.

- **Signs and Symptoms**: Patients may present with a range of symptoms from vague abdominal discomfort, decreased appetite, polyuria and polydipsia, headache, and visual disturbances. In advanced cases altered mental status, seizures, and coma are seen. CNS manifestations, lethargy, obtundation, dehydration, tachycardia, and hypotension may also be seen.

- **Treatment**: Goals include fluid volume replacement, decreasing and controlling serum glucose, and correcting electrolyte balances.

  Fluid replacement is the priority; however, care must be given to carefully monitor for signs of circulatory overload in patients of advanced age or with preexisting health problems. Fluid choice varies and should reflect medical direction and the written policies of each air medical program.

  Insulin therapy is similar to that in DKA and requires close monitoring.

  Potassium therapy should be started as soon as an adequate urine output is established.

Hypoglycemia

- **Definition**: The most frequently occurring endocrine emergency is hypoglycemia**.** A serum glucose of less than 50 mg/dl can produce a wide variety of signs and symptoms. Because of this fact, hypoglycemia should be considered in all patients with an altered mental status.

  Hypoglycemia occurs when the serum glucose level is inadequate to meet the demands of the tissues, especially those of the nervous system.

- **Causes**: Precipitating factors include lack of dietary intake, physical stress, change in diabetic medication regime, drug therapies for other conditions, pregnancy, and alcohol ingestion. Other medical conditions that can lead to hypoglycemia are adrenal insufficiency and hypopituitarism, severe liver disease, and pancreatic islet cell tumor.

- **Signs and Symptoms**: Patient presentations can range from mild too severe. Mild symptoms include palpitations, tachycardia, shakiness, perspiration, and hunger. The patient's condition progressively worsens without treatment and can result in an altered mental status, slurred speech, headache, isolated neurological deficits, and an appearance of alcohol intoxication. Worsening condition can result in disorientation, seizure, and coma.

- **Treatment**: Interventions are determined by the patient's level of consciousness. The alert patient who can control his or her airway and swallow without difficulty should be provided with a quick source of glucose and carbohydrates. For instance: 4–6 oz of orange juice, apple juice, ginger ale, or nondiet soda, or 6 oz of milk. 5–6 Lifesaver candies or 2–3 glucose candies can be used until a more complex carbohydrate snack or small meal becomes available.

  In the patient who is awake but lethargic or unresponsive, rapid administration of intravenous D50 is the preferred treatment. If intravenous access cannot be obtained, 1 mg of Glucagon IM should be given.

  The patient should be closely monitored for sustained improvement of serum glucose level. Protect the patient from harm if seizures occur and maintain airway patency until the patient is alert and oriented.

Adrenal Crisis

- **Definition**: Adrenal crisis is a life threatening condition that is the result of deficient cortisol production that produces electrolyte and fluid abnormalities. Acute adrenal crisis can produce cardiovascular collapse.

- **Causes**: Precipitating factors include acute injury or infection of the adrenals, a patient with chronic insufficiency that is suffering from a critical illness, and abrupt cessation of corticosteroid therapy.

  Decreasing cortisol and aldosterone levels that result from adrenal system failure cause massive sodium and water loss from the kidneys and GI tract. The resulting hypovolemia can lead to shock, coma, and death if not corrected. The concomitant electrolyte disturbance is hyperkalemia with potentially fatal cardiac arrhythmias resulting.

- **Signs and Symptoms**: Patients in acute adrenal crisis may present with weakness, fatigue, nausea, vomiting, abdominal pain, palpitations, and voice a craving for salt. Physical exam may include findings of poor skin turgor, dry mucous membranes, hypotension, tachycardia and tachypnea, fever, confusion or lethargy. EKG changes may demonstrate an elevated T wave or widened ORS complexes.

- **Treatment**: Due to the critical nature of adrenal crisis, careful monitoring of ABCs, replacement of glucocorticoids, and correction of electrolyte and fluid disturbances is required.

Hyperthyroidism/Thyrotoxicosis

- **Definition**: Another rare, but potentially life-threatening endocrine emergency is thyrotoxicosis, better known as a thyroid storm.

- **Causes**: Precipitating factors in thyroid storm are surgical procedures, trauma of any kind, and infection. Thyroid storm can also result from other medical conditions such as DKA, eclampsia, Graves disease, toxic multinodular goiter, iodine intake, pituitary adenoma, subacute thyroiditis, radiation, ectopic thyroid tissue (struma ovarii), or drugs (lithium and Amiodarone).

- **Signs and Symptoms**: The presentation of hyperthyroidism is multisystem in nature. Physical exam may reveal the following presentations: warm, moist, flushed, skin; tremors; eyelid lag; retracted eyelids; exophthalmia; and presence of a goiter or alopecia. Patients may present in severe tachycardia with rates as high as 200–300/bpm, congestive heart failure, shock, and hyperthermia with temperatures as high as 40° C. Patients may be in respiratory distress with dyspnea and rales. Patients can have mental status changes including restlessness, agitation, or coma or have GI complaints such as abdominal pain, nausea, vomiting, and diarrhea. Thyroid storm is a general, overall hyper-metabolic state.

- **Treatment**: Immediate treatment goals for thyroid storm include ABCs, oxygen therapy, heart-rate reduction, temperature reduction, thyroid loop interruption, fluid replacement, and monitoring. Treatment considerations may include:

    - PTU (propylthiouracil), 600 to 1000 mg PO/NG, loading and 200 mg q 4–6 hours (blocks thyroid hormone synthesis)
    - SSKI (potassium iodide), 3–5 gtt PO/NG q 8 hours (prevents hormone release)

- Propanolol 1–2 mg IV q 15 minutes PRN (blocks peripheral hormone effects)
- Consider steroids (dexamethasone/hydrocortisone), to block peripheral conversion of T4 to T3
- Supportive care, cooling blankets, Tylenol, rehydration
- Heart-rate reduction can be treated with intravenous Propanolol, which also helps to prevent further conversion of T4 to T3
- Temperature reduction should be treated with Acetaminophen instead of salicylates as they displace thyroid hormones from binding sites and may worsen the condition

Hypothyroidism/Myxedema Coma

- **Definition**: At the opposite end of the spectrum from a thyroid storm is severe hypothyroidism or myxedema coma. Myxedema coma affects more women than men, and if not treated promptly, has a 50 percent mortality rate. Hypothyroidism results from insufficient hormone production and is often precipitated by stress.

- **Causes**: Pre-existing factors that may lead to severe hypothyroidism include decompensation of a hypothyroid state following infection, exposure to cold, administration of tranquilizers, barbiturates, narcotics, or other physical stressors. Other potential causes include thyroidectomy, destruction of the thyroid gland after radioactive iodine therapy, chronic thyroiditis, Hashimoto's thyroiditis, dysfunction within the hypothalamic-pituitary axis, insufficient provision of exogenous thyroid hormone, and iodine deficiency.

- **Signs and Symptoms**: In thyroid storm the entire metabolic system speeds up, in myxedema coma the system slows down. Thus, the patient may complain of pronounced fatigue, decreased activity tolerance, shortness of breath, and weight gain (Sheehy). Other multisystem signs include cold intolerance, constipation, menorrhagia, hoarseness, nonpitting edema, paresthesias and delayed relaxation of DTRs. Altered mental status can progress to coma. There may be a presentation of "Myxedema madness" where the patient has psychiatric symptoms of hallucinations, paranoia, depression, and combativeness.

  The patient's skin is cool and pale with marked peripheral vasoconstriction. Hypothermia with body temperatures of 32° to 35° C can be present. Cardiovascular changes result in bradycardia, decreased stroke volume, and cardiac output. There may be pleural and pericardial effusions on x-ray. EKG changes may include T-wave depression, ST changes, and prolonged RT and QT intervals. Respiratory effort is slowed and shallow, resulting in hypoventilation and hypercarbia. Decreased renal blood flow leads to decreased sodium re-absorption and hyponatremia.

- **Treatment**: Interventions include ABC's, oxygen, IV fluids, monitoring, glucose, and passive rewarming for hypothermia. Treatment may include:

    - Levothyroxine is the most specific treatment for myxedema (300 to 500 mg slow IV)
    - Consider hydrocortisone (100 mg IV) as adrenal insufficiency is often present as well
    - Concomitant hypothermia and hyponatremia should be corrected with standard treatment

Syndrome of Inappropriate Antidiuretic Hormone (SIADH)

- **Definition**: SIADH results when there is a failure in the anti-diuretic hormone (ADH) negative feedback system or exogenous production of excessive ADH, resulting in an excess of the hormone.

- **Causes**: Precipitating factors that can lead to SIADH include oat cell carcinoma of the lung; carcinoma of the pancreas, duodenum, and GU tract; Hodgkin's and non Hodgkin's lymphoma; lung abscess and infections; asthma; positive pressure ventilation; tuberculosis; AIDS; viral and bacterial pneumonia; trauma to the brain; CNS infection; and CVA. Medication can also produce this syndrome including opioids, tricyclic antidepressants, vincristine, and general anesthetic agents.

- **Signs and Symptoms**: Signs and symptoms associated with SIADH are related to water intoxication. The water toxicity leads to hyponatremia and a decrease in plasma osmolality. Cerebral edema may result from the severe fluid shifts that occur. The resulting CNS symptoms may be confusion, lethargy, headache, seizures, and decreased deep tendon reflexes. The patient may complain of nausea, vomiting, diarrhea, and abdominal and muscle cramps. There is an increase in urine concentration and a decrease in urine output.

- **Treatment**: The key to treating SIADH is stringent fluid restriction with accurate intake and output monitoring. The identification and treatment of the precipitating factors becomes the focus of care.

Adrenocortical Insufficiency

- **Definition**: Acute adrenal insufficiency is the inadequate production of glucocorticoids and mineral corticoids to meet the physiologic demands of the body.

- **Causes**: Abrupt withdrawal of chronic steroids is the most common cause of adrenocortical insufficiency. Primary adrenal insufficiency or Addison's Disease, resulting from autoimmune destruction of the adrenal glands. Tuberculosis, neoplastic infiltration of the adrenal glands, adrenal hemorrhage, secondary adrenal insufficiency resulting from pituitary or hypothalamic insufficiency, and head trauma may also be precursors to the condition.

- **Signs/Symptoms**: Patient presentation may include weakness, confusion, anorexia, nausea, vomiting, abdominal pain, hypotension, hyper-pigmentation, hyperkalemia, hyponatremia, hypoglycemia, and pre-renal azotemia.

- **Treatment**: Intervention should include ABC's, oxygen, monitoring, D5 NS fluid resuscitation, and hydrocortisone 100 mg IV bolus.

  Avoid treating any hyperkalemia, as body stores of potassium are usually low and the hyperkalemia will resolve with glucocorticoid replacement and IV fluids.

ENDOCRINE SUMMARY

Metabolic, renal, and neural functions are regulated by the endocrine system and, therefore, shifts or changes in the balance of these hormones may cause catastrophic effects if not identified and treated promptly. Early recognition and treatment during the air medical transport is imperative for the patient to have an optimal outcome.

THE IMMUNE SUPPRESSED PATIENT

The immune suppressed patient poses many challenges for treatment in the air medical environment. The air medical crew must know the causes of immune suppression, the patient risk factors for infection, and the transport needs of these patients.

The immune suppressed patient is at risk for infection because of the underlying disease process or an untoward hematological or immunological effect of drug therapy. Precipitating factors for the immune suppressed patient may include a genetic predisposition or inherited trait, decreased neutrophil production, HIV infection or other underlying diseases such as myasthenia gravis, rheumatoid arthritis, multiple sclerosis, Graves disease, or lupus.

Presentations can range from minimal to catastrophic and can involve multiple organ systems. The stress created within the body due to severe illness or trauma can intensify these diseases by stimulating the hypothalamus and the pituitary to secrete hormones that produce inflammation. The stress response results in a release of corticosteroids that suppress synthesis of leukocytes in the bone marrow and is cytotoxic to pre-existing leukocytes in the blood stream. Thus, any severely injured or ill patient should be considered potentially immune suppressed.

Decreased Neutrophil Production

Patients with decreased neutrophil production are at an increased risk for infection. Because these patients do not have an adequate amount of WBCs to attack the infection, the classic signs and symptoms of infection may not be present. Fever may be the only sign noted upon physical exam, and in some cases the patient may not be able to generate a fever. The most common infections are pneumonia, septicemia, skin, GI and GU tract inflammation, and lesions. Common causative organisms are gram-negative bacilli like *Klebsiella pneumoniae* and *Escherichia coli*, and gram-positive bacilli such as *Staphylococcus aureus*, *Enterococcus* and *Staphylococcus epidermis.*

HIV/AIDS

Since it was first recognized in 1981, HIV or AIDS has been at the forefront of immune disorders. Common opportunistic infections can be found in the respiratory, neurological, cardiovascular, GI and integumentary systems of patients with these disorders.

The two most common opportunistic infections affecting the respiratory system are *Pneumocystis carinii* and *Mycobacterium tuberculosis. Toxoplasmosis gondii Cryptococcus neoformans*, and AIDS dementia complex may commonly affect the neurological system. The most common cardiac presentations include pericarditis, pulmonary hypertension, myocarditis, and congestive cardiomyopathy. Gastrointestinal infections are very common in the AIDS population, with *Cryptosporidium* the most common cause of diarrhea. The most common neoplasm in the integumentary system is Kaposi's Sarcoma.

Drug-Induced Immune Suppression

There are many drugs that can affect a patient's immunity. Generally these drugs are used to treat life-threatening illnesses or advanced stages of more common illnesses, and, therefore, the side effects of immune suppression must be weighed very carefully. Some of the more common immune-suppressing drugs are steroids, azathioprine, cyclosporine, and chemotherapeutic agents, especially those used in high doses for all types of transplant patients.

- **Steroids** and NSAIDs inhibit portions of the pathway that synthesizes prostaglandins, thromboxanes and leukotrienes. They may also mask the usual signs and symptoms of infection such as fever.

- **Azathioprine** (Imuran) is used as an adjunct for the prevention of rejection in renal homo-transplantation. It can also be used in the treatment of severe active rheumatoid arthritis.

- **Cyclosporine**, also an anti-rejection medication, is indicated in the pharmacological regime for kidney, liver, and heart allogeneic transplants.

Management of the Immune Suppressed Patient

Serious infections are a constant hazard for patients receiving long-term immuno-suppression therapy. Fungal, viral, bacterial, and protozoan infections are often fatal in this population.

Strict body substance isolation (BSI) and universal precautions must be observed during the care of these patients. The air medical crew must be attentive to the fact that the patient is at risk for exposure to infection, and the crew is at risk for exposure to infectious disease. Crew members with colds and/or coughs should reconsider being involved in the treatment of immune suppressed patients unless respiratory droplets are controlled.

Treatment of fluid volume deficits related to fever, hemorrhage, or shock is particularly important in these patients.

Patients with chronic diseases may be particularly afraid or anxious at the thought of leaving family and friends for an air medical transport to an unfamiliar environment. This stress and anxiety may intensify these diseases and exacerbate the inflammatory response and increase patient discomfort. Every effort should be made to decrease anxiety, pain, and discomfort during the transport.

IMMUNE SUPPRESSED PATIENT SUMMARY

Immune suppressed patients may be chronically or acutely ill, requiring aggressive life support or minimal supportive care. Due to the nature of the illness, the signs and symptoms are often vague and subtle, thereby presenting a challenge to the air medical provider who may not have previous knowledge of the patient's condition. A detailed history including onset of illness, medications, and current therapies is very important to prepare for any potential complications en route.

A. **Bibliography**:

Christiana Care Health Services, Inc. Drug Formulary 1995–present. Lex-corp, Inc.

Alspach, JoAnn Grif. *American Association of Critical-Care Nurses Core Curriculum for Critical Care Nursing*. W.B. Saunders Company, Philadelphia, PA 19106. 1998.

Conn, P.M., Melmed, S. *Endocrinology Basic and Clinical Principles*. Humana Press, Totowa, NJ 07512. 1997.

Holleran, Renee Semonin. *Flight Nursing Principles and Practices*. Mosby, St. Louis, MO 63146. 1996.

Kinney, M.R., Dunbar, S.B., Brooks-Brunn, J., N., Molter, Vitello-Cicciu. J.M. *AACN Critical Reference for Critical Care Nursing*. Mosby, St. Louis, MO 63146. 1998.

Newberry, Lorene. *Sheehy's Emergency Nursing Principles and Practice*. Mosby, St. Louis, MO 6 3146. 1998.

B. **Definitions of Keywords**:

Diabetic ketoacidosis—A potentially life-threatening condition that occurs primarily in patients with insulin-dependent diabetes mellitus

Hyperosmolar hyperglycemia nonketotic coma—A condition that is more common in non-insulin-dependent (Type II) diabetics. The difference between DKA and HHNK lies in the fact that the type II diabetic produces enough insulin to avoid the ketoacidosis, but not enough to prevent the profound hyperglycemia, dehydration, and hyperosmolality.

Adrenal crisis—A life-threatening condition that is the result of deficient Cortisol production that produces electrolyte and fluid abnormalities

Thyrotoxicosis—A potentially life-threatening endocrine emergency, better known as a thyroid storm

Myxedema coma—Results from insufficient hormone production and is often precipitated by stress

Syndrome of inappropriate antidiuretic hormone—Results when there is a failure in the anti-diuretic hormone (ADH) negative feedback system, or exogenous production of excessive ADH, resulting in an excess of the hormone

Pneumocystis carinii—A common opportunistic infection affecting the respiratory systems of HIV/AIDS patients

C. **Test Questions**:

1. Your aeromedical transport team is dispatched to a local rural emergency department for an unresponsive subject. Upon arrival you find a 25-year-male, pale, cool to touch, eyes closed, respirations are shallow. There is no response to verbal stimuli and very minimal withdraw to pain. Medical history is unknown at this time and there is no sign of trauma. His friends state that he attended an all night poker game and around 0400 stated he was tired and went and sat in a living room chair. At 0900 when the game broke up, they were unable to arouse the patient. Being concerned, the friends put the patient in the back of their car and brought him to the ED.

   No treatment other than nasal cannula oxygen at 4L has been started. Please describe your assessment and treatment modalities in order of their importance:

   a. Secure airway, monitor, tox screen
   b. IV line, monitor, core temp
   c. **Secure airway, blood sugar, monitor**
   d. Pulse ox, monitor, secure airway

2. You are dispatched on an interfacility transport of a 56 year-old female with a history of insulin dependent diabetes. She has been admitted to the intensive care unit of a local hospital following 4 days of severe vomiting and diarrhea.

   She is being transferred to a referring center for treatment of her fluid volume deficit and impending renal failure.

   Upon arrival the patient is awake and alert and appears to be complaining about the cramps in her lower leg.

   Her cardiac monitor reveals increasing ventricular ectopy.

   Based on the above presentation, the crew should be suspicious of what metabolic condition?

   a. Hypocalcemia
   b. Hyperglycemia
   c. Hypernatremia
   d. Hyperkalemia

3. A patient who presents with nausea, vomiting, abdominal cramps, polyuria, polydipsa and Kussmal's respirations is most likely to have:

   a. Thyroid storm
   b. Adrenal insufficiency
   c. DKA
   d. Myxedema

4. All of the following are pre-existing factors that can lead to severe hypothyroidism EXCEPT:

   a. Hypothermia
   b. Narcotics
   c. Infection
   d. Tricyclics

5. The most appropriate treatment for hyperkalemic cardiac dysrhythmias is:

   a. Glucose, insulin, bicarbonate
   b. Kayexcalate
   c. Calcium
   d. Lidocaine

D. **<u>Didactic Hours</u>**: 4

E. **<u>Skills Hours</u>**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- EKG review to identify changes seen with electrolyte imbalances
- Practice with titration of fluid volumes for various age groups and diagnoses

F. **<u>Patient Care Hours</u>**: 8

MODULE 21: HYPOTHERMIC AND HYPERTHERMIC PATIENTS

Author: Ms. Jacqueline C. Stocking, RN, MSN, CEN, CFRN, FP-C, EMT-P/CEP/LP, Director of Clinical Education and Outreach, Critical Air Medicine, Austin, TX

Reviewers: Mr. Paul Marcolini, CEP, Program Coordinator, LifeFlight of Maine, Lewiston, Maine
Dr. Debra Perina, University of Virginia, Pegasus Flight Operations, Charlottesville, Virginia

KEYWORDS

Radiation
Conduction
Convection
Evaporation
Hypothermia
Hyperthermia

OBJECTIVES

Upon completion of this module, the student will be able to:

- Describe the four methods of heat loss
- List three physiological responses of the human body to hypothermia
- State treatment modalities for mild, moderate, and severe hypothermia
- List the signs, symptoms, and treatment for heat cramps, heat exhaustion, and heat stroke
- Identify the patient groups at highest risk for hypothermia

INTRODUCTION

This module will discuss the general transport preparation and en route care of the hypothermic and hyperthermic patient. A review of the physiology of heat loss and heat production will be presented, as well as definitions and treatment modalities for cold- and heat-related illnesses. A discussion of mild, moderate, and severe hypothermia with signs and symptoms, precipitating factors, physiological responses, and treatment is presented. In addition, a discussion of heat cramps, heat exhaustion, and heat stroke is presented with an emphasis on signs and symptoms, precipitating factors, physiological responses, and treatment.

TEMPERATURE REGULATION

A stable body temperature is the result of a delicate balance between internal heat production and loss to the external environment. Basal heat production generates approximately 40–60 kcal/m2 of body surface area per hour.

Normal heat loss occurs through four different mechanisms: radiation (55–65 percent), conduction (2–3 percent, but may increase by 5x due to wet clothing or 25x due to contact with cold water), convection (12–13 percent), and evaporation (25 percent). With exposure to cold environments, heat production can increase by as much as 2–5 times with ingestion of food, muscular activity, shivering, and acute cold exposure. Unfortunately, this maximal heat production only lasts a few hours due to fatigue and glycogen depletion.

With exposure to heat, the body attempts to compensate by decreasing peripheral vascular resistance and shunting blood to the periphery. The purpose is to cool the body, as heat is lost from the skin surface by evaporation of sweat from the skin.

HYPOTHERMIA

Hypothermia, which is defined as a core body temperature of less than 35 degrees Centigrade (C), occurs because the body can no longer generate enough heat to maintain bodily functions. Several variables contribute to development of accidental hypothermia through increased heat loss, decreased heat production, or impaired thermostability. These variables include: exposure, age, health, medication, nutrition, and drug and alcohol use.

There are three categories of hypothermia, based on core temperature. Physical findings and treatment vary with the degree of hypothermia as well as the nature and extent of associated illness or injury.

Mild Hypothermia

Mild hypothermia is defined as a core body temperature of 32–35 degrees C. In this temperature range, heat can still be conserved by vasoconstriction. In addition, shivering can still produce heat. Mild hypothermia is associated with low morbidity and mortality.

Signs and symptoms of mild hypothermia include tachyapnea, vasoconstriction, tachycardia, ataxia, apathy, dysarthria, loss of fine motor coordination, lethargy, confusion, and shivering.

Moderate Hypothermia

Moderate hypothermia is defined as a core body temperature of 28–32 degrees C. It is important to note that at temperatures below 32 degrees C, the body no longer attempts to conserve or produce heat.

Signs and symptoms of moderate hypothermia include cessation of shivering, poikilothermia, delirium, stupor, slowed reflexes, decreased level of consciousness, dilated pupils, slowed respiration, bradycardia, J waves on electrocardiogram, susceptibility to ventricular fibrillation, and cold diuresis.

Severe Hypothermia

Severe hypothermia is defined as a core body temperature of less than 28 degrees C. At temperatures below 28 degrees C, the body can no longer generate heat by itself and essentially becomes poikilothermic.

Signs and symptoms of severe hypothermia include unresponsiveness/coma, significant hypotension, very cold skin, pulmonary edema, acidemia, appearance of death, ventricular fibrillation, and loss of reflexes.

Predisposing Factors to Hypothermia

Decreased Heat Production

- Endocrine failure: hypopituitarism, hypoadrenalism, hypothyroidism
- Insufficient fuel: hypoglycemia, malnutrition, extreme exertion
- Neuromuscular inefficiency: age extremes, impaired shivering, inactivity

Increased Heat Loss

- Environmental: immersion, cold environment
- Induced vasodilatation: pharmacologic, toxicologic (including ethanol)
- Erythrodermas: burns, psoriasis, exfoliative dermatitis
- Iatrogenic: cold IV infusions, heat stroke treatment, overzealous burn treatment

Impaired Thermoregulation

- Peripheral failure: neuropathies, acute spinal cord transection, diabetes

- Central failure: CNS trauma, stroke, metabolic, pharmacologic, toxicologic, hypothalamic dysfunction, Parkinson's disease, anorexia nervosa, neoplasm, cerebellar lesion, multiple sclerosis
- Other: sepsis, pancreatitis, vascular insufficiency, uremia

Patient Age

- Patients at age extremes are particularly vulnerable to hypothermia, and every effort should be made to protect these patients against further environmental insults during transports.

Physiologic Responses to Hypothermia

Renal

Hypothermia reduces renal blood flow significantly. As a result, the kidneys excrete a large amount of dilute urine, termed "cold diuresis." Alcohol ingestion can double this increase. This dilute urine does not clear nitrogen waste products.

Respiratory

Initially, hypothermia stimulates respiration. This response is quickly followed by a decrease in respiratory minute volume and carbon dioxide retention, leading to respiratory acidosis. In addition, the respiratory system is affected by an increase in thick secretions (bronchorrhea), decreased ciliary motility, and noncardiogenic pulmonary edema.

Central Nervous System

Hypothermia results in progressive depression of the central nervous system (CNS). In addition, hypothermia protects the CNS and allows the brain to withstand long periods of anoxia. Cerebral oxygen requirements are 50 percent of normal at 28 degrees C, 25 percent of normal at 22 degrees C, and 12.5 percent of normal at 16 degrees C. Because of the decreased oxygen requirements, the brain can survive without perfusion for approximately 10 minutes at 30 degrees C, 25–30 minutes at 20 degrees C, and 32–48 minutes at 16 degrees C.

Patients who are mildly hypothermic are clumsy, apathetic, withdrawn, or irritable. LOC begins to decrease significantly at 32 degrees C, resulting in lethargy and disorientation. At lower temperatures, the protective cough reflex is absent and aspiration can occur. Coma develops at temperatures between 28–30 degrees C and the pupils dilate and become nonreactive. Corneal and deep tendon reflexes may be absent, contributing the appearance of death.

Cardiovascular

Initially, hypothermia will result in tachycardia as a result of sympathetic stimulation. After this initial tachycardia, a progressive bradycardia occurs. Changes in the conduction system begin at 27 degrees C and include a widened QRS complex, a prolonged PR or QT interval, and the presence of an Osborne or J wave. The J wave, which is clearly seen at 25 degrees C, is an extra deflection at the junction of the QRS complex and ST segment. Ventricular irritability is seen at temperatures below 30 degrees C. At temperatures below 28 degrees C, ventricular fibrillation may result from rough handling of the patient, careless endotracheal intubation, or external cardiac compressions. Ventricular fibrillation may occur spontaneously at temperatures below 25 degrees C. At temperatures below 30 degrees C, dysrhythmias become increasingly refractory to pharmacological intervention and defibrillation. Below 20 degrees C, asystole occurs.

Hypothermia also increases blood viscosity, resulting in an increased risk of thromboembolism.

General Treatment

The first step in treatment of hypothermia is recognition of the problem. Wet clothing must be removed and the patient must be protected from further heat loss and wind chill. Treatment of all hypothermic patients should include oxygenation, cardiac monitoring, blood glucose monitoring, IV fluids, and gentle handling and transport.

Mild Hypothermia

Mild hypothermia is best treated with passive external rewarming. The removal of wet clothing and the addition of blankets prevent further heat loss and allow the body to produce heat. The average increase in temperature desired is approximately 0.5–2.0 degrees C per hour.

Moderate Hypothermia

Moderate hypothermia is treated with either passive external rewarming or active external rewarming.

Severe Hypothermia

Severe hypothermia is treated with active core rewarming.

Rewarming Techniques

Passive External Rewarming

Passive external rewarming (PER) is used in mild hypothermia, when the patient can still generate heat by shivering and vasoconstriction. It may also be used to augment rewarming measures in the moderately or severely hypothermic patient. With PER, the patient is stripped of any wet clothing, covered with blankets, and allowed to rewarm naturally. Recommended rewarming rates are 0.5–2.0 degrees C per hour.

Active External Rewarming

Active external rewarming (AER) remains controversial. With AER, heat-producing objects are placed directly on the patient's skin. Examples include heated baths, thermal blankets, and heat packs to the axilla, groin, and neck. Thermal injury to vasoconstricted skin is a hazard. If AER is performed, warming devices should be applied to the thorax only, leaving the extremities vasoconstricted. Application of heat to the extremities may result in afterdrop, which is a further drop in core temperature and pH as lactic acid rich blood is moved from the periphery to the core once AER has begun. With AER, rewarming rates of 1.0–2.5 degrees C per hour have been reported without evidence of afterdrop. AER may be used in conjunction with active core rewarming.

Active Core Rewarming

Active core rewarming (ACR) techniques are used to minimize rewarming collapse (afterdrop) in patients with severe hypothermia. Methods of ACR include: airway rewarming with heated, humidified air; peritoneal dialysis with a double catheter system; heated irrigation of the gastrointestinal, genitourinary, or pleural cavities; diathermy; and extracorporeal blood rewarming using cardiopulmonary bypass, arteriovenous rewarming, venovenous rewarming, or hemodialysis. With ACR, core temperature can be increased by 1.0–2.0 degrees C every 3–5 minutes. Unfortunately, most forms of ACR are not feasible in most transport environments.

Transport Team Management

Management of hypothermia remains controversial. One agreed-upon point is the adage "a patient is not dead until he is warm and dead." Warm, in this case, is defined as 32 degrees C. Management of the patient suffering from mild hypothermia is rather straightforward. Management of the patient with moderate or severe hypothermia is more controversial and presents more of a challenge to the crew member.

Gentle Handling

All hypothermia patients should be handled gently, with minimal stimulation during transport. Rough handling may result in ventricular fibrillation.

Prevention of Further Heat Loss

Prevention of further heat loss is paramount. The patient's wet clothing should be removed, if present. The patient must also be protected from any wind source and contact with cold objects, such as the skin of the aircraft. Insulating and windproof blankets should be placed both under and on top of the patient. Do not forget to cover the patient's head, as this is a major source of heat loss. In the alert patient, warm fluid may be given by mouth if the gag reflex is intact.

Active Core Rewarming

Although not all ACR methods are appropriate for the transport environment, some can be accomplished with relative ease.

Warm, humidified oxygen is easy to administer, safe in transport, effective, and noninvasive. The rate of rewarming ranges from 0.5–2.0 degrees C per hour up to 3.5 degrees C in 20 minutes. Administration of warm, humidified oxygen warms the lungs, eliminating a major source of heat loss. Additional advantages include stimulation of pulmonary cilia, decrease in pulmonary secretion viscosity, and a reduction in cold-induced bronchorrhea. In addition, the myocardium is perfused by warmer, oxygenated blood.

Rehydration with warm IV fluids is also easily performed in the transport environment. This method increases blood flow to the heart and decreases blood viscosity, vasoconstriction, likelihood of cardiac dysrhythmias, and the potential for afterdrop. Hypothermic patients also have an increased chance of survival when a warm (40 degrees C) bolus of 250–500 cc of IV fluid is infused prior to moving the patient. The IV fluid of choice is D5NS, because LR is not fully metabolized in the hypothermic liver.

Monitoring of Vital Signs

In addition to monitoring of typical parameters, the hypothermic patient's core temperature must be monitored with a hypothermia thermometer.

Airway and Breathing

Monitor the patient's respiratory status for 1 full minute to obtain an accurate respiratory rate. A spontaneous respiratory rate of 4–6 breaths per minute is considered to be sufficient in severe hypothermia. If spontaneous respirations are present, an effective cardiac rhythm can be assumed.

The hypothermic patient's airway is opened without the use of adjuncts whenever possible. Invasive airway management techniques are performed only if the patient's airway reflexes are absent. Ventricular fibrillation may ensue if rough airway manipulation or endotracheal intubation is attempted. If the patient is not breathing spontaneously and artificial ventilation is necessary, a respiratory rate of 10 or fewer breaths per minutes is sufficient. Hyperventilation must be avoided, as the ensuing respiratory alkalosis may precipitate ventricular fibrillation.

Circulation and Cardiac Resuscitation

In general, established ventricular fibrillation or asystole on the cardiac monitor is the only indication to initiate external cardiac compressions in the severely hypothermic patient. Treatment of dysrythmias in hypothermic patients is controversial. Strong evidence-based guidelines to guide treatment protocols are lacking. In general, it is recommended that programs follow ACLS guidelines. However, defibrillation is typically not effective until the core temperature is above 28 degrees C. Pharmacological intervention is typically not effective until the core temperature is 30 degrees C or above, as the liver cannot metabolize drugs when the patient is severely hypothermic.

It is important to remember that blood pressure monitoring may be difficult or impossible due to muscle tremors, vasoconstriction, and the transport environment itself.

Pharmacological Therapy

This, too, is an area of controversy. In general, pharmacological manipulation of respiratory and cardiovascular parameters should be avoided in the hypothermic patient until the core temperature is at least 30 degrees C. The generally agreed upon exception is dextrose for known or suspected hypoglycemia.

SUMMARY

Management of the mildly hypothermic patient presents few challenges to the crew member. In contrast, management of the moderately or severely hypothermic patient remains controversial and presents significant challenges to the crew member. Management techniques include gentle handling, accurate assessment of respiratory and cardiovascular status, PER to prevent further heat loss, and careful use of ACR with warm, humidified oxygen and warm IV fluids.

HYPERTHERMIA

Hyperthermia and heat related illness are a major cause of preventable morbidity and mortality worldwide. A continuum of illness related to hyperthermia exists: heat cramps, heat exhaustion, and heat stroke.

Heat Cramps

Heat cramps are extremely painful, sustained muscle contractions. They tend to occur in healthy, physically fit individuals who, while exerting themselves, sweat profusely but tend to replace sweat losses with water and inadequate amounts of sodium. The resultant hyponatremia hinders muscle relaxation, resulting in painful sustained muscle cramps. The muscles of the calves and thighs are most commonly affected. A slight rhabdomyolysis may be observed, but long-term effects are rarely seen.

Heat Exhaustion

Heat exhaustion is a syndrome of hyperthermia (38–41 degrees C) and dehydration. If untreated, it may progress to heat stroke. Typically, heat exhaustion occurs in individuals who are not acclimatized to the environment and who have been doing strenuous activity in the heat.

Heat exhaustion may be a result of water-depletion from inadequate fluid replacement or salt-depletion when water is replaced without enough salt intake. In general, water-depletion heat exhaustion is the more serious of the two entities and tends to develop within a few hours. This is typically seen in laborers, athletes, military personnel, or invalids without free access to water. Salt-depletion heat exhaustion tends to develop over the course of several days.

Signs and symptoms of heat exhaustion include: weakness, fatigue/exhaustion, nausea, vomiting, muscle cramps, headache, muscle cramps/myalgias, orthostatic dizziness, syncope, impaired judgment, sweating (which may be profuse), tachycardia, hypotension, and hyperventilation.

Pathophysiology: In heat exhaustion, vasodilation coupled with underlying hypovolemia results in a significant decrease in cardiac output. The signs and symptoms, therefore, are a result of the extreme stress placed upon the cardiovascular system as it attempts to maintain normothermia. Laboratory values show classic signs of dehydration: elevated hematocrit, blood urea nitrogen, serum protein, and concentrated urine. In addition, moderate elevations of CPK may occur as a result of muscle damage.

Heat Stroke

Heat stroke is a syndrome of extreme hyperthermia with thermoregulatory failure. Heat stroke is characterized by core temperatures of greater than 41 degrees C and results in serious end-organ damage. Damage is a function of temperature as well as exposure time. Neurologic dysfunction is the hallmark sign of heat stroke, and cerebral edema is common.

Signs and symptoms of heat stroke include hyperventilation, respiratory alkalosis, tetany, hypokalemia, tachycardia, confusion, seizures, combative delirium, sudden onset of delirium or coma, cessation of sweating with hot and dry skin (although sweating may persist), and hepatic damage.

Pathophysiology: In heat stroke, the body responds with peripheral dilatation, tachycardia, and a hyperdynamic state. Hypotension is a late finding in heat stroke. Three components of heat stroke may lead to increased bleeding: heat increases fibrinolysis and circulating anticoagulants; hepatic damage results in decreased production of clotting factors; and heat causes damage to the vascular endothelium. Splenic vasoconstriction, as response to peripheral vasodilation, causes nausea, vomiting, and diarrhea. Extremely elevated temperatures result in extensive muscle damage, represented by an increase in CPK and rhabdomyolysis, which can result in acute renal failure. Additional laboratory findings may include: elevated blood urea nitrogen and creatinine, decreased glucose, increased hematocrit, and elevated liver enzymes.

Predisposing Factors to Hyperthermia

- Illnesses: heart disease, skin diseases, extensive burns, dehydration, endocrine disorders (hyperthyroidism, diabetes, pheochromocytoma), neurologic diseases (autonomic neuropathies, parkinsonism, dystonias), delirium tremens, fever
- Behavior: exercise in a hot environment, lack of air conditioning or proper ventilation, inappropriate clothing, lack of acclimatization, decreased fluid intake, hot environments
- Pharmacological: beta-blockers, anticholinergics, diuretics, ethanol, antihistamines, tricyclic antidepressants, sympathomimetics, phenothiazines, lithium, salicylates
- Other: salt or water depletion, obesity

Physiologic Responses to Hyperthermia

Hyperthermia places a tremendous strain on the body. Specific manifestations for heat cramps, heat exhaustion, and heat stroke have already been discussed.

General Treatment

The first step in treatment of hyperthermia is recognition of the problem. Treatment of all hyperthermic patients should include oxygenation as needed, cardiac monitoring, blood glucose monitoring, fluid and electrolyte assessment with replacement as warranted with IV fluids, cooling of core temperature as outlined below, and rapid transport.

Heat Cramps

Treatment of heat cramps is aimed at placing the patient in a cool environment, gently stretching the muscle, and having the patient replace fluid and electrolyte losses. If cramps are particularly severe and do not abate with fluid and electrolyte replacement. Valium may be used to relieve them.

Heat Exhaustion

Treatment of heat exhaustion includes rest, removal to a cool environment, assessment of volume status, fluid replacement with IV normal saline or PO free water as indicated, Treatment of severe electrolyte derangements will require admission and be done as an inpatient. Rehydration is guided by laboratory values and cardiovascular status.

Heat Stroke

Treatment of heat stroke includes the treatments outlined above as well as passive and/or aggressive cooling measures. Passive cooling measures include removal of the patient's clothing, removal to a cool environment, and keeping skin wet. Circulating air over the patient will also help to decrease core temperature. Ice packs to the neck, axillae, and inguinal area may also be used to aid in cooling. One must be careful to avoid counterproductive shivering, however, as this will create endogenous heat, making the patient that much more difficult to cool. If present, shivering may be treated with chlorpromazine 10–50 mg intravenously. More invasive methods of cooling include ice-water gastric lavage, iced peritoneal lavage, hemodialysis, and cardiopulmonary bypass.

Transport Team Management

Management of hyperthermia presents many challenges in the transport environment. Evaporative cooling is the preferred method, as it is safe, effective, and fairly easy to accomplish in the transport environment. Support of vital functions must also be maintained. Complications of heat stroke that must be guarded against, or treated once they occur, are listed below.

Cardiac: sinus tachycardia, hypotension, ST segment and T wave changes, elevated cardiac enzymes, subendocardial hemorrhage, and ruptured cardiac muscle

Pulmonary: aspiration, respiratory alkalosis from hyperventilation, pulmonary edema, and ARDS

Renal: rhabdomyolysis, acute renal failure, acute tubular necrosis

Electrolyte imbalances: hypokalemia, hyperkalemia, hypocalcemia, hypernatremia, hypoglycemia, and lactic acidosis

Hematologic: coagulopathies, DIC

Neurologic: coma, dementia, ataxia, seizures

Hepatic: jaundice, liver failure

SUMMARY

Management of the hyperthermic patient presents many challenges to the crew member. Treatment modalities for heat cramps, heat exhaustion, and heat stroke have been discussed.

A. **Bibliography**:

Air and Surface Transport Nurses Association (2001). *Heat Related Illness*. Available at www.astna.org.

Air and Surface Transport Nurses Association (2001). *Cold Injuries*. Available at www.astna.org.

Decker, W. (2001). Hypothermia. *EMedicine Journal*, 2 (8). Available at www.emedicine.com.

Holleran, R. (ed.) (1995). Cold-related emergencies, *Flight Nursing: Principles and Practice*, pp. 526–541.

Holleran, R. (ed.) (1995). Heat-related emergencies, *Flight Nursing: Principles and Practice*, pp. 542–555.

Kunihiro, A. (2001). Heat exhaustion and heat stroke. *EMedicine Journal*, 2 (6). Available at www.emedicine.com.

Phillips, T. (2001). Hypothermia. *EMedicine Journal*, 2 (10). Available at www.emedicine.com.

Rosen, P. (ed.) (1998). *Emergency medicine*: *Concepts and clinical practice*, 4th ed. Mosby.

B. **Definitions of Keywords**:

Radiation—Heat loss or gain by radiation occurs when a difference between body temperature and ambient temperature exists. The body absorbs heat when the ambient temperature exceeds body temperature; the body releases heat to the environment when body temperature exceeds ambient temperature.

Conduction—Heat loss or gain by conduction occurs when the body comes into direct contact with an object that is colder or hotter than body temperature. The body gains heat when the object temperature exceeds body temperature; the body loses heat when body temperature exceeds the temperature of the object.

Convection—Heat loss by convection occurs when either air or water moves across the patient. Heat loss is accelerated by increasing air movement, such as created by wind and rotor wash.

Evaporation—With heat loss through evaporation, water on the body's surface is converted from a liquid state to a gaseous state. This process occurs naturally through the lungs, upper airway, and skin. Evaporation increases when the patient is wearing damp clothing or has nonintact skin from burns or various skin lesions.

Hypothermia—defined as a core body temperature of less than 35 degrees C

Hyperthermia—defined as a core body temperature of greater than 38 degrees C

C. <u>**Test Questions**</u>:

1. Hypothermia patients may have hypovolemia due to cold diuresis by hypothermic kidneys.

   a. True
   b. False

2. In the severely hypothermic patient, IV medications and defibrillation are effective treatment modalities.

   a. True
   b. False

3. If active external rewarming (AER) techniques are used, the heat source should be applied to the thorax only, while the extremities are left vasoconstricted.

   a. True
   b. False

4. You are transporting a severely hypothermic patient from a rural emergency department. Appropriate active core rewarming methods for transport via helicopter include:

   a. Heated, humidified oxygen
   b. Heated irrigation of the pleural cavities
   c. Extracorporeal blood rewarming
   d. None of the above

5. You are called to transport a 28-year-old marathon runner for hyperthermia. On arrival, you find the patient awake, but lethargic. He is sweating profusely and his core body temperature is 39 degrees C. This patient is most likely suffering from:

   a. Heat cramps
   b. Heat exhaustion
   c. Heat stroke
   d. None of the above

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- BLS airway skills, endotracheal intubation, defibrillation, core temperature monitoring, cardiac monitoring, cooling measures, and warming measures.

F. **Patient Care Hours**: N/A

MODULE 22: RESTRAINT AND CARE WITHIN A CONFINED SPACE

Author: Ms. Jacqueline C. Stocking, RN, MSN, CEN, CFRN, FP-C, EMT-P/CEP/LP, Director of Clinical Education and Outreach, Critical Air Medicine, Austin, TX

Reviewers: Mr. Paul Marcolini, CEP, Program Coordinator, LifeFlight of Maine, Lewiston, Maine
Dr. Debra Perina, University of Virginia, Pegasus Flight Operations, Charlottesville, Virginia

KEYWORDS

Pharmacological restraint
Physical restraint

OBJECTIVES

Upon completion of this module, the student will be able to:

- List 4 physical conditions that may precipitate violent behavior in air medical transport
- List 4 indications when physical restraint of the patient may be necessary prior to transport
- Demonstrate proper physical restraining techniques to be used with combative or potentially combative patients
- Discuss the indications, risks and potential complications for pharmacological restraints
- Describe the circumstances under which air transport of a combative patient is inappropriate

INTRODUCTION

Transport of combative or potentially combative patients poses a significant risk to air crew member (ACM) safety. Under the best conditions, transport of combative or potentially combative patients can be stressful for ACMs. Under the worst conditions, it can be deadly. This module will discuss restraint and care of combative or potentially combative patients within a confined space at altitude. Pre-transport stabilization and patient care en route for special patient populations who are likely to require pharmacological or physical restraint to ensure safe transport will also be addressed. Indications and techniques for pharmacological and physical restraint prior to flight will be discussed, in addition to appropriate management of the patient who becomes combative in flight. Finally, circumstances under which air transport of a combative patient is inappropriate will be discussed.

PRE-TRANSPORT STABILIZATION

Predictors of Violent or Combative Behavior

The astute ACM is able to recognize situations or diagnoses that increase a patient's potential for combative or violent behavior during transport. Positive predictors include patients with the following conditions or diagnoses:

- Psychiatric patients, especially in the presence of acute psychotic crisis (i.e., hearing voices, agitated, pacing, and excessive, repetitive, or purposeless behavior)
- Acute alcohol or drug intoxication, overdose, or withdrawal
- Toxic chemical exposure or poisoning (hydrocarbons, organophosphates, etc.)
- Organic brain syndrome, dementia, or disorientation
- Postictal states
- Prisoners, especially if there is a history of violence
- Hypoxia for any reason (profound shock, carbon monoxide poisoning, respiratory depression, ALOC, etc.)
- Patients with traumatic brain injury or other CNS insult

Often, there are aspects of the patient's history that will only be partially available to the transport crew. Every attempt should be made to ascertain the etiology or pathology resulting in behavioral abnormalities in any patient transported. This determination will assist in making the most appropriate and efficacious treatment and transport decisions. Appropriate medical treatment based on the history, physical exam, and diagnostic tests should be rendered before or in conjunction with use of pharmacological or physical restraints. In addition, all transport programs should have written policies covering the transport of combative or potentially combative patient populations. Consideration of crew, aircraft, and patient safety must be a priority.

Behavioral Clues to Potentially Violent Behavior

Numerous behavioral clues may alert the ACM to impending violent or combative behavior. These include, but are not limited to:

- Posture—defensive/angry, sitting on the edge of the bed or chair
- Speech patterns—rapid, abusive, loud, overly animated
- Motor activity—clenched fists, tightening of the jaw muscles, pacing, excessive fidgeting
- History of claustrophobia or fear of flying

Noninvasive Treatment Modalities

A patient who is calm, cooperative and oriented in a controlled hospital environment may be at risk for behavioral decompensation in the cramped and noisy aviation environment, especially if the patient feels more threatened or more out of control. ACMs must anticipate and prepare for this potential. In addition, ACMs must attempt to determine the precipitating cause of the patient's combative behavior.

The least invasive and most available means of defusing the potentially combative patient is a calm, interactive, professional demeanor on the part of the ACM. The ACM must appear calm and nonconfrontational. Once the situation is under control, the patient should be provided with a headset or other means for clear communication with the flight crew during transport. By giving the patient a means of feeling some control over the environment, the crew will be lessening the chances of worsening the patient's agitation. Physical and pharmacological restraint should be readily available if the patient becomes combative at any time. In a patient with known or extreme confinement anxiety, alternative means of transport may need to be considered. Once again, the safety of the patient, flight crew, and aircraft must be the primary concern.

Restraints

Should less invasive treatments fail to control the situation, restraints may be necessary. Restraints are pharmacological or physical means used to restrict a patient's movement or activity for their safety and the safety of those around them. Examples of situations in which restraints may be necessary include:

- Protection of the patient from self-harm
- Protection of ACMs from patient violence
- Facilitation of life-saving medical procedures in combative patients

Physical Restraints

Although numerous types of physical restraints are used by law enforcement officers, pre-hospital personnel, and hospital staff, physical restraints alone cannot ensure adequate immobilization in the extremely combative patient. Examples of restraint devices that may be appropriate for use in the flight environment include

- Manufactured rayon webbing/Velcro devices—sturdy and easily applied. Provide padding next to the patient's skin. If soiled, need to be washed and disinfected.
- Leather restraining straps—can be locked. If soiled, need to be washed and disinfected.

- Polyethylene cable ties—can cause soft tissue damage in very combative patients or if applied too tight. Must be removed by cutting. Disposable.
- Handcuffs—nylon disposable or metal. Rarely used by healthcare workers and should only be applied by professionals trained in their use.

Other restraint devices that are not appropriate for combative patients in the transport environment include:

- Gauze or kerlix
- Posey restraints
- Triangular bandages

Indications for Physical Restraint Prior to Transport

If less invasive measures to alleviate the patient's precipitating cause of combative behavior fail, the ACM must consider more invasive means to ensure patient, crew, and aircraft safety. Physical restraints may be attempted before or in conjunction with pharmacological restraints.

Proper Physical Restraining Techniques

When utilizing physical restraints, numerous precautions must be taken to prevent injury to the patient and the health care worker. First and foremost, an appropriate number of people are needed to initiate physical restraints in the combative patient. Typically, this means at least one person per limb plus a team leader. The patient must be adequately secured to the frame of the stretcher, but care must be taken to ensure that circulation to the patient's limbs is not compromised. Typically, restraints are applied with one finger's width of space between the restraint and the patient's skin. The patient's limbs must also be secured at a comfortable and natural angle to prevent joint and nerve damage, as well as unnecessary pain.

Once the restraints have been placed, the patient must be monitored closely. Frequent neurovascular checks must be assessed and documented. In addition, the ACM must ensure the patient's airway is patent. The potential for emesis with aspiration must be anticipated and guarded against. This can be accomplished by turning the patient to the side and suctioning as needed.

Pharmacological Restraints

Pharmacological restraints may be used as a primary method or as an adjunct to physical restraint or verbal de-escalation.

Indications for Pharmacological Restraints

The goal of using pharmacological restraints is to control violent or combative behavior in the acute care setting, thus preventing injury to the patient of the ACMs.

Risks and Potential Complications of Pharmacological Restraints

All pharmacological restraints are associated with some form of risk or potential complications. Disadvantages of pharmacological restraints include:

- Respiratory depression and/or loss of the gag reflex
- Need for invasive airway management and mechanical ventilation
- Occasional paradoxical reaction that results in increased agitation
- Limited neurological and physical examination while sedated

Types of Pharmacological Restraints

Numerous pharmacological agents are available for use. It is the responsibility of the individual air medical program to determine appropriate protocols for use.

- **Antipsychotic**: There are several classes of antipsychotics This discussion will focus on the phenothiazines, specifically chlorpromazine, and the butyrophenones, haloperidol and droperidol.

    - ***Chlorpromazine***: 5–10 mg IV. Time of onset is 10–15 minutes. Side effects include hypotension, making it less favorable in the air medical transport environment.
    - ***Haloperidol:*** 2–5 mg IM or IV (2 mg in the elderly)—may repeat. Onset when given IM is 20–40 minutes; onset when given IV is 10–15 minutes. The predominant side effect is acute dystonia, which can be relieved with diphenhydramine, 25–50 mg IM or IV. Rarely, neuroleptic malignant syndrome may result.
    - ***Droperidol***: 2.5–5 mg IM or IV, titrated to effect—may repeat. Onset when given IM or IV is 3–10 minutes. Major side effects include respiratory depression, tachycardia and hypotension (usually transient, will respond to IVF bolus), restlessness/internal turmoil with external calmness, and extrapyramidal reactions (which will respond to diphenhydramine 25–50 mg IV or IM).

- **Benzodiazepines**

  - ***Diazepam***: 2–10 mg IV. Onset is 5–20 minutes; duration is 15–60 minutes. May cause respiratory depression or arrest, especially if give too rapidly.
  - ***Midazolam***: 1–3 mg IV. Onset is 2–5 minutes; duration is 15 minutes or less. May cause respiratory depression or arrest, especially if give too rapidly. May cause hypotension in elderly patients in higher doses.
  - ***Lorazepam***: 1–3 mg IM or IV (reduce dose in the elderly). Onset when given IM is 15–30 minutes; onset when given IV is 5–10 minutes. Rapid administration may result in apnea, bradycardia, or hypotension.

- **Narcotics**

  - ***Morphine sulfate***: 2–10 mg IV. Onset is almost immediate. Side effects include histamine-induced vasodilation and hypotension. May cause respiratory depression.
  - ***Fentanyl***: 1–2 mcg/kg IV or IM. Onset when given IM is 7–15 minutes; onset when given IV is 1–2 minutes. Side effects include bradycardia (reversible with atropine), truncal rigidity (reversible with narcan), and respiratory depression.

- **Neuromuscular Blockade Agents**: It is important to note that use of these agents mandates invasive airway management and mechanical ventilation.

  - ***Succinylcholine***: 0.6–1.5 mg/kg IM or IV (1–2 mg/kg in peds). Onset when given IM is 2–3 minutes; duration is 10–30 minutes. Onset when given IV is 30–60 seconds; duration is 4–10 minutes. Major side effects of this depolarizing agent include hyperkalemia and rhabdomyolysis.
  - ***Rocuronium bromide***: 0.6–1.0 mg/kg. Onset when given IV is 1 minute; duration is 30 minutes. Major side effects of the nondepolarizing agent include prolonged paralysis (less so than with vecuronium bromide) and tachycardia (which is usually transient and will respond to beta blockers if persistent).
  - ***Vecuronium bromide***: 0.08–0.1 mg/kg IV bolus. Maintenance dose is 0.01 mg/kg given every 20 minutes. Onset is within 1 minute; duration is 25–40 minutes. Major side effects of this nondepolarizing agent include prolonged paralysis.

<u>*NOTE</u>: All neuromuscular blockade agents should be administered with extreme caution. Respiratory assistance is mandatory when these agents are used. In the conscious patient, these agents must always be used in conjunction with sedation. In cases where the patient may be in pain, concurrent use of both sedation and narcotic analgesia is indicated.

PATIENT CARE EN ROUTE

Control Environmental Stimulation

As mentioned earlier, environmental stimulation associated with air medical transport can increase agitation in the combative or psychotic patient. Thus, the ACM must take steps to try to reduce environmental stimulation for the patient. Such steps may include:

- Do not load or unload while the engine and/or blades are still running, unless absolutely necessary for patient care.
- Speak in a calm and reassuring tone; keep mannerisms deliberate and unhurried.
- Provide ear protection for the patient. Use a headset, if available.
- Do not invade the patient's personal space, if at all possible. If it is necessary to invade the patient's personal space, do so in a calm, slow manner.

Management of the Patient Who Becomes Combative in Flight

It is not always possible to predict with 100 percent accuracy which patients will become combative, and at what point in time. If there is any doubt in the ACMs mind about whether a transport can be safely accomplished, the patient should <u>not</u> be flown and should be transported by some other means. This point cannot be overemphasized! **DO NOT** let convenience or peer pressure affect good judgment!

If a patient suddenly becomes combative in flight and cannot be safely subdued, the aircraft should be landed immediately. Dispatch should be notified. Law enforcement and alternate ground transportation may need to be called. When in doubt, do not fly!

CIRCUMSTANCES UNDER WHICH AIR TRANSPORT IS INAPPROPRIATE

Air transportation is inappropriate in any of the following circumstances:

- The patient cannot be safely subdued
- The ACM feels transport by air would endanger the patient, the crew, or the aircraft

SUMMARY

Pre-transport stabilization and patient care en route for special patient populations who are likely to require pharmacological or physical restraint can be extremely stressful, even under the best of conditions. The skill and knowledge of the ACM regarding care of potentially combative patients in the transport environment will contribute significantly to the safety of the patient, the crew, and the aircraft during these encounters. A solid knowledge base regarding special patient populations, pharmacological and physical restraints, and safety in the air medical transport environment is paramount. In addition, each program, under direction of the medical director, must develop written protocols addressing safe transport of combative or potentially combative patients. Such protocols should address the use of pharmacological and physical restraints as well as situations in which the ACM may refuse such transports.

A. **Bibliography**:

Air and Surface Transport Nurses Association (2001). *Position paper on patient restraint*. Available at: www.astna.org.

Blanchard, J. & Curtis, K. (1999). Violence in the emergency department. *Emergency Medicine Clinics of North America*, 17(3).

Brauer, K. & Hutton, K. (1997). Use of restraints in air medical transport: A survey. *Air Medical Journal*, 16(4), 105–107.

Eastes, L. (1988). The combative patient. *Air Medical Crew National Standard Curriculum*. ASHBEAMS.

Hill, S. & Petit, J. (2000). The violent patient. *Emergency Medicine Clinics of North America*, 18(2).

McMullen, P., Carlton, F., Summers, R., Deschamp, C., & Galli, R. (1999). The use of chemical restraint in helicopter transport. *Air Medical Journal*, 18(4), 136–139.

Rosen, C. et al. (1997). The efficacy of intravenous droperidol in the prehospital setting. *Journal of Emergency Medicine*, 15, 3–17.

Wigder, H. & Matthews, M. (2001). Restraints. *EMedicine Journal*; 2(8).

B. **<u>Definitions of Keywords</u>**:

Pharmacological restraint—Drug therapy used to restrict a patient's movement or activity

Physical restraint—Mechanical devices used to restrict a patient's movement or activity

C. **<u>Test Questions</u>**:

1. You are called to a rural emergency department to transport a 23 year-old patient from a motorcycle collision. The patient has a possible liver laceration, a GCS of 8, and he is trying to remove his oxygen mask and his spinal precautions. You anticipate:

   a. Refusing the transport
   b. **Considering the need for sedation, neuromuscular blockade, and endotracheal intubation**
   c. Completing a primary and detailed assessment and calling medical control for direction
   d. Completing a primary and detailed assessment after loading the patient into the helicopter

2. Which of the following is <u>not</u> a predictor of a potential for violent behavior?

   a. Talking in a loud, abusive tone
   b. **Wringing one's hands with worry**
   c. Sitting on the edge of the bed or chair with arms crossed
   d. Clenching one's jaw repeatedly while refusing to make eye contact

3. You are called to a rural emergency department to transport a possible PCP patient who is violent and suicidal. On arrival, you assess the patient and feel you cannot safely transport him in the aircraft. Your partner disagrees and wants to attempt the transfer. What should you do?

   a. Go ahead and do the flight, your partner probably knows best
   b. Ask the pilot what she thinks you should do
   c. Refuse to do the flight, your partner is just being antagonistic
   d. **Contact medical control and consider transporting by ground**

4. Which of the following physical restraint devices is appropriate in the air medical transport environment?

   a. Gauze or kerlix
   b. Posey vest
   c. Triangular bandages
   d. **Webbing and Velcro soft restraints**

5. Possible complications of pharmacological restraints include:

   a. Respiratory depression
   b. Paradoxical increased agitation
   c. Limited neurological examination
   d. **All of the above**

B. **<u>Didactic Hours</u>**: 1

C. **<u>Skills Hours</u>**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Application of physical restraints, de-escalation techniques

F. **<u>Patient Care Hours</u>**: N/A

CHAPTER 7: TRAUMATIC INJURIES

Module 23: Mechanism of Injury: Blunt Force/Penetrating Injuries

Module 24: Orthopedic Trauma: Amputations and Deformities

Module 25: Burns: Thermal/Chemical/Electrical

Module 26: Head, Neck, and Facial Trauma

Module 27: Thoracic Trauma

Module 28: Abdominal Trauma

MODULE 23: MECHANISM OF INJURY: BLUNT FORCE/PENETRATING INJURIES

Author: Dr. Kenneth J. Robinson, FACEP, Hartford Hospital, CT

Reviewer: Mr. David Kearns, ASTNA, Lakewood, CO

KEYWORDS

Blunt trauma
Penetrating trauma
Velocity
Kinetic energy
Acceleration
Deceleration
Compression
Shear
Over-pressure
Cavitation

OBJECTIVES

Upon completion of this module, the student should be able to:

- Discuss Newton's Laws of energy and motion, and how they relate to the injured patient
- Describe the wounds resulting from low, medium and high-energy weapons
- Define "shearing" force and list the organs most affected by this injury
- List the three impacts that an adult pedestrian sustains when hit by a motor vehicle
- Describe the different forces and types of blunt trauma

INTRODUCTION

An accurate history is vital to the care of the trauma patient. Details of the event can significantly enhance prediction and identification of injuries. Understanding the laws of motion and energy and how they affect the human body during a traumatic injury can assist the air medical provider in anticipating the nature and type of both primary and secondary injuries. In addition to understanding the transfer of energy, the forces of trauma must also be understood.

ENERGY AND MOTION LAWS

Traumatic injuries result from a transfer of energy. This transfer of energy occurs between the object, weapon or vehicle, and the victim. Understanding the laws of energy and motion will assist the medical flight crew to understand the mechanisms of injury that are encountered during a trauma response. The following laws and definitions will help to explain the actions and reactions that occur during a traumatic injury or event.

Newton's Conservation of Energy Law

Energy can neither be created nor destroyed, but it can be changed in form.

Newton's First Law of Motion

An object at rest remains at rest and an object in motion remains in motion until acted upon by an outside force. The victim of a head-on motor vehicle collision continues to move until stopped by the windshield, steering wheel, restraint system or other obstacle.

Newton's Second Law of Motion

Force equals mass multiplied by acceleration or deceleration, $F = M \times A$. Force is also equal to mass multiplied by distance, $F = M \times d$. Acceleration is the change in velocity for the change in time. Therefore, the greater the velocity change, the greater the force applied to the victim. Similarly, the longer the duration of the change in velocity, the lesser the force applied to the victim. A victim going 50 mph who hits a tree receives more force than a similar victim going 20 mph. If the victim is going 50 mph and brakes to a stop over 7 seconds, less force is applied than if the victim went from 50 mph to an immediate stop, as would happen if the victim hit a tree.

Kinetic Energy Definition

Kinetic energy is equal to the mass of an object in motion multiplied by the square of the velocity of the object and divided by two, $KE = (M \times V^2)/2$. Kinetic energy increases exponentially as velocity increases. The faster a victim is moving, the greater the amount of energy that will be delivered to the body in a deceleration or collision. An increase of a car's speed from 50 mph to 70 mph (40 percent increase) doubles the kinetic energy (100 percent increase).

The injury that is sustained by a patient is determined by the amount and speed of the energy transmission, the surface area over which the energy is applied, the amount of time over which the energy is delivered and the elastic properties of the tissue to which the energy is delivered.

BLUNT TRAUMA

Types of Forces

Three different forces of trauma can cause injury to the body: compression, shear and overpressure. When tissue is caught between two solid objects and compressed, the affected cells are compressed and crushed. Shearing occurs at the site of organ or tissue attachment. In a deceleration, the organ or tissue and the structure to which it is attached can move at different velocities. This results in the organ being torn from the supporting structures. Structures commonly affected by shearing forces are the aorta, spleen and gravid uterus. Overpressure results when a structure is compressed at a rate greater than that of the surrounding tissue. This results in expansion of the compressed tissue or structure into the surrounding tissue. An example of this is blunt abdominal trauma that results in a diaphragmatic herniation.

Types of Blunt Trauma

- **Motor Vehicle Collisions**

    - ***Frontal Impact***—Frontal impact collisions result in the vehicle stopping abruptly. The unrestrained occupant continues at the initial velocity until stopped by the dashboard, windshield or the ground. The kinetic energy developed while moving is then delivered to the occupant.

      There are two courses the unrestrained occupant of a frontal impact collision can take: the down-and-under pathway or the up-and-over pathway. In the down-and-under pathway, the lower extremities are the initial point of contact. The resulting injuries are to the lower extremities and include foot and ankle fractures, knee dislocations, femur fractures, and posterior hip dislocations. The secondary impact of the down-and-under pathway is the skull or torso hitting the steering wheel, dashboard or windshield. This results in head injuries, cervical spine injuries, and thoracic and intra-abdominal injuries.

    - ***Lateral Impact***—Lateral impact collisions involve many different forces, including compression, torque, distraction and shear. The compression forces result in injuries on the side of the impact. The driver hit on the driver's side is more likely to sustain injuries to his left extremities and left side of his abdomen and thorax. As the impact occurs, the head and neck may rotate and the head is accelerated away from the side of impact. This can result in cervical spine injuries and neurological trauma.

- ***Rear Impact***—Rear impact collisions often occur when a vehicle is at a complete stop and is struck from behind. The vehicle and the occupant are accelerated forward. If the head is not properly supported**,** this mechanism can result in a hyperextension of the cervical spine. Lower spine injuries can also result from this mechanism.

- ***Rollover***—A rollover can result in compression and shearing forces. The unrestrained occupant can impact many different parts of the vehicle interior and can tumble violently within the passenger compartment.

- ***Rotational***—Rotational impacts are also known as off-center collisions. The missile vehicle hits the target vehicle and as a result of the impact, the missile vehicle spins. This results in compression, rotational, and shearing forces. The injuries sustained are similar to those in the side impact collision and the rear impact collision.

- ***Pedestrian Collisions***—There are three impacts that a pedestrian sustains when hit by a vehicle. The initial impact of a vehicle striking an adult pedestrian is to the lower extremities and can result in fractured extremities. The second impact occurs if the pedestrian rolls onto the hood or is thrown into the windshield of the vehicle. This can result in injuries to the abdomen, pelvis, chest and back. The third impact occurs if the pedestrian falls off the vehicle or is thrown to the ground. This impact can produce head and neck injuries as well as compression injuries to the organs. This group of injuries is known as Waddel's Triad.

- ***Motorcycle Collisions***—There are four types of motorcycle collisions: frontal, lateral, ejection and "laying the bike down". The **frontal collision** usually results in head, neck, chest, abdomen and sometimes femur injuries. The **lateral or angular collision** more often causes lower extremity injuries, but can also result in chest and abdominal trauma. If a rider is ejected from the motorcycle, he becomes a missile and hits the ground or other object with the same energy as when he was moving. **Ejection collisions** can result in more serious injuries. To avoid collision, motorcyclists may often **"lay the bike down**". This acts to slow the motorcycle and separate the rider from the bike. Lower extremity soft tissue injuries are common with this mechanism, but any injury can result.

- ***Falls***—The height of the fall, the material onto which the victim fell, and the part of the body that hit the ground first determines the type and severity of the injury. Falls from greater than three times the victim's height are considered severe. If a victim lands on his or her feet, there is a greater chance for a deceleration injury to an internal organ than if the victim lands directly on his back.

- ***Blasts***—Blast injuries are classified as primary, secondary and tertiary. The **primary blast** injuries result from the pressure waves of the blast. Gas-filled or hollow organs are the most susceptible. This may result in tympanic membrane rupture, pulmonary contusion, pneumothorax, air embolus, intraocular hemorrhage and intestinal rupture. The **secondary injury** results from objects that become airborne and strike the individual. The **tertiary blast** injuries occur when the individual is thrown against a solid object or to the ground.

PENETRATING TRAUMA

Weapons that cause penetrating injuries are classified by the amount of energy of the missile. Low energy weapons are hand-driven weapons such as a knife. Medium energy weapons include handguns and some small rifles. High-energy weapons are hunting rifles and assault rifles.

Energy

The energy of the weapon, in part, determines the wound. Low energy weapons transfer less kinetic energy to the tissue they impact. These wounds will have a permanent cavity, but due to the low energy they are not associated with a temporary cavity. Medium energy weapons have both a permanent and temporary cavity. The cavity of these weapons is usually three to six times the diameter of the missile. The high-energy weapons create a permanent cavity and a substantial temporary cavity. The cavity is so great that a vacuum is created and can result in debris being pulled into the wound.

Determination of the Wound

The factors that influence the shape and extent of the wound are the shape of the missile, the angle of the missile at impact, whether there were missile fragments, and the density of the tissue that the missile impacts.

Cavitation

Cavitation is the defect in tissue that results from the impact of a missile. There are two types of cavitation, permanent and temporary. The permanent cavity results from the force of the missile itself as it passes through the tissue. This cavity is evident when the patient is examined. The temporary cavity results from the shock waves created by the missile as it passes through the tissue. The temporary cavity exists for only a fraction of a second and is not visible during examination or exploration.

SUMMARY

The human body is very resilient, but when impacted by blunt force or penetrating trauma, the results can be devastating. The air medical provider who understands the mechanisms of injury, the forces that impact the victim and the laws of nature that govern motion and the transfer of energy will recognize even the more subtle signs of a traumatic injury. Assessing not only the patient but also the incident scene and mechanism of injury will provide the air medical team with crucial information that may improve morbidity and decrease mortality.

A. **Bibliography**:

Biomechanics of injury. In: *Advanced Trauma Life Support Program for Doctors*. Chicago, Il, American College of Surgeons, 1997, pp. 417–437.

Gin-Shaw, S.L., Jorden, R.C.: Multiple trauma. In: Rosen, P., et al (eds.): *Emergency Medicine—Concepts and Clinical Practice*. St. Louis, Mosby, 1997, pp. 352–355.

Hollerman, J.J., Fackler, M.L.: Wound ballistics. In: Tintinalli, J.E., Ruiz, E., Krome,R.L. (eds.): *Emergency Medicine—A Comprehensive Study Guide*. New York, McGraw-Hill, 1996, pp. 1196–1203.

McSwain, N.E.: Kinematics of trauma. In: Mattox, K.L., Feliciano, D.V., Moore, E.E. (eds.): *Trauma.* New York, New York, McGraw-Hill, 1999, pp. 127–151.

Multiple trauma. In: *Flight Nursing Core Curriculum*. Parkridge, Il, National Flight Nurses Association, 1997, pp. 213–220.

B. **Definitions of Keywords**:

Blunt trauma—Trauma caused by something not sharp, such as a motor vehicle collision, a bicycle accident, a fall, or being struck with a dull object

Penetrating trauma—Trauma caused by a sharp object that results in the object entering the body or disrupting the integrity of the skin, such as a gunshot wound or a stab wound

Velocity—The change in distance per time

Kinetic Energy—The energy of a body with respect to the motion of that body (KE = (M x V^2)/2, M = mass, V = velocity)

Acceleration—The positive change in velocity per time

Deceleration—The negative change in velocity per time

Compression—The act of being forced into less space

Shear—The resultant force on two objects when they are attached but moving at different velocities

Over-pressure—The compressing of a structure at a rate greater than that of the surrounding tissue

Cavitation—The defect in tissue that results from the impact of a missile

C. <u>**Test Questions**</u>:

1. The greater the velocity change in an accident, the greater the amount of kinetic energy delivered to the victim.

   a. **True**
   b. False

2. A diaphragmatic herniation often results from which of the following types of forces?

   a. Compression
   b. Shearing
   c. **Overpressure**
   d. Cavitation

3. Off-center collisions result in all of the following forces except:

   a. Shearing
   b. Rotational
   c. **Vertical**
   d. Compression

4. Waddel's Triad describes injuries occurring when?

   a. Motorcycle collisions
   b. Car vs. truck collisions
   c. **Car-pedestrian collisions**
   d. None of the above.

5. What is one of the courses that an unrestrained occupant in a front-end collision can take?

   a. Down and out
   b. Over and out
   c. **Up and over**
   d. Up and out

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Review of trauma related CXRs, CT and MRI scans; review
- Discussion of trauma case scenarios

F. **Patient Care Hours**: 36 Medical/Surgical/Trauma ICU

MODULE 24: ORTHOPEDIC TRAUMA: AMPUTATIONS AND DEFORMITIES

Author: Dr. Kenneth J. Robinson, FACEP, Hartford Hospital, Hartford, CT

Reviewer: Mr. David Kearns, ASTNA, Lakewood, CO

KEYWORDS

Rhabdomyolysis
Compartment syndrome
Ecchymosis
Pneumatic anti-shock garment (PASG)
Traction
Splinting

OBJECTIVES

Upon completion of this module, the student should be able to:

- Discuss the incidence and treatment priority of orthopedic injuries
- Describe 3 serious complications of traumatic orthopedic injuries
- Describe the components of the orthopedic physical exam
- Complete a history on a suspected orthopedic trauma patient
- Demonstrate proper techniques for extremity splinting of fractures and joints, application of the pneumatic anti-shock garment (PASG), and initiation of extremity traction

INTRODUCTION

Musculoskeletal injuries occur in 85 percent of the victims of blunt trauma. Orthopedic injuries are often a low priority during the evaluation and transport of patients with multisystem trauma. They are rarely a threat to life, but they are a threat to limb and limb function. Proper identification and immobilization are essential.

There are many serious complications associated with orthopedic injuries. Fractures of large bones, especially the femur, can result in significant blood loss and shock. Extensive crush injuries can result in rhabdomyolysis and potential renal failure. A compartment syndrome, which can result from a crush injury or edema, can result in neurologic and vascular damage to the affected extremity. Major musculoskeletal injuries indicate significant force delivered to the body. The presence of an upper and lower extremity injury increases the chance for an abdominal or thoracic injury.

PHYSICAL EXAM

In the pre-hospital setting the physical exam or initial survey often precedes the history. When assessing and managing the airway, breathing and circulation, orthopedic injuries may need to be emergently managed because of their high risk of significant bleeding. It is essential that this hemorrhage be recognized and controlled during this initial evaluation. Control of the hemorrhage is usually with direct pressure.

Life threatening injuries are identified first and addressed. After this evaluation, a search for limb threatening injuries should occur.

Visualize

- Deformity
- Edema
- Color and perfusion
- Open wounds

Palpate

- Distal pulses
- Capillary refill
- Crepitus

HISTORY

The incident history and mechanism of injury are important to help predict occult injuries and to properly care for the patient. In addition to the customary history questions asked of all EMS victims or patients, there are particular questions that must be asked that pertain specifically to each incident.

Event of Accident or Injury

- **Motor vehicle collision**
    - Driver/passenger position in vehicle
    - Speed of vehicle
    - Damage to vehicle, type, intrusion
    - Direction of impact
    - Type/use of passenger restraints
    - Object or type of vehicle collided with

- **Fall**
    - Height
    - Surface
    - Part of body that made impact first

- **Medical history**
    - Patient age
    - Medical problems/disabilities
    - Medications
    - Allergies
    - Ingestion of ethanol and/or drugs

MANAGEMENT PRINCIPLES

Life threatening injuries should be sought and addressed during evaluation of the airway, breathing and circulation. These would include, but are not limited to, control of significant hemorrhage and the management of penetrating or blunt force trauma injuries impacting oxygen delivery or circulation. Limb threatening injuries are then managed. After more important resuscitation has been initiated, the injured extremity should be immobilized and splinted. Fractures should be splinted with some effort toward realignment of the extremity while dislocated joints should be splinted in the position in which they are found. Pain management should be considered, especially with the increased movement, longer transport times, and altitude changes experienced by patients transported by air.

Goals of Effective Splinting

- Immobilization of extremity
- Pain reduction
- Reduction of neuro-vascular trauma secondary to excessive movement
- Control of blood loss

Splinting Technique

- The joint above and below the fracture should be immobilized
- The skin should be padded to prevent pressure on the area
- Splint should be secured with circumferential wrapping
- Wrapping should provide immobilization but not be so tight as to impede vascular flow

MANAGEMENT OF SPECIFIC INJURIES

Unstable Pelvis Fracture

An unstable pelvis fracture can result in significant blood loss and shock. The bone fractures may disrupt large blood vessels or the pelvic venous plexus.

Unstable pelvic fractures with hemorrhage are manifested by hypotension, instability of the pelvis, and ecchymosis or edema of the perineal area, scrotum, or flank.

Management of an unstable pelvis fracture includes aggressive fluid resuscitation and immobilization to control the bleeding. Pre-hospital immobilization can be accomplished with the pneumatic anti-shock garment (PASG).

Major Arterial Hemorrhage

Vascular disruption can result from extremity trauma if there are penetrating bone fragments or if the artery is close to a dislocated joint. Significant blood loss from the wound or into the surrounding tissue and loss of distal pulses are evidence of major arterial hemorrhage.

Management consists of direct pressure to the wound to control the hemorrhage and aggressive fluid resuscitation.

Femur Fracture

Femur fractures can result in significant hemorrhage. Signs of a femur fracture are thigh deformity, edema and leg shortening.

A traction splint should be applied to the affected limb, which helps to realign the femur and thereby acts to reduce the blood loss and minimizes the secondary soft tissue damage.

Traumatic Amputation

Current practice in the management of traumatic amputations is focused on reduction of blood loss, stabilization of the exposed body part, pain management, and recovery of the amputated part. Whenever possible, the amputated part should be wrapped with clean, dry, drapes and transported in a cool environment. Placing the wrapped, amputated part in an insulated cooler alongside, but not in direct contact with, ice, is preferable. Local or regional protocols should be followed to optimize the chances for successful reattachment. The air medical program should consult with the trauma surgeon or re-plantation specialist to determine best practice and policy given the resources of an individual community or trauma system.

SUMMARY

Although musculoskeletal injuries occur in 85 percent of the victims of blunt trauma, these injuries are usually a low priority. That doesn't mean however, that they are not without risk. Significant hemorrhage, swelling, and resulting tissue damage can occur if these injuries are not assessed and triaged appropriately. The air medical provider must also understand the effect of altitude on patients' injuries and overall well-being.

A. **Bibliography**:

Magnusson, A.R.: Orthopedic injuries: management principles. In: Rosen P, et al (eds.): *Emergency Medicine—Concepts and Clinical Practice*. St. Louis, Mosby, 1997, pp. 617–619.

Menkes, J.S.: Early management of fractures and dislocations. In: Tintinalli, J.E., Ruiz, E., Krome, R.L. (eds.): *Emergency Medicine—A Comprehensive Study Guide*. New York, McGraw-Hill, 1996, pp. 1205–1216.

Musculoskeletal trauma. In: *Advanced Trauma Life Support Program for Doctors*. Chicago, Il, American College of Surgeons, 1997, pp. 301–319.

Musculoskeletal trauma. In: *Flight Nursing Core Curriculum*. Parkridge, Il. National Flight Nurses Association, 1997, pp. 227–245

B. **Definitions of Keywords**:

Rhabdomyolysis—Breakdown of muscle tissue

Compartment syndrome—Pain, pallor, paresthesia and paralysis of an extremity caused by the compromise of blood flow through muscle and nerve capillaries that results from an increase of pressure within a closed tissue space

Ecchymosis—The bruising of the skin caused by release of blood into the tissue

Pneumatic anti-shock garment (PASG)—A multichambered, inflatable device that resembles trousers. It is applied around the patient's lower extremities and abdomen, and the chambers can be individually inflated to apply pressure to specific areas or to help maintain stability

Traction—The force applied to a fractured bone by pulling in line to maintain stability

Splinting—The application of a rigid support to a fractured bone to maintain stability

C. **Test Questions**:

1. All of the following are serious complications associated with orthopedic injuries except:

    a. Significant blood loss
    b. Rhabdomyolysis
    c. **Diabetic ketoacidosis**
    d. Compartment syndrome

2. The first step in management of a victim with a secure airway and significant orthopedic injuries is:

    a. Splinting
    b. **Control hemorrhage**
    c. Secure patient to long-spine board
    d. Intravenous antibiotics

3. All of the following are potential signs of an orthopedic injury except:

    a. Deformity
    b. Edema
    c. Ecchymosis
    d. **All are possible indications of an injury**

4. Which is not a goal of effective splinting?

    a. Pain reduction
    b. **Restriction of blood flow to extremity**
    c. Immobilization
    d. Control blood loss

5. Signs of an unstable pelvic fracture include:

    a. Hypotension
    b. Perineal ecchymosis
    c. Pelvic instability
    d. **All of the above**

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Splinting
- Application of PASG
- Conduct training with "real" patients, not mannequins, as this will provide immediate feedback to the air medical crew regarding patient comfort and security

F. **Patient Care Hours**: 8, on orthopedic or trauma floor

MODULE 25: BURNS: THERMAL/CHEMICAL/ELECTRICAL

Author: Dr. Kenneth J. Robinson, Hartford Hospital, Hartford, CT

Reviewer: Mr. John R. Lunde, RN, MSN, CRNP, CFRN, NREMT-P, Clinical Director, Emory Flight, Griffin, Georgia

KEY WORDS

Burn classification
Thermal burns
Chemical burns
Electrical burns

OBJECTIVES

Upon completion of this module the participant should be able to:

- Estimate the degree and size of a burn
- Describe the indications for transfer to a burn center
- Calculate the proper fluid resuscitation of a burn victim
- Describe the differences in management of a thermal burn, chemical burn and electrical burn patient
- Identify the injuries associated with electrical burns

INTRODUCTION

There are three primary types of burn patients that the air medical provider may encounter: thermal, chemical and electrical. It is important for the provider to ascertain the cause of the burn, the extent of the burn, and the severity of the burn. Once this information is known, treatment, triage, and transport decisions can be made more appropriately.

THERMAL BURNS

Between 1.2 and 2 million people are burned in the U.S. each year. The majority of these burns are minor, but up to 60,000 people sustain moderate to severe burns that require hospitalization. Five percent of the hospitalized patients die as a result of their burn injuries.

Burn Categorization

- **Depth**
    - First degree
        - Minor epithelial damage
        - Redness, pain, tenderness

- Second degree
  - Superficial partial thickness—involves the epidermis and superficial dermis
  - Deep partial thickness—involves deeper layers of the dermis; damages hair follicles and sweat glands
  - Skin appears pink, moist, and extremely tender to blistered and charred
- Third degree
  - Full thickness
  - Involves epidermis and dermis down to the subcutaneous fat
  - All epidermal and dermal layers are destroyed
  - Skin is pale, "leathery", painless, and charred
- Fourth degree
  - Through skin and involving the underlying tissue, muscle, bone, and fat
  - Potentially life threatening injuries

- *Body Surface Area*

  The total body surface area (TBSA) involved in a burn is estimated using the "rule of nines". This method of body surface estimation differs slightly for an infant. Alternatively, the patient's palmar surface (palm plus fingers) represents approximately 1 percent of the total body surface area. Surface area can also be estimated using the Lund and Browder chart.

- Rule of Nines—adult

Head and neck	9 percent
Upper extremity (each)	9 percent
Anterior trunk	18 percent
Posterior trunk	18 percent
Lower extremity (each)	18 percent
Perineum/genitalia	1 percent

- Rule of Nines—child

Head and neck	18 percent
Upper extremity (each)	9 percent
Anterior trunk	18 percent
Posterior trunk	18 percent
Lower extremity (each)	14 percent
Perineum/genitalia	1 percent

- ***American Burn Association Classification of Burns***

  - Minor Burns
    - TBSA < 15 percent in 10- to 50-year-old age group
    - 10 percent TBSA in children less than 10 or adults older than 50
  - Moderate Burns
    - Partial thickness, 15–25 percent TBSA in 10- to 50-year-old age group
    - Partial thickness, 10–20 percent TBSA in children less than 10 or adults older than 50
    - Full thickness burns $\leq$ 10 percent in anyone
    - Not involving hands, feet, face, perineum or circumferential limb burn
  - Major Burns
    - Partial thickness, TBSA > 25 percent in 10- to 50-year-old age group
    - Partial thickness, TBSA > 20 percent in children less than 10 or adults older than 50
    - Full thickness burns, TBSA > 10 percent in anyone
    - Burns involving hands, feet, face, perineum
    - Burns complicated by inhalation injuries or traumatic injuries

Indications for Treatment at Designated Burn Center

- Second degree burns > 10 percent TBSA
- Full thickness burns >5 percent TBSA
- Any burn involving hands, feet, face, eyes, perineum
- High voltage electrical injury, including lightning
- Burn associated with inhalation injury or traumatic injury
- Chemical burns
- Burns in patients with significant comorbidities (diabetes mellitus, COPD, cardiac disease)

Management

- Remove patient from burning environment
- Airway assessment and management
- Any patient with evidence of airway injury of compromise should be intubated immediately. Signs of potential inhalation injury include dyspnea, hoarse voice, stridor, wheezing, facial burns, singed nares hair, carbonaceous sputum, history of confinement in a burning environment, and a carboxyhemoglobin level greater than 10 percent

- Assess breathing and circulation and perform appropriate interventions
- Remove all clothing to stop the burning process
- Intravenous fluid resuscitation
- Cover burns with clean sheets. Do not permit patient to become hypothermic
- Pain management
- Perform an emergency escharotomy on the chest if there is a full thickness, circumferential thoracic burn that restricts chest wall excursion or prevents proper oxygenation and ventilation.
- Transport to appropriate facility

Fluid Resuscitation

Lactated Ringers solution is the most commonly accepted fluid for resuscitation. Two intravenous access sites should be obtained through uninjured and unburned skin. For these formulas, fluid resuscitation time is calculated to start at the time the burn occurs.

- There are a number of estimated fluid administration rate formulae.
- The Parkland formula is the most widely used.
- Parkland Formula—4 ml/kg x TBSA burned. Half of the volume is given in the first 8 hours after the burn occurs, and the second half is given in the next 16 hours.
- Modified Brooke Army formula—2 ml/kg x TBSA burned. Half of the volume is given in the first 8 hours after the burn occurs, and the second half is given in the next 16 hours.
- Infants and children—2–4 ml/kg x TBSA burned modified to maintain a urine output of 1 ml/kg per hour.
- Galveston (pediatric)—5,000 ml/m^2 burned + 1,500 ml/m^2 total.

CHEMICAL BURNS

Chemical burns can result from products commonly found in the home, school, workplace, industrial and medical environments. There are tens of thousands of products capable of causing chemical burns. The most commonly burned sites of the body are the face, eyes and extremities.

Most chemical burns are caused by acids and alkalis. In general alkali burns are worse than acid burns. Alkalis cause liquefaction necrosis and are able to penetration to deeper tissue. Acids cause coagulation necrosis and usually develop an eschar, which limits the extent of the burn.

Chemical burns are usually smaller than thermal burns and require less aggressive fluid resuscitation, but healing times are usually longer.

TISSUE DAMAGE DETERMINATION

Tissue damage is determined by several factors, including the concentration of the agent, the duration of contact, the manner of contact, the quantity of the agent, the mechanism of action, and the extent of penetration.

HISTORY

It is important to know what the agent is and to ensure that the scene is safe before to the EMS crew enter the scene to care for the patient. If the scene is determined to be a hazmat incident, the crew should wait for the hazmat response team before proceeding any further. Patients should be decontaminated prior to being taken onboard any aircraft, and the air medical crew should refrain from entering either the hot or warm zone whenever possible. The crew should wear protective clothing at all times as a precautionary measure to prevent self-contamination. A hazmat reference text should be kept on every emergency response vehicle. This handbook should be referred to in the event of an unknown agent.

GENERAL MANAGEMENT

- The goal of chemical burn management is to minimize the extent of the irreversible tissue damage.
- The burned area should generally be irrigated with copious amounts of water, although there are a few exceptions.
- The burning process should be stopped by removing the causative agent and the affected clothing.

SPECIFIC AGENTS

Metals

- Metals should not be irrigated with water because an exothermic reaction can result.
- These agents can be smothered with a class D fire extinguisher or mineral **oil to enable removal.**

Hydrocarbons

- Decontamination with water is recommended.
- Full thickness burns can result from prolonged contact with gasoline, which is a common occurrence at the scene of a motor vehicle collision.
- In cold environments, gasoline can cause frostbite injuries secondary to its rapid evaporation.

ELECTRICAL BURNS

Electrical injuries result from the patient's body making contact with a source of electrical power. Electrical injuries account for about 1,000 deaths annually in the U.S. Most household electrocutions involve 110 V or 220 V current and result from failure to ground appliances or tools or from accidental immersion. Electrical burns are often worse than they appear because the majority of the injury is internal.

FACTORS ASSOCIATED WITH SEVERITY OF ELECTRICAL INJURIES

Current power—The greater the power, the more severe the injury.
Current intensity—The higher the amperage, the more severe the injury.
Type of current—Alternating current is more dangerous than direct current.
Resistance of tissue—The resistance of tissue, in decreasing order is bone, fat, tendons, skin, muscle, blood vessels and nerves. If the skin becomes damaged, the current is permitted easier internal flow. Skin resistance is reduced by sweat and moisture.
Duration of contact—The longer the contact, the greater the amount of electricity delivered and the greater the damage.
Surface area of contact—A small surface area can cause a more severe local injury but may limit the internal current flow.
Pathway of current through body—The tissue in the pathway of the current is at greatest risk for damage. Current passing through the thorax or head has a greater chance of causing respiratory or cardiac arrest.
Extent of multisystem involvement—Co-morbidities include traumatic injuries, neurologic, or cardiac involvement.
Circumstances surrounding the injury—Events such as the patient contacting a metallic conductor or being immersed in water further complicate the extent of injury.

ELECTRICAL INJURIES

Tissue Damage

- Tissue with the least resistance sustains the greatest damage.
- This can result in burns, vascular injuries, and muscle and neurologic damage, evidenced by the development of such conditions as rhabdomyolysis.
- The current can diffuse as it spreads through the tissue and can cause more significant internal injuries than the observable skin damage.

Cardiac and Pulmonary Damage

- Cardiopulmonary arrest can be caused by a number of different mechanisms.
- Alternating current is more likely to cause ventricular fibrillation.
- Direct current usually causes asystole.
- The electrical current may cause coronary artery spasm.
- Respiratory arrest can be caused by electrical current directly to the head, affecting the medullary respiratory center, tetanic contraction of the chest wall and diaphragm, and paralysis of the respiratory muscles.

Neurologic Damage

- Electrical current can damage the brain and the spinal cord via coagulation necrosis, demyelination and cerebral edema.
- Peripheral nerves are also at high risk for electrical injuries. The nerves are damaged directly by the current and indirectly by involvement of the surrounding tissue and blood vessels.

Renal Damage

- Renal damage can be significant as a result of an electrical injury.
- The damaged tissue releases myoglobin into the circulation. This myoglobin can cause acute renal failure.
- Extensive tissue damage can lead to significant volume loss and resulting hypovolemia and renal cortical ischemia.

MANAGEMENT

Airway

- Airway should be secured early because airway edema is a common complication.
- Facial burns may further complicate airway management, necessitating the use of advanced airway adjuncts.

Breathing

- The patient may be apneic due to CNS damage or involvement of the respiratory muscles.
- Eschar may circumferentially restrict chest wall movement, necessitating an escharotomy to allow adequate chest expansion.

Circulation

- Treat dysrhythmias with appropriate defibrillation, cardioversion, and/or medications as indicated.
- Establish aggressive fluid resuscitation.
- Maintain spinal protection and immobilization if necessary.
- Assess for traumatic injuries.
- Continue aggressive fluid resuscitation to treat potentially severe volume loss from extensive tissue involvement and to prevent renal damage. Urine output should be maintained at 1 ml/kg per hour.
- Provide burn or wound management as indicated.
- If urine is dark and does not clear with aggressive fluid resuscitation, consider urinary alkalinization with sodium bicarbonate to prevent acute tubular necrosis.
- Transport to a burn center if indicated.

SUMMARY

Although there are many types of burns, their assessment and treatment remains consistent and based on symptomology. The air medical provider must be able to thoroughly assess the patient and the scene to plan for and guard against secondary injury to the patient or to any providers on scene. Understanding the physiology of burns, the need for fluid replacement, and the prevention of heat loss is imperative for the EMS provider, who often provides care in uncontrolled and difficult environments. It is imperative that all provider levels understand the local and regional resources for burn care. The dispatcher or communication specialist must be well versed in LZ concerns surrounding any electrical burn or chemical burn site, as well as the levels of care provided at various institutions. The air medical crew must also be aware of hazardous materials scene risks and their role in rescue and recovery prior to transport of these victims.

A. **Bibliography**:

Cooper, M.A: Electrical and lightning injuries. In: Rosen P, et al (eds.): *Emergency Medicine—Concepts and Clinical Practice*. St. Louis, Mosby, 1997, pp. 1010–1020.

Edlich, R.F., Moghtader, J.C: Chemical injuries. In: Rosen, P., et al (eds.): *Emergency Medicine—Concepts and Clinical Practice*. St. Louis, Mosby, 1997, pp. 1003–1009.

Edlich, R.F., Moghtaler. J.C: Thermal burns. In: Rosen, P., et al (eds.): *Emergency Medicine—Concepts and Clinical Practice*. St. Louis, Mosby, 1997, pp. 941–953.

Fontanarosa, P.B: Electrical and lightning injuries. In: Tintinalli, J.E., Ruiz, E., Krome, R.L. (eds.): *Emergency Medicine—A Comprehensive Study Guide*. New York, McGraw-Hill, 1996, pp. 905–914.

Injuries due to burns and cold. In: *Advanced Trauma Life Support Program for Doctors*. Chicago, Il, American College of Surgeons, 1997, pp. 337–351.

Martin, M.L., Harchelroad, F.P: Chemical burns. In: Tintinalli, J.E., Ruiz, E., Krome, R.L. (eds.): *Emergency Medicine—A Comprehensive Study Guide*. New York, McGraw-Hill, 1996, pp. 899–905.

Schwartz, L.R.: Thermal burns. In: Tintinalli, J.E., Ruiz. E., Krome. R,L, (eds.): *Emergency Medicine—A Comprehensive Study Guide*. New York, McGraw-Hill, 1996, pp. 893–898.

Wolf. S.E., Herndon, D.N.: Burns and radiation injuries. In: Mattox, K.L., Feliciano, D.V., Moore, E.E. (eds.): *Trauma*. New York, New York, McGraw-Hill, 1999, pp. 1137–1152.

B. **Definitions of Keywords**:

Thermal burns—Thermal burns are caused by direct or close contact with a surface, object, or gas that is at an excessively high temperature

Burn classification—Burns are classified based on the depth of the tissue damage, the percent body surface area effected, the location of the burn (i.e. face vs. hand) and patient age

Chemical burns—Chemical burns are caused by solutions or products that are often found in the home and work place. Acids and alkalis are the most prevalent causative agents.

Electrical burns—Electrical injuries result from the patient's body making contact with a source of electrical power. In the U.S., 110 or 220 volt current is the most commonly encountered**.**

C. **Test Questions**:

1. Which of the following are hallmarks of a second-degree burn?

   a. Extremely tender
   b. Appears pink
   c. Damage to hair follicles
   d. **All of the above**

2. Which of the following are American Burn Association criteria for a major burn?

    a. Full thickness, TBSA > 10 percent
    b. Burns involving face
    c. Burn with inhalation injuries
    d. **All of the above**

3. Which of the following is NOT an indication for treatment at a burn center?

    a. Full thickness, TBSA > 5 percent
    b. Hand burns
    c. **First degree burn of back**
    d. Chemical burns

4. Using the Parkland formula, what is the proper fluid resuscitation in the first 8 hours for a 20-kg child with 25 percent total body surface area burned?

    a. 500 cc
    b. **1000 cc**
    c. 1500 cc
    d. 2000 cc

5. Which of the following factors does NOT affect the tissue damage as a result of a chemical burn?

    a. **Time of day of exposure**
    b. Duration of contact
    c. Concentration of agent
    d. Extent of penetration

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Case scenario discussion including calculation of burn area, fluid requirements, and treatment required
- Appropriate triage and transport destinations based on severity of injury

E. **Patient Care Hours**: 12–24, in burn unit or burn center

MODULE 26: HEAD, NECK, AND FACIAL TRAUMA

Author: Ms. Deborah Wilson, RN, CFRN, CCRN, CEP, LifeFlight of Maine, Lewiston, Maine

Reviewers: Mr. Glenn Susskind, RN, CEP, Erlanger Medical Center, Chattanooga, TN
Dr. Michael Duchesneau, Emergency Department, Tampa General Hospital, Tampa, FL

KEYWORDS

Rapid sequence induction
Intracranial pressure
Cerebral Blood flow
End tidal carbon dioxide monitoring
Cricothyrotomy
Retrograde intubation
High dose steroids

OBJECTIVES

Upon completion of the module the student will be able to:

- Discuss the need for airway management of the head injury patient
- Perform rapid sequence induction intubation and verbalize medications commonly used
- Discuss end-tidal carbon dioxide monitoring and the impact on head injury patients
- List priorities for in-transport treatment of patients with head injuries

INTRODUCTION

Patients with head, neck, or facial trauma require rapid assessment, treatment and triage to an appropriate facility. In addition to cervical spine immobilization, they often require the placement of advanced airway adjuncts and close monitoring of oxygenation and saturation during transport. Securing and managing the airway can be complicated and difficult in these patients, necessitating the use of rapid sequence induction. Medications are now available for use in the air medical environment to decrease spinal cord swelling. In addition to complex airway and stabilization needs, these patients are also at risk for altitude related complications.

HEAD TRAUMA

Head injuries include closed head injury, open head injury, and penetrating head injury. In treatment of closed head injury, providing maximum oxygenation and maintaining adequate cerebral blood flow are of utmost importance. Techniques of airway management in the head trauma patient include the use of rapid sequence induction intubations. Rapid sequence induction involves using a combination of analgesia, sedatives, and paralytic agents to effectively anesthetize the patient prior to intubation, making intubation a less noxious stimulus to the patient. The already neurologically compromised patient should be treated with a combination of medications to minimize the increase of intracranial pressure. The use of medications also allows the practitioner to better insert a laryngoscope and visualizes vocal cords on the patient who still has a gag reflex and may be combative, due to the head injury.

Maximizing Cerebral Blood Flow

The evidence-based *Guidelines for Prehospital Management of Traumatic Brain Injury* outline the most recent assessment, treatment, triage and transport recommendations for both children and adults. Recognizing the potential for secondary brain injury, performing the Glasgow Coma Scale (GCS) evaluation and pupillary exam early in the initial patient survey, and basing treatments on those assessment findings are the core concepts of these research findings. Once the assessment and treatment have been initiated, utilizing this patient information to determine the appropriate level of care and type of receiving facility is imperative.

Maximizing cerebral blood flow by providing normal ventilation at rates of 10–12 breaths/minute for adults, maintaining oxygen saturation above 90 percent, and maintaining or achieving a GCS score greater than 9 and a systolic blood pressure greater than 90 mmHg, for an adult, will optimize patient outcome. These threshold values of 90 mmHg, 90 SaO_2 and GCS of 9 should be the guiding principles of traumatic brain injury (TBI) management. The low-normal ventilation rates maintain oxygen saturation without decreasing the cerebral blood flow. The fluid support necessary to maintain an SBP of greater than 90 also assists in maintaining adequate blood flow to the brain. Although the cerebral perfusion pressure (CPP) is the most accurate indicator of blood flow within the brain, the SBP parallels the CPP and is readily monitored in the field or during transport.

Assessing the neurological status of a patient early in the initial assessment will provide a baseline for all subsequent evaluations. Knowing this initial and subsequent GCS scores as well as pupillary responses will alert the air medical provider to the improvement or decompensation of the patient’s condition. If a patient exhibits fixed, dilated, or unequal pupils along with extensor or decerebrate posturing, this may be an indication of impending brain herniation. In the case of suspected brain herniation, the treatment parameters change to include, in this situation only, hyperventilation of 20–24 breaths/minute for an adult, which slows the increase in intracranial pressure (ICP) until definitive treatment can be accomplished at a trauma center with TBI capabilities. The air medical crew must be diligent in the reassessment of neurological function every 5 minutes or as frequently as time permits. An increase or decrease of 2 or more points in a GCS score is a significant finding that correlates with increased or decreased morbidity and mortality.

The body's auto-regulatory system is responsible for carbon dioxide levels in the blood are indicative of cerebral blood flow; therefore, monitoring end tidal CO2 levels may be helpful in identifying changes in patient status. Patient positioning may also be an intervention useful to decrease ICP. If not contraindicated, elevating the head of the stretcher and maintaining a mid-line head position may be of some benefit. Because ICP can be affected by noise, vibration, and light, positioning the patient to eliminate or minimize noxious stimuli can also be beneficial.

Sedatives may be used both in conjunction with paralyzing agents and in the situation of increased ICP. Sedative use in the chemically paralyzed patient should be guided by patient vital sign parameters and time since last sedative.

Common Medications Used for Sedation:

Ativan	0.04–0.05 mg/kg	IV
Versed	0.3–0.35 mg/kg	IV
Morphine	0.1–0.2 mg/kg	IV
Valium	2–10 mg adult	IV

Cerebral edema can be temporarily reduced by the use of osmotic diuretics. Mannitol is a commonly used diuretic that can be administered in the air medical environment. The average dose is 1.0–1.5 grams per kilogram. Storage of Mannitol can be problematic, due to the fact that the medication can precipitate into crystal formation in temperatures below 62F. For this reason, the air medical program must have in place guidelines on the availability, storage and use of this medication specific to the climate in which the program operates.

Rapid Sequence Medications:

- **Pretreatment**

Lidocaine	*blunts ICP, decreases laryngeal spasm
Atropine	prevents reflexive bradycardia
Analgesics	decrease ICP by blunting pain response

- **Sedatives**
  Versed amnesiac and sedative
  Etomidate anesthetic
  Valium sedative

- **Anesthetic Paralytic Agents**
  Succhinycholine
  Vecuronium
  Rocuronium
  Ketamine
  Propofol
  Pavulon

<u>Rapid Sequence Induction Intubation Procedure</u>

- Assemble equipment
  - Oral airway
  - Oxygen
  - Endotracheal tube appropriate sizes
  - Bag-Valve-Mask (BVM)
  - Laryngoscope handle/blade
  - Stylet
  - Suction
- Check for secure IV line
- Connect patient to monitoring equipment and pulse oximetry
- Allow the patient to breathe 100 percent oxygen without causing gastric distention
- Select and prepare medications
- Prepare and have available alternate airway supplies
- Assign tasks
- Give medications, premedicate as necessary
- Apply cricoid pressure to prevent aspiration
- Accomplish intubation, inflate cuff, and assess for placement, adequately secure tube
- Ventilate patient as prescribed
- It is imperative to have alternate airway supplies at hand when accomplishing rapid sequence induction intubation, in the circumstance that oral intubation attempts fail. Back-up airway procedures may include:
  - Surgical cricothyrotomy
  - Needle cricothyrotomy
  - Retrograde intubation
  - Laryngeal mask airway

FACIAL INJURIES

Facial injuries may be caused by direct, blunt, soft tissue injuries such as lacerations, various degrees of fractures and /or cranial nerve injuries. Facial injuries should be assessed after initial stabilization of the patient's airway, breathing, and circulation.

Bone and Tissue Injury

Physical derangement of facial structures, accompanied by profuse bleeding, may complicate the detailed patient assessment and make securing the airway more difficult. An oxygen mask or BVM may be inadequate or ineffective depending on the structural deformities. If oral intubation is difficult to accomplish, due to obstructions or bleeding, surgical cricothyrotomy may be necessary.

If nasal fractures are suspected, any blood or obstructions should be carefully cleared away to assure a patent airway. Consideration should be given to the possibility of sinus and ethmoid communication with air. In either a nonpressurized aircraft or a pressurized aircraft, consideration must be made for adjusting the cruising altitude to avoid air trapping within these cavities. Discussing these concerns with the pilot prior to lift-off is imperative. If a gastric tube is necessary, oral insertion is the preferred method for all facial fractures.

Intraocular Injuries

Intraocular injuries should be suspected with any facial or intracranial trauma. Although not life threatening, eye injuries can leave the patient with a permanent disability. Patients with eye injuries should receive high flow oxygen to maximize tissue perfusion. In addition, these patients should be flown at lower altitudes, due to the potential for increased intraocular pressure. The patient should be instructed to avoid any maneuvers that will increase intraocular pressure, such as vomiting or valsalva maneuvers. The patient's head should be elevated and a loose bandage or eye patch put in place to prevent further movement of the eye. Objects protruding from the orbit should be protected with a cup or cone device, and the head should be immobilized to prevent further damage from the foreign object.

NECK AND CERVICAL SPINE TRAUMA

Common causes of injury to the anterior neck include both blunt and penetrating injuries. Injuries to the anterior neck may cause airway compromise and require immediate evaluation for respiratory distress and subsequent airway intervention.

Soft Tissue Injuries

Management of anterior neck injuries includes the use of humidified oxygen, elevation of the head, if not otherwise contraindicated, and continuous assessment for airway compromise.

Edema of the tissue surrounding the airway structures or within the airway itself can quickly and severely impair airway patency and oxygenation. This swelling may dictate early intervention with endotracheal intubation, although the use of a smaller than normal tube may be required. If tracheal intubation cannot be accomplished with a smaller than normal tube, the Seldinger Method of passing the endotrachial tube over a guide or tube changer may be helpful.

Laryngeal/tracheal avulsions and disruptions can be airway management challenges and may result in immediate mortality. These injuries are life threatening, and tracheal integrity must be maintained with either intubation with sealing of the trachea beyond the avulsion or occlusion of the avulsion and tracheal intubation. Clearing the airway of blood and bone fragments allows for optimum oxygenation.

Cervical Spine Injury

Cervical spine trauma should be suspected in all unconscious patients involved in a traumatic event, all pediatric trauma patients, and all injuries that have associated symptoms above the clavicles. Spinal immobilization not only maintains the integrity of the cervical spine, but also affords the patient greater safety and security in a confined space. Cervical spine immobilization must be maintained in the air medical environment, while addressing airway management concerns. Tracheal intubation may be difficult to perform while attending to cervical spine, and, if necessary, manual cervical spine immobilization can be held during intubation to allow the practitioner greater jaw flexibility than possible in a rigid collar.

Patients with high cervical injuries can initially present with adequate respiratory effort but with a significant diaphragmatic or abdominal component. These patients can deteriorate rapidly in flight and should be evaluated for early endotracheal intubation. Proficient nasal intubation skill can be useful in these and other patients in need of a rapid airway with minimal cervical manipulation and minimal equipment.

High-Dose Steroids and Cervical Spine Injury

Air medical transport affords the patient the benefit of decreased transport times. High-dose steroids can be used for the treatment of spinal cord injuries in an effort to reduce and limit swelling of the spinal cord. Early treatment reduces the amount of medication needed, and can often be initiated in the air medical environment. If used early in long distance transports from rural and inaccessible areas, high dose steroids may increase function and decrease the severity of injury.

Methlprednisolone (Solu-Medrol) is currently the most common high-dose steroid used in the treatment of cervical spine injuries. The dosage is determined by patient weight. One common treatment regime is to bolus 30 mg/kg IV over 15 minutes, followed in 45 minutes by 5.4 mg/kg/hr for 23 hours if started within 3 hours of injury. If greater than 3 hours of injury, the dosage is continued for 47 hours.

SUMMARY

Patients with head and neck injuries require rapid assessment, treatment and triage to an appropriate trauma center with TBI capabilities. Early airway intervention with normal ventilation rates, cervical spine immobilization, assessment of GCS and pupils, and adequate fluid support will assure the patient the best possible outcome. Because establishing an effective airway can be a challenge, air medical crew members must be skilled in rapid airway management and capable of utilizing many advanced airway techniques. The availability of high-dose steroids is a medical direction and policy decision, but should be considered whenever there are longer transport times and a high trauma call volume frequent re-assessment and adjustments in treatment are the key to improving morbidity and decreasing mortality for the patient with head, neck, and facial injuries.

A. **Bibliography**:

Colvin, J., Langford, S. Emonson. D. Initial Management and Transport of Patients with Perforating Eye Injuries. *Aust Family Physician* 1995 June; 24 96).

Davey, A.L., Macnab, A.J., Green, G.. Changes in PCO2 During Air Medical Transport of Children with Closed Head Injuries*. Air Medical Journal*, July 2001; 20 (4).

Letarte, P.B., Shea, J.F., Dries, D.J. Management of Head Injury in the Flight Environment. *Air Medical Journal*, 1999 Apr–June; 18 (2).

National Flight Nurses Association. *Flight Nursing Core Curriculum*, 1997

Talbert, S., Talbert, P. Summary of Strategies for Managing Severe Traumatic Brain Injury During the Early Posttraumatic Phase. *Emergency Nursing Journal*, 1998 June; 24 (3).

Gabriel. E. J., Ghajar, J., Jagoda, A., Pons, P.T., Scalea, T., Walters, B.C., et.al. *Guidelines for Prehospital Management of Traumatic Brain Injury*. Brain Trauma Foundation, NY. NHTSA, 2000

B. **Definitions of Keywords**

Rapid sequence induction—The use of a sequence of medications quickly administered to aid in the sedation, relaxation, and muscle paralysis of a patient prior to intubation

Intracranial pressure—The amount of pressure in the cranial vault. Monroe-Kelly Doctrine states when there is an increase of one component within the vault, the other components must be adjusted.

Cerebral blood flow—The amount of blood flow to the brain. Regulated by the auto-regulatory system of the body, and by the Monroe-Kelly Doctrine. A decrease of cerebral blood flow can adversely affect brain tissue.

End tidal carbon dioxide monitoring—A monitoring device that measures CO2 levels at end expiration. These levels can be correlated with PCO2 levels.

Cricothyrotomy—Incision into the trachea through the cricoid membrane

Retrograde intubation—A method of intubation in which a wire is passed through the trachea into the oral pharynx from below. The patient is then intubated over the wire.

High-dose steroids—Medications of the steroid family, which in large doses are used to treat spinal cord edema.

C. **Test Questions:**

1. In preparation for rapid sequence induction of a head injury patient, it is most important to consider:

   a. Patient's age
   b. Level of anesthesia needed to accomplish intubation
   c. **Methods to decrease ICP**
   d. Positioning of the patient's feet

2. Carbon dioxide is part of the body's auto-regulatory system and affects the:

   a. Cerebral blood flow
   b. Cellular transport of glucose
   c. Rate of respirations
   d. Systolic blood pressure

3. Your 29-year-old trauma patient has a hematoma on the right side of his neck, your most important intervention will be:

   a. Transfer the patient to a Level 1 trauma center
   b. Head to toe assessment and establishing and IV
   c. Complete and thorough documentation of the injury
   d. Thorough assessment of the airway

4. Tracheal intubation is contraindicated in cervical spine injuries.

   a. True
   b. False

5. The threshold values recommended in *Guidelines for Prehospital Management of Traumatic Brain Injury* include:

   a. CPP 90, SaO2 90, GCS 9
   b. **SBP 90, SaO2 90, GCS 9**
   c. CPP 10, SaO2 100, GCS 10
   d. None of the above

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Oral and/or nasal intubation
- Ventilation (adults: low/normal rates of 10–12, hyperventilation of 20–24)
- Surgical Cricothyrotomy
- Needle Cricothyrotomy
- Retrograde Intubation

- Laryngeal Mask Airway
- ETCO2 monitoring
- It is recommended that air medical crew members attend frequent advanced airway labs consistent with program competencies. The equipment and supplies should reflect those used by the air medical program and the referring EMS agencies.
- Due to the changes in practice of slower ventilation rates, aggressive fluid support and use of paralytics and high-dose steroids, air medical programs should customize their airway labs to reflect these changes. Of particular note is the change in ventilation rates. Hyperventilation is to be used in the cases of suspected brain herniation ONLY, with normal ventilation rates at 10–12 breaths/minute. Because this is a significant change in practice, care should be taken to provide practice opportunities for timed BVM ventilation.

F. **Patient Care Hours**: 12–24

MODULE 27: THORACIC TRAUMA

Author: Dr. Jonathan Beach, DO, Assistant Clinical Instructor, Department of Emergency Medicine, Upstate Medical University, Syracuse, NY

Reviewers: Ms. Diane J. Fojt, MSC, BS, REMT-P, MECA, Inc., Tampa, FL
Dr. Michael Duchesneau, Emergency Department, Tampa General Hospital, Tampa, FL

KEYWORDS

Sucking chest wound
Flail chest
Hemothorax
Pneumothorax
Cardiac amponade
Aortic rupture

OBJECTIVES

Upon completion of this module, the student should be able to:

- Recognize the treatments for different thoracic conditions that require immediate treatment
- Distinguish between pulmonary contusion, flail chest, hemothorax, and pneumothorax
- Identify treatments for cardiac tamponade, and cardiac and aortic rupture

INTRODUCTION

Thoracic trauma is responsible for approximately 25 percent of trauma-related deaths. Types of thoracic trauma include penetrating and blunt trauma. Penetrating injuries most often result in pneumothorax, and a majority of those progress to hemothorax. Similarly, penetrating trauma has the potential to result in multiple variations of thoracic trauma and secondary abdominal trauma. Blunt trauma results in injury through various mechanisms. These include organ rupture through compression, fracture through direct trauma, and vascular damage with acceleration-deceleration forces. The following conditions require immediate action to stabilize the patient for survival.

IMMEDIATE LIFE THREATS

Inadequate Airway

The oropharynx must be cleared of any obstruction. The patient's ability to maintain an adequate airway should be evaluated, if necessary, advanced airway adjuncts should be utilized. Establishing a secure airway is easier in a controlled setting, therefore advanced adjuncts should be placed whenever possible, before the patient is en route or at altitude.

Sucking Chest Wounds

This occurs when the architecture of the chest wall has been altered in a fashion that allows air to be sucked through the wound into the chest. Sucking chest wounds are also known as a communicating pneumothorax. This is treated with an occlusive dressing and placement of a chest tube into the pleural space. Early repair and closure should be a high priority.

Pneumothorax

A pneumothorax is defined as air in the pleural space. There are three different classifications of a pneumothorax, each of which is described in the following chart.

Type	Definition	Etiology	Treatment
Simple Pneumothorax	No communication between pleural space and atmosphere	1- Blunt trauma with closed glottis 2- Rib fractures puncturing pleura (Rosen 434)	Observe or place chest tube depending on percentage of space occupied and expansion
Penetrating Pneumothorax	Air can enter and exit the pleural space through the chest wall. Sucking chest wound	Penetrating trauma that allows bi-directional air flow	Occlusive dressing, chest tube placement
Tension Pneumothorax	Air can enter the pleural space through the chest wall, but can not leave. A one way valve is formed in the chest wall, increasing pressure within the pleural space, and leading to a collapse of the lung	Penetrating trauma that allows expansion of the trapped air	Needle decompression, and chest tube placement

A pneumothorax can be graded according to the degree of collapsed lung. According to Rosen, a small pneumothorax occupies 15 percent or less of the cavity, moderate is between 15 percent and 60 percent, and greater than 60 percent represents a large pneumothorax.

Hemothorax

A hemothorax is characterized by the accumulation of blood in the pleural space. This can be a result of blunt or penetrating trauma and has the potential to lead to rapid respiratory deterioration. According to Rosen and his colleagues, about 25 percent of the patients suffering from hemothorax will have an associated pneumothorax. This type of injury should be suspected when there are decreased breath sounds on one side, and the same side of the chest is dull to percussion. At a facility, both ultrasound and plain films can demonstrate the collection of pleural fluid, but in the field, care providers depend on clinical evaluation.

Tension Pneumothorax

This results from damage to lung parenchyma that allows air to enter the pleural space, but not to exit. Air enters the pleural space, increasing the pressure and causing a shift of the mediastinum. This shift compresses the opposite lung and heart, and decreases the venous return. Treatment includes a release of tension with needle decompression and placement of a chest tube on the affected side.

- **Signs and Symptoms of Hemo/Pneumothorax**

  Patients are most likely to complain of shortness of breath and chest pain, and present anywhere from critical to healthy in appearance, depending on the type of pneumothorax and other secondary injuries. The diagnosis of a pneumothorax can be established with chest films, however, at the scene of an accident, a pneumothorax can be suspected based on decreased breath sounds, dullness to percussion, and the patient's respiratory status. The diagnosis of tension pneumothorax is clinical, and based on the above criteria as well as shifting of the trachea.

- **Treatment of Hemo/Pneumothorax**

  Intervention varies according to the size and etiology of the pneumothorax. Any moderate or large pneumothorax requires a thoracostomy or chest tube. However, a small simple pneumothorax can be observed for resolution. This observation includes constant evaluation of the patient's oxygenation, respiratory effort, and size of the pneumothorax. Massive hemothorax is defined by initial chest tube drainage greater than 1.5 L, or greater than 200 mL of blood per hour. A massive hemothorax usually requires a thoracotomy for exploration and treatment.

To avoid hypovolemia, during the initial resuscitation and stabilization, the patient should be given adequate intravenous fluid resuscitation. When a patient with a hemothorax is to be air transported, the fact that there is a decreased vital capacity as a result of fluid accumulation must be taken into account. If there is an associated pneumothorax, increasing altitude will cause expansion of the trapped air necessitating a thoracostomy or chest tube. Similarly, the patient should be given supplemental oxygen, because, as the altitude of the aircraft increases the patient is at higher risk for hypoxia. Hence, adequate fluid therapy, consideration of chest tube placement, and careful observation of the patient's hemodynamic status during transport are essential.

- **Transport Considerations**

As previously noted, the volume of a trapped gas varies inversely with atmospheric pressure. Thus, as an aircraft increases altitude, decreasing atmospheric pressure, the volume of a trapped gas will increase. A small simple pneumothorax will begin to expand as the aircraft elevates. Thus, for transport purposes, adequate management of a pneumothorax can be assured with placement of a chest tube. If a small pneumothorax is observed during transport, any indication of increased work of breathing or respiratory failure demands the placement of a chest tube. A communicating pneumothorax requires an occlusive dressing to be placed. This must be re-evaluated frequently to ensure that a one way valve has not been formed allowing tension to develop. A tension pneumothorax requires more aggressive treatment prior to transport. This includes needle decompression of the chest, and chest tube placement.

Flail Chest

Flail chest is defined as two point breaks of three or more consecutive ribs. This is more frequent secondary to blunt trauma, and results in a free-floating section of the chest wall. The chest wall demonstrates paradoxical rib motion with breathing and can be diagnosed during the primary survey. Hence, endotracheal intubation and positive pressure ventilation are frequently required for survival.

- **Signs and Symptoms**

  In many situations, the victim will be unable to maintain adequate ventilation secondary to the associated pulmonary contusion. As the patient works harder to ventilate the damaged lung tissue, the paradoxical movement of the chest can increase.

- **Treatment**

  Intubation and early mechanical ventilation support are indicated in patients with three or more of the following symptoms: severe head injury, shock, pulmonary co-morbidities, 8 or more ribs involved, or age greater than 65 years. These patients seem to do best with intermittent mandatory ventilation. Patients without other injuries, and mild to moderate flail chest may be managed with analgesia and aggressive pulmonary toilet.

- **Transport Considerations**

  Patients that require air transport should be managed according to the criteria above. However, the duration of transport should be considered when contemplating intubation and ventilation. If transport is directly from the scene of the incident, stabilization can be maintained by having the patient lay with the affected side down. However, careful observation for signs of tension pneumothorax, or increased work of breathing is mandatory. If the patient's respiratory status declines, endotracheal intubation may be necessary.

PULMONARY INJURIES

Pulmonary Contusion

Contusion of lung tissue results from blunt injury. It is diagnosed by the fluffy appearance on chest x-ray. Typically, this is not evident until 24–48 hours after injury.

- **Signs and Symptoms**

  The pathophysiology of pulmonary contusion occurs in two stages. The first is directly related to the lung damage. This includes damage to capillaries leading to hemorrhage. Secondly, as IV fluid resuscitation begins, edema becomes apparent. As a result, there is an increase in perfused lung that is not ventilated. Thus, blood is shunted, the work of breathing increases, and frequently, the patient is unable to maintain adequate tissue oxygenation.

- **Treatment of Pulmonary Contusion**

  Treatment is necessary if a large area of lung is involved, and consists of mechanical ventilation. The goal of mechanical ventilation is to provide a form of internal fixation, therefore increasing the amount of lung tissue that is ventilated, and avoiding atelectasis. This treatment is usually short-term.

- **Transport Considerations**

  In situations involving air transport of patients with pulmonary contusion, evaluation of the extent of injury is necessary. Any trapped air in the lung will expand as altitude increases, and thus, the threshold for more aggressive treatment should be lowered.

CARDIOVASCULAR TRAUMA

Cardiac Tamponade

Cardiac tamponade is characterized by blood collecting in the pericardial sac. Secondary to the poor compliance of the pericardial sac, pressure around the heart will increase rapidly. Although much more common with penetrating injuries, cardiac tamponade can result from either penetrating or blunt trauma. As blood fills the pericardial space, the increased pressure results in limited ventricular filling ability. This decreased filling capacity leads to decreased stroke volume, decreased cardiac output, increased central venous pressure, and eventually cardiac arrest.

- **Signs and Symptoms**

  Cardiac tamponade should be suspected in a patient with blunt or penetrating thoracic trauma or penetrating abdominal injuries. Beck's Triad may be present, providing more clinical evidence of tamponade. This Triad includes hypotension, distended neck veins, and muffled heart tones. However, in the patient with signs and symptoms of shock combined with the above mechanism of trauma, one should be very suspicious of cardiac tamponade or tension pneumothorax, which may have a similar etiology and clinical presentation

- **Treatment**

  Initial stabilization of the patient suspected to have cardiac tamponade, includes fluid resuscitation and care to other life threatening injuries. If after aggressive fluid resuscitation, the patient is still unable to maintain an adequate blood pressure, the diagnosis of tension pneumothorax or cardiac tamponade must be considered. Treatment of the more common tension pneumothorax should be initiated. This entails needle decompression or thoracostomy. Tamponade can be treated with pericardiocentesis, utilizing a needle to drain the pericardial sac. However, pericardiocentesis is a difficult procedure, especially in an uncontrolled environment, and can often be unsuccessful. In this case, thoracotomy may be the only life saving procedure, and the patient should be rapidly transported to a facility capable of providing definitive treatment.

- **Transport Considerations**

  During air transport of these patients, it must be remembered that any trapped air will expand. This includes air in IV lines, IV bags, and any type of catheter including those used for pericardiocentesis. This necessitates that the lines be closely monitored, because aggressive fluid resuscitation and drainage of the tamponade must be accomplished.

Cardiac/Aortic Rupture

Cardiac rupture is one of the most common autopsy findings in patients who have died at the accident scene. The patients who make it to the hospital tend to be unstable and have poor response to resuscitation. Cardiac rupture can result from blunt or penetrating trauma, and should be suspected when the degree of shock is out of proportion to the mechanism of injury. This tends to be the result of an acceleration-deceleration injury. Varied stressors combine to produce significant force at the inner surface of the aorta at the ligamentum arteriosum. Approximately 85 percent of these patients die at the scene. Of those patients that arrive at the hospital, 50 percent die within 24 hours, and an additional 75 percent within one week.

- **Signs and Symptoms**

  Patients with aortic rupture present with shock symptoms. A contained rupture, may present with vague chest pain, whereas a full rupture may present with absent breath sounds (consistent with a hemo/pneumothorax), pale, cool extremities and/or diminished femoral pulses.

- **Treatment**

  Treatment of cardiac and aortic rupture patients is focused on fluid resuscitation. Likewise, other life threatening injuries should be stabilized. If, after the initial stabilization, the degree of shock remains significant, either cardiac or aortic rupture must be considered, and rapid transport initiated. Occasionally, an aortic rupture may tamponade on itself and decrease blood loss. This improves the chance of survival only slightly, and still requires aggressive fluid resuscitation and immediate transport.

- **Transport Considerations**

  Air medical transport is often utilized for these very unstable patients to decrease transport time and improve the likelihood of reaching a Level I Trauma Center for definitive treatment. The mechanism of injury and symptoms will dictate treatment to include aggressive fluid resuscitation, advanced airway adjuncts, and performance of a chest tube insertion or thoracostomy. It is for this reason that air medical providers must be skilled to perform these skills and knowledgeable in the subtleties of cardiothoracic assessment.

SUMMARY

Air medical personnel frequently encounter thoracic trauma ranging from minor injuries to life-threatening crush, blunt, or penetrating injuries. In all cases, aggressive airway management, adequate fluid therapy, consideration of chest tube placement, and careful observation of the patient's hemodynamic status during transport are essential.

A. **Bibliography**:

Auerbach, Paul, ed. *Wilderness Medicine Management of Wilderness and Environmental Emergencies*. 3rd ed. St. Louis:Mosby-Year Book Inc. 1995.

Howell, John, ed. *Emergency Medicine*. Philadelphia: W.B. Saunders Company, 1998.

Rosen, Peter, et. al. *Emergency Medicine Concepts and Clinical Practice*. 3rd ed. St. Louis: Mosby-Year Book Inc. 1992.

Schwartz, Seymour, ed. *Principles of Surgery*. 7th ed. New York: McGraw-Hill, 1999.

Tintinali, Judith, et. al. *Emergency Medicine A Comprehensive Study Guide.* 5th ed. New York: McGraw-Hill, 2000.

B. **Definitions of Key Words**:

Sucking chest wound—Occurs when the architecture of the chest wall has been altered in a fashion that allows air to be sucked through the wound in the chest

Flail chest—**Two-point fractures of three or more consecutive ribs**

Hemothorax—Characterized by the accumulation of blood in the pleural space

Pneumothorax—Air in the pleural space

Cardiac temponade—Characterized by blood collecting in the pericardial sac

Aortic rupture—Potential result of blunt or penetrating trauma

C. **Test Questions**:

1. A 16-year-old male is presenting with a sucking chest wound. The highest priority in his treatment is:

   a. Release of tension with needle decompression
   b. **Early repair and closure**
   c. Thoracotomy for exploration and treatment
   d. Mechanical ventilation

2. A transport request is made for a 40-year-old female car accident victim. During initial assessment it is determined she has a flail chest. She is also presenting symptoms of shock. When transporting the patient by air, what should be considered when contemplating intubation and ventilation?

   a. **Duration of the transport**
   b. Altitude of the transport
   c. Vital capacity
   d. Expansion of trapped air

3. A 16-year-old male is being treated for a stab wound that is allowing air to enter the chest, but not exit. The treatment for this wound is to relieve tension with needle compression and chest tube placement. The pnemothorax grade described here is:

   a. Simple
   b. Penetrating
   c. **Tension**
   d. Rupture

4. The above patient is not responding to the treatment. It is determined he has a cardiac tamponade. He is then treated with pericardiocentesis, which is also unsuccessful. The only life saving procedure left to perform before transport is:

    a. **Thoracotomy.**
    b. Fluid resuscitation
    c. Occlusive dressing
    d. Intubation

5. Cardiac and Aortic Ruptures usually lead to death for the patient. What does the treatment of these ruptures focus on?

    a. **Fluid resuscitation**
    b. Intubation
    c. Stabilization of other injuries
    d. Needle decompression

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Establish a secure airway
- Occlusive dressing
- Placement of a chest tube
- Needle decompression
- Endotracheal intubation
- Positive pressure ventilation
- Thoracotomy
- Mechanical ventilation
- Intravenous fluid resuscitation

F. **Patient Care Hours**: 12–24 in trauma ICU

MODULE 28: ABDOMINAL TRAUMA

Author: Mr. Dennis A. Taylor, RN/CEP, MedCenter Air, Charlotte, NC

Reviewers: Dr. Michael Duchesneu, Emergency Department,
Tampa General Hospital, Tampa, FL
Ms. Shirley Scholz, RN/CEP, AeroCare, Lubbock, TX

KEYWORDS

Focused abdominal assessment
Mechanism of Injury
Index of suspicion
Kehr's sign
Grey-Turner's sign
Cullen's sign
Balance sign
Chvostek's sign
Trousseau's sign

OBJECTIVES

Upon completion of this module, the student will be able to:

- Discuss mechanism of injury in abdominal trauma
- Perform a complete abdominal assessment
- State diagnostic procedures used in identifying abdominal trauma
- Describe specific abdominal injuries, complications, and potential interventions
- Demonstrate how to properly package an abdominal trauma patient for air medical transport

INTRODUCTION

This module will discuss the general transport preparation and en-route care of the abdominal injured patient. This module will also discuss the procedure for a complete abdominal assessment, how to manage various open abdominal packing systems, the importance of abdominal decompression, and how to measure abdominal pressures to prevent abdominal compartment syndrome. An excellent initial physical exam coupled with serial re-evaluations will greatly enhance the caregiver's ability to recognize a life-threatening condition early.

MECHANISM OF ABDOMINAL INJURY

Abdominal injuries are common. They are the third leading cause of traumatic death (head injuries are first and chest injuries are second). One-fifth of all trauma patients require abdominal operative intervention.

The abdomen has minimal bony protection. The most common mechanism of injury is blunt trauma from motor vehicle crashes. They represent nearly 25 percent of all trauma deaths. The liver and spleen are most frequently injured. Common nonpenetrating injuries include blunt injuries, crushing injuries, blast injuries and seatbelt injuries.

The other major category of abdominal injuries is penetrating trauma. They represent 25 percent of all traumatic injuries. The most common penetrating injuries involve the liver, small bowel, and stomach. These injuries include gunshot wound (GSW), stabbings, shrapnel, glass, etc.

There are often concurrent injuries. They include:

Lower rib cage: Liver and spleen
Chest trauma: Esophageal and gastric
Pelvic trauma: Intra-abdominal injuries

Equipment Needs

Equipment required on board the aircraft should be relatively simple to care for the injured patient. Most abdominal drainage systems are connected to suction. Make sure prior to departure that you have a sufficient number of suction collection canisters, extra suction tubing, several Y connectors, an abdominal binder that will fit around the patient and plenty of 2” and 3” tape.

Altitude Restrictions

Altitude restrictions should be discussed with the pilot prior to lift off. This will assist the pilot with flight planning and the possible need for additional fuel stops. Patients at risk for developing intra-abdominal compartment syndrome and those with sub capsular hematomas may need to be flown at lower altitudes when transported in a nonpressurized aircraft. When flying these patients in pressurized aircraft, the cabin pressure setting should be discussed with the pilot and monitored for the duration of the flight.

PATIENT ASSESSMENT

ANATOMY

The peritoneal cavity includes the following structures:

stomach	liver
spleen	gall bladder
large intestines	small intestines
sigmoid colon	transverse colon

The retroperitoneal space includes:

duodenum	kidneys
descending colon	ascending colon
pancreas	major vessels

The pelvic cavity includes:

rectum	iliac vessels
bladder	female reproductive organs

HISTORY

If the patient is complaining of any abdominal pain, use the PQRST mnemonic to assess:

P—What provokes the pain?
Q—What is the quality of the pain (sharp, dull, etc…)?
R—Does the pain radiate to another place?
S—What is the severity of the pain (scale of 1–10)?
T—Time—when did the pain start—does it coincide with meals?

A complete past medical history may be beneficial in determining if the patient's current pain or condition is chronic or acute. The AMPLE mnemonic may be helpful:

A—Any allergies?
M—Current medications?
P—Past medical history?
L—Last meal?
E—Events leading up to this incident or accident?

ASSESSMENT

PRIMARY SURVEY

Airway—C-Spine stabilization/immobilization
Breathing
Circulation—control hemorrhage
Disability
Expose and Examine

SECONDARY SURVEY

INSPECTION

- How would you describe the abdomen? (Round, flat, distended, concave)
- Document if gastric tube present, location of gastric tube, size, how placement was verified, method used to secure gastric tube, description of and amount of secretions from gastric tube, whether tube is clamped or to suction, when was the patient's last meal, and has there been any nausea or vomiting?
    - Serial inspections are very important.—Has the appearance of the abdomen changed? Is the abdomen round, flat, distended, obese, concave?
    - Is the lower chest wall intact? Pay particular attention to the lower ribs over abdominal structures.
    - Location, size, shape, and number of wounds. Describe the wound—be careful and do not document entrance and/or exit. Just describe the wound and the tissue surrounding the wound. Preserve all clothing—be careful when cutting clothing off a patient—try to avoid cutting through holes.
    - Any bruising or surgical scars present?
    - Cullen's sign—periumbilical ecchymosis
    - Grey-Turner sign—flank ecchymosis indicative of retro peritoneal hemorrhage
    - Remember, the abdomen rarely swells from blood or fluid—if the abdomen is swelling, it is probably due to air in the stomach—insert an NG/OG and decompress.

AUSCULTATION

- Less than 5 sounds per minute are hypoactive; 5 to 35 sounds per minute are normal; greater than 35 sounds per minute is hyperactive.
- Listen for bowel sounds in the chest—indication of diaphragmatic rupture

PALPATION

- Always begin in the quadrant opposite of any pain—palpate the quadrant with pain last. Palpate for focal tenderness, rigidity, rebound tenderness (press down slowly, then release quickly), and guarding.
- Subcutaneous air is generally a sign of a thoracic injury; could potentially be an esophageal injury.

- Palpate femoral pulses—a decrease on one side versus the other could indicate a vascular injury.
- Kehr's sign—referred left shoulder pain upon palpation of the left upper quadrant—may indicate a splenic injury.

PERCUSSION

- Presence of dullness in all four quadrants may indicate free fluid in the abdominal cavity.
- Balance sign—left upper quadrant dullness—may indicate a sub capsular or extra capsular hematoma of the spleen or flank.

DIAGNOSTIC PROCEDURES

ULTRASOUND

- Used widely in Emergency Departments and being used in the field as well. Very quick and reliable tool to evaluate for hemorrhage in the abdominal compartment.

DIAGNOSTIC PERITONEAL LAVAGE (DPL)

- Quick procedure to evaluate for free blood in the abdominal compartment. A needle is placed in the abdomen and sterile saline is infused. The fluid is then drained back into a collection bag or container and evaluated for the presence of blood. Does not identify the source of the hemorrhage.
- This procedure is not specific for retroperitoneal injury.

COMPUTERIZED TOMOGRAPHY (CT) WITH CONTRAST

- This exam may take some time and its completion will be dependent upon the hemodynamic stability and resuscitation efforts. This exam can pinpoint an injured organ.

LABORATORY STUDIES

- Trend hemoglobin (hgb) and hematocrit (hct) values
- Amylase/Bilirubin
- Electrolytes
- PT/PTT
- Urinalysis

INTERVENTIONS AND TRANSPORT

Address Primary Survey first. Then assure that the patient has two large bore IV lines that are patent with fluids infusing without difficulty. Remember, if the abdominal injured patient begins to hemorrhage internally, fluid resuscitation will be a vital and key element to survival. Place the patient on a cardiac monitor and watch for sudden onset of tachycardia (this may be your first sign of hemorrhage). Monitor all vital signs frequently (at least q. 15 minutes). Insert and secure an NG or an OG tube prior to transport. Stomach contents should be evacuated prior to transport to reduce the risk of aspiration in the event of emesis secondary to motion sickness. If transporting a patient in a pressurized aircraft, connect the NG/OG to low wall suction. Monitor urine output. A sudden drop in urinary output is an early indicator of developing shock.

SPECIFIC ABDOMINAL ORGAN INJURIES

SPLEEN

- Most common organ injured following blunt trauma
- Assessment may reveal Balance sign; Kehr's sign; hypotension; tachycardia; abdominal tenderness, rigidity and/or guarding; rebound tenderness; hypo-active or absent bowel sounds; and over time, a decreasing hemoglobin and or hematocrit.
- A delayed rupture of the spleen or of a sub capsular hematoma may occur one to two weeks after the injury.
- Fractures of the 10th to 12th ribs may be associated with underlying damage to the spleen.
- Nonoperative management of the splenic injured patient requires hemodynamic stability.

LIVER

- Second most common organ injured following blunt trauma.
- The mortality rate for liver injuries is 13 percent with a higher percentage of deaths occurring from penetrating injuries.
- Blunt or penetrating injuries may include:
  - Sub capsular hematoma
  - Lacerations to the parenchyma
  - Severe vascular injuries
  - Hepatic avulsion
- There is a 50 percent mortality with a major resection of the liver when associated with greater than five injuries.
- Post-operative complications may include: hypoglycemia, thrombocytopenia, hypoalbuminemia, coagulation disorders,

sepsis, pulmonary insufficiencies, adult respiratory distress syndrome (ARDS), and hepatomegaly.

PANCREAS AND DUODENUM

- Both the pancreas and the duodenum lie within the retroperitoneal space. They are in close proximity to each other and are usually injured together.
- Injuries are most commonly associated with penetrating trauma. Injury in blunt trauma should be suspected when direct force is applied to the left upper quadrant. Often associated with T11–12, and L1–L3 fractures.
- Assessment may reveal Cullen's sign, Gray-Turner's sign, abdominal rigidity and or tenderness, and signs and symptoms of a post-operative infection.
- Hypocalcemia—occurs as calcium binds to fatty acids released from fatty necrosis after injury. Signs and symptoms of hypocalcemia include muscle cramps, tingling in fingers, toes, and the mouth, hyperactive reflexes, impaired mental function, and seizures. Monitor for Chvostek's sign and Trousseau's sign. Also monitor ECG changes.

COLON AND SMALL INTESTINE

- Most commonly injured as the result of penetrating injury. The most common injury is a contusion.
- The small bowel is located retroperitoneally, and injuries may take several hours to several days to become apparent.
- Assessment includes a complete physical exam looking for ecchymotic areas and eviscerations. Make sure to note estimated blood loss. In the event of an evisceration, cover the exposed bowels with warm moist saline gauze. Keep the area as moist and clean as possible.
- An ileus is common after injury.
- Complications include sepsis, fistula formation, wound or intraperitoneal infection, ischemic bowel, bowel obstruction, or abscess formation.

A. **Bibliography**:

Holleran, RS. *Flight Nursing Principles and Practice*, 2nd ed. National Flight Nurses Association, 1997.

National Flight Nurses Association. *Flight Nursing Core Curriculum*, 1997.

National Flight Nurses Association. *CFRN Study Guide*, 2nd edition, 1996.

B. **Definitions of Keywords**:

Focused abdominal assessment—The complete and comprehensive assessment conducted to assess the abdomen for external and internal injury

Mechanism of injury—A description of the forces brought about the body to cause an injury. May be as brief as a "stab wound" or as descriptive as the type of motor vehicle crash, where the vehicle was damaged and a description of the internal damage to the vehicle

Index of suspicion—A high degree of alertness to the "potential" for injury when there is no evidence of external or internal injury

Kehr's sign—Referred left shoulder pain (from left hemi diaphragm irritation) upon palpation of the left upper quadrant—may indicate a splenic injury

Gray-Turner's sign—A gray-blue discoloration of the flanks, which may be indicative of retroperitoneal hemorrhage or acute hemorrhagic pancreatitis

Cullen's sign—A bluish discoloration around the umbilicus sometimes occurring in intraperitoneal hemorrhage

Balance sign—Left upper quadrant dullness upon percussion. This sign may be indicative of a sub capsular or extra capsular hematoma of the spleen or flank

Chvostek's sign—a Spasm of the facial muscles elicited by tapping on the facial nerve in the region of the parotid gland. May indicate tetany from hypocalcemia

Trousseau's sign—A sign for tetany in which carpal spasms can be elicited by compressing the upper arm (i.e., BP cuff) and causing ischemia to the nerves distally.

C. **Test Questions**:

1. The order of physical assessment should be:

    a. Palpation, inspection, auscultation, and percussion
    b. **Inspection, auscultation, percussion, and palpation**
    c. Inspection, palpation, percussion, and palpation
    d. Auscultation, palpation, inspection, percussion

2. What is the most commonly injured solid organ in blunt injuries?

    a. liver
    b. bladder
    c. **spleen**
    d. pancreas

3. Upon palpation of the left upper quadrant, referred pain to the left shoulder is referred to as:

    a. Cullen's sign
    b. Chvostek's sign
    c. Gray-Turner's sign
    d. **Kehr's sign**

4. Which of the following tests would be best to pin-point an injured organ?

    1. Diagnostic peritoneal lavage (DPL)
    2. **Computerized tomography with contrast**
    3. Ultrasound
    4. Hemoglobin and hematocrit

5. Injury to which organ is associated with hypocalcemia?

    a. **Pancreas**
    b. Spleen
    c. Stomach
    d. Liver

D. **Didactic Hours**: 2

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

- Naso-gastric and or oro-gastric tube insertion, central line management, fluid resuscitation skills, specialty medications, set-up and measurement of intra-abdominal pressures via bladder pressure measurement and wound closure devices management (as per licensure and scope of practice)

- All lab equipment and supplies should represent the brands and types of equipment the air medical crew will be working with in their aircraft and when interfacing with hospital personnel and ground EMS providers. At minimum, medical crew members should be familiar with all types and sizes of NG/OG tubes, vacuum dressings, drainage systems, transducing bladder pressure lines, and sterile dressing techniques.

F. **Patient Care Hours**: 12–24, in trauma ICU

CHAPTER 8: OBSTETRICS, NEONATAL, AND PEDIATRICS

Module 29: Obstetrics and Childbirth

Module 30: Neonatal Care

Module 31: Pediatric Care

MODULE 29: OBSTETRICS AND CHILDBIRTH

Author: Ms. Pamela Adams, RN, OB-STAT Consulting, Arden, NC

Reviewer: Dr. Robert (BJ) Johnson, Phoenix Perinatal Associates, Phoenix, AZ

OBJECTIVES

Upon completion of this module, the student should be able to:

- Perform a primary and secondary assessment of the obstetrical patient
- Describe fetal assessment modalities and how to determine reassuring versus nonreassuring fetal heart rate patterns prior to transport
- List common conditions warranting transport, stabilization techniques, as well as care and consideration en route
- Understand the pregnant patient psychosocial responses to transport
- List steps in preparation for an emergency delivery and potential complications

KEYWORDS

Amniotic fluid
Clonus
Deep tendon reflexes (DTRs)
Dilation
Effacement
Estimated date of confinement (EDC)
Fetal well being
Gravida
Para
Last menstrual period (LMP)
Nonreassuring fetal tracing
Presentation (fetal lie)
Station
Nonstress Test (NST)
Contraction Stress Test (CST)
Oxytocin Challenge Test (OCT)
Biophysical Profile (BPP)

INTRODUCTION

Documentation and research have shown that there is a significantly improved outcome of both the high-risk mother and neonate when delivery occurs in a tertiary care center. The goal of obstetrical transports is to provide safe and rapid transport of the obstetrical patient to a facility most appropriate to meet her needs. This is accomplished by careful assessment, stabilization, and transport by skilled personnel who are comfortable dealing with obstetrical crisis and emergencies.

There are many factors that must be considered when caring for a pregnant woman in the air medical environment. The foremost is an understanding that two patients are being transported. Because the neonate cannot be visually assessed, the crew must take extra precautions to remember that all treatments and interventions have the potential to adversely or positively affect the status of the unborn fetus.

TEAM CONFIGURATION

Although there are many specially trained obstetrical transport teams, all EMS and air medical crew members will eventually be requested to transport a pregnant medical, trauma or at term laboring patient. For that reason, training in triage, assessment and stabilization, and transport of these patients is mandatory to ensure patient safety. Regardless of the initial telephone triage report, it must be assumed that the expected patient acuity may change for the worse before the arrival of the transport team. The *Air Medical Physician Handbook* outlines suggested triage schemes based on team preparation and availability.

FLIGHT NURSING INITIAL ASSESSMENT

Depending on the nature of the illness or injury, or if the reason for transport is identified as a primary obstetrical problem, the initial assessment will vary slightly. Regardless of the initial presentation, the initial steps must always include:

- Scene /environmental survey
- Blood and body fluid precautions
- Assessment of Airway, Breathing, and Circulation, GCS and pupils
- Treatment to establish or correct impaired Airway, Breathing, or Circulation
- Treatment of immediately life-threatening injuries or conditions

Once the above steps have been addressed, the presenting illness, injury, obstetrical emergency or impending delivery should become the focus for the air medical crew.

Pregnant Medical and Trauma Patients

If the call is a result of a medical or traumatic emergency, the focus should be to treat and support the pregnant patient as any other patient with the same clinical presentation. The significant difference is that you are responsible for treating two patients, the mother AND fetus. It is important to remember that the effects of all treatments, fluids, and medications will impact, positively or negatively on the fetus. Assessment and stabilization must be initiated prior to moving the patient and should begin with the preliminary phone triage report.

Obstetrical Patients

The following parameters can and should be assessed by **any** air medical team responding to and transporting **any** pregnant patient. This information may be obtained in the initial phone triage report.

- Gravida, para, multiple gestation
- Estimated date of confinement (EDC), ultrasound confirmation (if available)
- Contraction status
- Cervical dilation
- Intact or ruptured membranes; color of amniotic fluid
- Patient weight, age, allergies
- Patient vital signs and fetal heart rate(FHR) pattern
- Current medications, IVs, laboratory values
- Results from antepartum testing such as NST, CST,OCT, Biophysical profile or ultrasound
- EKG or X-ray results in cardiac or trauma cases
- Patient consent and physician's order for transport
- Copy of medical chart
- Past medical, surgical, and obstetrical history
- Previous physical or mental disabilities
- Medical conditions or surgeries that might affect this pregnancy

Prior to Air medical Crew Arrival

Whenever possible, information obtained during the initial triage call or contact with the referring staff or physician should be used to determine whether additional stabilization recommendations should be made while the team is en route. This allows the team to prepare a preliminary patient care plan prior to their arrival, and may shorten the on-scene time.

DETAILED OBSTETRICAL EVALUATION

Transport members who provide care to the obstetrical patient must be able to do a rapid initial and detailed survey and prepare to provide intervention as the need arises. Life threatening situations noted for the mother must be treated immediately. The effects of all treatments provided to the mother will directly impact the fetus.

Once initial assessment and stabilization have been completed, an in-depth head-to-toe examination should be conducted, including an assessment of fetal well being.

System Approach

System	Assessment Parameters
Respiratory	Rate, depth, quality, breath sounds and equality, chest rise and symmetry, presence of cough/sputum/congestion
Cardiac	Skin color, temperature, hydration; capillary refill; peripheral edema; most distal palpable pulse, quality of extremity pulses; systolic and diastolic BP
Neurologic	Glasgow Coma Score; best motor and verbal responses; pupil dilation and reactivity; extremity strength and equality; presence of deep tendon reflexes (DTRs) or clonus; sensitivity to light or noise
Gastro-intestinal	Abdominal size; palpable masses; rigidity or tenderness; Bowel sounds, presence or absence, location;
Genito-urinary	Voiding or catheterization; urine color, clarity, odor, specific gravity or presense of protein or sugar; intake and output
Reproductive	Presence of bloody show; fundal height; fetal lie; suspected rupture of membranes, color/odor of amniotic fluid; last measured cervical dilation, effacement and station;

Preparing the OB Patient for Care at Altitude

When anticipating the air transport of a maternal patient, the air medical crew must give thought to the effects of altitude on both the mother and fetus. There are subtle differences between maternal patients and other adult patients when they are taken to altitude. The medical crew must be alert for symptoms associated with hypoxia, gas expansion, and G-forces.

Although these forces affect all patients, physiologically, the pregnant woman is at greater risk for certain complications:

- Pressure from gas expansion in the bowels can cause an irritation of the uterus and aggravate or increase contractions.
- Gas expansion in the breast area can cause a release of oxytocin, which stimulates uterine contractions.

- Gas expansion also causes an increase permeability of the cell membrane, which may decrease gas exchange in the lungs and increase the risk of pulmonary edema.
- Gas expansion in the ears and sinus areas can aggravate any upper respiratory symptoms.
- Any tubes such as a urinary catheter or ET tube that have balloons should be deflated and filled with saline to prevent the over-expansion seen with air filled balloons.
- With a patient in pre-term labor or with premature rupture of the membranes (PROM), it is important to remember to position the patient in such a way as to minimize the G force effect.

EN ROUTE CARE

The importance of assessment parameters depends largely on the chief diagnosis. For instance, it is very important to know the hourly output, lung sounds, and DTRs on a patient with pre-eclampsia, eclampsia, H.E.L.L.P. syndrome or renal compromise that is being stabilized on $MgSO_4$, so as not to fluid overload the patient or cause $MgSO_4$ toxicity.

Vital signs, including blood pressure, temperature, pulse and respirations, should be taken initially and repeated every 15 minutes or more often as needed during transport (temperature every 2 hours if ruptured membranes). Patients on $MgSO_4$ should have baseline SaO_2 readings as well as hourly DTRs. The use of a portable cardiac monitor that reads SaO_2 levels is very helpful in this transport situation.

Determination of cervical dilation either through a digital exam or sterile speculum should always be reassessed prior to departure. Also notation on quantity and color of amniotic fluid, if present, as well as bloody show should be made.

Once the detailed assessment is completed, the initial plan of care is revised to accommodate any changes. At this time, stabilization and packaging of the patient should be done in preparation for transport.

NURSING DIAGNOSIS AND INTERVENTION

Upon completion of both the initial and detailed maternal and fetal survey, it is important to finalize the nursing diagnosis and care plan that was formulated at the time of your initial telephone triage. The team must begin interventions following the preprinted standing orders written by the medical director of the transport team.

The intervention stage should move rapidly so that stabilization and packaging of the patient are expedited. Plan of care should be discussed with both the patient and any family members present. Consideration must be given to all details of the transport, from the most appropriate positioning and mode of transport to interventions and drug therapy needed en route.

FETAL ASSESSMENT

A review of the past several hours of fetal monitor tracings should tell a great deal about contraction patterns and FHR variations. The normal FHR should run between 110–160. *Variability* is the fluctuation of the heart rate in response to the interplay between the sympathetic and parasympathetic. It is a very good indicator of fetal well being. The wavy pattern of the heart rate that varies from 6–25 beats from the baseline is called long-term variability. A decrease in the variability for 20–40 minutes may be noted during a sleep cycle. Periodic changes in the FHR should occur as a response to fetal movement or contractions. Accelerations are expected with fetal movement. A hypoxic fetus is unable to accelerate the heart rate, producing a nonreassuring FHR tracing.

Abnormalities in the FHR tracing should be looked for over the course of the strip review. Three major types of decelerations may be seen; early, variable, & late. Tachycardia and bradycardia (if persistent) may be signs of nonreassuring patterns as well.

Variable decelerations are characteristically noted as having a “V” shape. They are caused by cord compression and are commonly seen in patients with oligohydramnios, nuchal cord, true knot in the cord, short cord, or fetal cord entanglement. These decelerations may be improved by maternal position changes, possibly alleviating the cord compression.

Early decelerations are shown as a “mirror” of the contraction. They begin with the start of the contraction and end with the ending of the contraction. Head compression causing a vagal stimulation produces this deceleration. It is imperative to reexamine the patient when these are noted as they usually occur in active labor with a dilation of 4–7 cm. There is no treatment for this deceleration; rather it should be a warning of advancing dilation and fetal descent.

Late decelerations begin after the start of the contraction and remain below baseline until after the contraction is completed. They indicate placental insufficiency and must be treated promptly. The patient should be positioned on the left side, an IV fluid bolus given for hydration, O2 initiated at 100 percent via face-mask, and a reevaluation of the cause of the deceleration made. Some causes of late decelerations include pregnancy induced hypertension (PIH), placental abruption or placenta previa, chorioamnionitis, post maturity, maternal hypotension, or uterine hypertonicity. Persistent late decelerations are nonreassuring, and delivery of an infant should be made as soon as possible.

Bradycardia occurs when a FHR of less than 110 is noted for greater than 10 minutes. A fetus cannot tolerate a bradycardic rate for very long before becoming acidotic. Bradycardia can be noted with such catastrophic episodes as cord prolapse, placental abruption or uterine rupture. Treatment should include maternal reposition (attempt to establish and alleviate cause of bradycardia), IVF bolus, O2 via nonrebreather facemask, and consideration of prompt delivery if FHR does not return to baseline rapidly.

Tachycardia occurs when a FHR is greater than 160 for 10 minutes or more. It is a compensatory mechanism to alleviate transient hypoxia. Causes include maternal fever, fetal hypovolemia, chorioamnionitis, or maternal hyperthyroidism. It is important to search for and correct the underlying cause of the tachycardia before the fetus is in danger of metabolic acidosis.

Knowledge of normal fetal tracings will allow for prompt recognition of abnormalities and necessary interventions. Certain changes in the FHR may be indicative of problems. For example, variable decelerations can indicate cord compression or oligohydramnios (low amniotic fluid volume). This deceleration may be relieved by a simple position change of the mother. Early decelerations usually indicate head compression of the fetus, which might warrant a vaginal exam to see if the dilation is advanced. Late decelerations are indicative of uteroplacental insufficiency and require intervention and delivery if unresolved. It is imperative that fetal heart patterns and contraction status be very well evaluated prior to transfer of the patient.

Fetal monitoring during transport is recommended in the presence of fetal distress. If fetal well being has been established, doppler F.H.R. could be utilized at least every 15 minutes, and after contractions during transport. Interventions during signs of fetal distress involve evaluation and treatment of suspected causes. Some suspected causes include placental abruption or previa, cord prolapse, tetanic contractions, maternal hypotension or hypovolemia. Maternal position should be changed to extreme right or left side, trendelenburg or knee chest (if possible) in the presence of fetal distress. In suspected hypotension or hypovolemia, a fluid bolus of 250–500 cc should be considered and repeated as needed. Oxygen should be administered via facemask at 10 liters. Reevaluation and interventions should be continued until fetal distress is resolved.

It is important to remember that the reason for transporting the maternal patient is to deliver the fetus at a facility that will provide the best treatment for its needs. When faced with a fetal distress, many factors must be figured into the decision to transport or not. The time of transport including any unexpected delays should be considered thoroughly, as well as any special equipment or expertise that is necessary for this delivery.

NORMAL FETAL WELL BEING DIAGNOSTIC TOOLS

While it is understood that the most transport nurses will not be doing the following antepartum tests prior to transport, it remains important for the team members to have a good understanding of the validity of these tests in order to determine the well being of the unborn fetus that they are transporting. It also allows for understanding of the rationale for certain orders such as oxygen or fluid hydration. When reviewing the patient records or interviewing the nurse or physician at the referring facility, do not hesitate to ask for results of these tests and discuss inappropriate results with the team medical director prior to transport the patient.

The most common antepartum tests done to assess fetal well being are: NST (nonstress test), CST (contraction stress test), OCT (oxytocin challenge test), BPP (biophysical profile). The transport nurse will most likely find the results of one or more of these tests in the patient records and should be familiar with how to interpret the test results.

INTERPRETATION OF ANTE-PARTUM TESTING

While most transport teams will not be called upon to interpret or review the results of antepartum testing, the air medical provider must possess the knowledge and ability to determine fetal well being as reflected by results of the Nonstress Test (NST), Contraction Stress Test (CST), Oxytocin Challenge Test (OCT), and the Biophysical Profile (BPP).

Nonstress Test

The NST is done for a number of indications, such as diabetes, hypertension, IUGR (intrauterine growth retardation), decreased fetal movement, multiple gestation, or simply the need to show reassurance of fetal well being. It is interpreted as reactive or nonreactive. A reactive NST is a reassuring sign that the infant has met the criteria of having accelerations of 15 beats per minute above the baseline lasting 15 seconds. It must have at least two accelerations within a 10-minute time frame to be considered reactive. A fetus under 30 weeks gestation may not have a reactive test due to the fact that the autonomic nervous system is not mature.

Contraction-stress or Oxytocin-challenge Tests

The CST or OCT requires the patient to have three contractions within ten minutes. The contractions can be spontaneous or induced with either nipple stimulation or the use of IV Oxytocin (OCT). A negative CST/OCT is reassuring in the fact that the FHR remains stable throughout all contractions. A positive or equivocal CST/OCT means there were late decelerations with one or all three contractions. When a positive or equivocal CST/OCT is obtained, a biophysical profile or consideration of delivery based on gestational age should follow.

Biophysical Profile

A biophysical profile (BPP) is fetal observation done during real time ultrasound to determine fetal well being and identify fetal compromise. It is indicated for many different reasons such as a nonreassuring NST, a positive or equivocal CST/OCT, post dates, decreased fetal movement, IUGR, or premature rupture of membranes. The following is the BPP scoring system; each variable scores two points for a maximum of 10 points:

Biophysical Profile (BPP) Scoring System

Variable	Method of obtaining points
Fetal reactivity	A reactive NST would be accepted. There must be 2 or more fetal heart rate accelerations of 15 bpm lasting 15 seconds in a 40 minute time frame
Fetal tone	At least one episode of motion of a limb from flexion to extension and rapid return to flexion
Fetal breathing	At least 30 seconds of sustained fetal breathing movements noted in 30 minutes
Fetal movements	Three or more gross body movements noted in a 30-minute time frame
Amniotic fluid volume	A pocket of amniotic fluid measuring at least 1 cm in 2 perpendicular planes

Scoring	Interpretation
10	Normal infant.
8	Normal infant, low risk of chronic asphyxiation
6	Suspect chronic asphyxia. Strongly suggest delivery if oligohydramnios is present.
4	Suspect chronic asphyxia. Repeat test again the same day. If < 4 again, deliver.
0–3	Strongly suspect chronic asphyxia; extend test time, If score remains <4, deliver, regardless of gestational age.

CONDITIONS WARRANTING TRANSPORT

Preterm Labor (PTL)

Preterm labor is defined as regular contractions producing cervical changes occurring between the 20th and 36th week of gestation. With advanced diagnosis and treatment of preterm labor, combined with prenatal care and reduction of risk factors, the incidence of preterm birth has dropped to between 6 percent and 9 percent of all deliveries.

Many factors can predispose the OB patient to preterm labor. The most prevalent appears to be a sub-clinical infection of the urinary tract or vagina caused by either bacteria or virus. Infection is also believed to cause premature rupture of membranes, which then makes the patient more susceptible to preterm labor and delivery. Other suspected causes of preterm labor are dehydration, cigarette smoking, diabetes, maternal age, cervical incompetence, placenta previa or abruption, abdominal trauma, fetal anomalies, or stress (either physical or mental).

The diagnosis of suspected preterm labor should be made with a history of contractions every 10 minutes or less for at least 1 hour. A confirmation of labor is made when cervical change is noted on digital or speculum exam. Most physicians prefer to treat any patients with preterm contractions as if they were in labor, regardless of whether the cervix has changed to prevent premature dilation.

Premature Rupture of Membranes (PROM)

The leading predisposing factors causing PROM are the same as with preterm labor. It is theorized that most women who experience PROM probably have an undiagnosed sub-clinical infection, of which the most common is beta strep. This is being heavily researched in many teaching institutions throughout the country.

The diagnosis of PROM is made when the following factors are present: pooling of amniotic fluid in the vagina, positive nitrazine testing of the fluid, and positive ferning of the fluid on a microscope slide. The easiest way to access the above information is with the use of a sterile speculum exam to verify and collect amniotic fluid from the vaginal vault. A sample of fluid may be obtained and tested with nitrazine paper, turning dark blue upon the presence of amniotic fluid. It is important to remember that blood, cervical mucous, betadine, and some lubricants may give a false positive results. The true confirmation is made by spreading a small amount of amniotic fluid on a microscope slide and allowing to completely dry. A crystallization pattern will form resembling a Boston fern. This is noted by the use of a microscope, which is not available in all institutions, so this definitive diagnostic procedure is not always done prior to transport.

If the diagnosis of PROM has been made, several potential problems could develop. The most severe of these is chorioamnionitis. The signs and symptoms are fever, tachycardia, uterine tenderness, fetal tachycardia, and purulent vaginal drainage. The CBC will show elevated WBC counts.

Chorioamnionitis may develop after PROM, or may have actually caused the rupture. The incidence of infection increases greatly after a PROM of greater than 24 hours.

The transport team must make several observations of the patient prior to packaging for transport. Using a sterile speculum, a determination of the cervical dilation must be made. A patient with an incompetent cervix may dilate without contractions. A patient with a history of multiple pregnancy losses complaining of low abdominal pain and pressure or fullness should be suspected of incompetent cervix. The team must also be aware and treat any symptoms of preterm labor associated with the PROM, as the patient is at greater risk of preterm delivery once the membranes are ruptured.

PROM and PTL-Stabilization and Drug Therapy

Once the determination of past and current obstetrical history is made, it is important to begin stabilization of the PROM or PTL patient immediately. It is imperative to start with the least invasive stabilization, such as making sure the patient is not dehydrated. An IV fluid bolus (lactated ringers) of 500 cc on a normal healthy patient is often helpful in stopping contractions and irritability problems. Ensuring that the patient's bladder remains empty may also combat many contractions. A Foley catheter may be needed for transport; especially for those patients where accurate intake and output measures (I & Os) are needed.

The administration of tocolytic drugs is almost always attempted to allow for safe transport of the patient to a facility that can meet the needs of both the antepartum patient and her fetus. The most common tocolytics used in the field are terbutaline sulfate (Brethine), and magnesium sulfate ($MgSO_4$).

- **Terbutaline sulfate** is administered at a dosage of 0.25 mg S.Q. This may be repeated in 1 hour, although some institutions administer it every 20 minutes for 3 dosages. This is administered in accordance with the individual order of each team medical director.

  Terbutaline is a beta-sympathomimetic. By stimulation of the beta-2 receptors, uterine relaxation is achieved. There are several side effects that the patient should be made aware of prior to administration. These are tachycardia and palpitations, shaking and jitteriness, nausea and vomiting, and restlessness. More serious side effects that require cautious use in certain patients include: transient hyperglycemia and hypokalemia, and possible pulmonary edema. Use of terbutaline is contraindicated in patients with suspected Chorioamnionitis, insulin dependent diabetes, cardiac or chronic hypertension, and active hemorrhage.

The antidote for overdose is Inderal 0.5 mg slow IVP or Verapamil HCL 5–10 mg slow IVP.

- **Magnesium sulfate (MgSO4)** is often used as the first line drug with PTL/PROM. It acts at the neuromuscular junction to slow impulses by displacing calcium and interfering with the release of acetylcholine. It is administered IV piggyback by infusing a 4–6 gram loading dose over 30 minutes and running a maintenance infusion of 1–3 grams per hour. There are several variations from facility to facility in the way the infusion is mixed. An easy way to calculate drips is to mix 50 grams in 500 cc of D5W (remove 100 cc of D5W before adding the 100 cc of MgSO4, so there is only 500 cc in the bag). This yields 1 gram of MgSO4 to every 10 cc. Administration of 2–4 grams is 20–40 ccs/hr. This concentration works well when there is a need to limit the total amount of fluids the patient receives.

  MgSO4 will cause a generalized muscle relaxation. The patients' respiratory rate and DTRs should be observed every 15 minutes during transport. Side effects noted with this drug include flushing, sweating, nausea and vomiting, drowsiness and dizziness, weakness, and visual disturbances at higher levels. MgSO4 should be used with caution in patients with impaired renal function as it is primarily excreted in the urine. The urine output should exceed 30 cc/hour with patients on MgSO4. Therapeutic levels are within 4 to 7 mEq/L. MgSO4 should be decreased or stopped when levels are above 7 mEq/L., the patient has loss of DTRs, or respirations are less than 12/min. The antidote for MgSO4 toxicity is calcium gluconate, 1 gram of a 10 percent solution administered over at least 3 minutes.

Care and Consideration of PTL En Route

One of the most important considerations when deciding to transport a PTL patient is whether the labor can be stopped or slowed significantly to allow for a safe and comfortable transport of the patient, keeping in mind any possible delays that could occur. As with the transport of any maternal patient, all crew members must remember that there is always a potential for an unexpected delivery, but careful and skilled assessment as well as calculations of transport time frames should diminish those possibilities. Crews should always be prepared for an emergency delivery and fully equipped for neonatal resuscitation and stabilization.

The mode of transport must be carefully evaluated prior to transfer. A patient in advanced dilation or with bulging membranes would benefit from air transport, as opposed to bouncing around in a ground ambulance. These patients should be positioned in a Trendelenburg position to decrease pressure on the cervix. The patient should be transported in a comfortable position with safety belts secured below the uterus. The left lateral position is used for several reasons. It improves uterine perfusion, which decreases uterine irritability, and prevents postural hypotension common in pregnant women. The team should also be prepared to give additional tocolytic drugs en route.

It is important to consider pre-medicating the patient with some type of antianxiety, antinausea medicine such as Vistaril. This will help alleviate any side effects from drugs such as Terbutaline or $MgSO_4$, and help to prevent vomiting which could cause a patient with bulging membranes or advanced cervical dilation to experience PROM.

HEMORRHAGIC COMPLICATIONS OF PREGNANCY

Placenta Previa

Vaginal bleeding is often a reason for maternal transports. In some cases, the bleeding could be significant enough to cause hemodynamic instability and the need for emergency delivery and blood transfusions. The most common causes of serious uterine bleeding in the latter half of the pregnancy are placenta previa and abruptio placenta.

Placenta previa is defined as a condition in which the placenta implants in the lower segment of the uterus and covers the internal cervical os. Placenta previa is divided into the following categories:

- Total placenta previa covers the internal os completely
- Partial placenta previa covers only a portion of the internal os
- Low lying or marginal placenta previa extends to or near the internal os, but does not cover any portion of the os.

The diagnosis of placenta previa is usually made with ultrasound evaluation. The classic symptom of previa is painless bright red vaginal bleeding. As the lower uterine segment stretches and the cervix begins to change shape during the third trimester, the placenta begins to shear away from the implantation over the os. Bleeding may occur at any time, even with the patient on bedrest.

Potential complications include hemorrhage and associated hypovolemia, shock, disseminated intravascular coagulation (DIC), anemia, postpartum infection and or hemorrhage, fetal distress and death.

Placental Abruption (Abruptio Placentae)

A placental abruption is defined as the premature separation of a normally implanted placenta prior to delivery of the infant. The separation may occur in a small, area as with a marginal sinus rupture, or may occur with a total separation, causing devastating morbidity and mortality. The separation occurs along the decidua basalis which is maternal blood, rich in thromboplastin, causing rapid clotting. Approximately 1 percent of all pregnancies will have the diagnosis of placental abruption. There is also a significant incidence of recurrence in up to 16 percent of previous abruptions.

Placental abruptions may be classified as marginal, concealed, or combined.

- A marginal separation is usually near the edge allowing blood to escape from behind the placenta. These patients often have dark red vaginal bleeding.
- A concealed abruption is a hemorrhage from the arterioles that supply the decidua causing a retroplacental hematoma. Separation is somewhere in the center of the placenta and blood is trapped preventing vaginal bleeding.
- A combined abruption is a combination of the marginal and concealed.

  The cause of placental abruption is unknown but largely associated with arteriolar changes noted in hypertensive disease during pregnancy. Some other risk factors that increase the chances of abruption are: Trauma, multiparity with previous abruption, sudden decompression of uterus during twin delivery, cigarette smoking, and substance abuse especially cocaine.

  Patients with significant abruption usually present with uterine tenderness and pain, uterine irritability or frequent contractions, and vaginal bleeding. There is usually a decreased or absent resting tone to the uterus, making it palpate very rigid or board like. There may be a history of a recent blunt trauma or fall, PIH, or chronic hypertension, or other risk factors listed above.

- **Stabilization and Drug Therapy**

  - The obstetrical management of a mild preterm abruption or placenta previa may respond to tocolytic therapy and bedrest. The management of a moderate to severe bleeding episode will be dependent on a number of factors, including the maternal hemodynamic or coagulation status, as well as fetal response to therapy. In the case of maternal hypovolemia or fetal compromise, immediate abdominal delivery is indicated. When faced at a referring facility with a patient who is unstable and does not respond to aggressive stabilization techniques, the decision may be in the best interest of the mother and fetus to deliver at the referring facility and transfer the neonate when stable.

- It is imperative to assess maternal vital signs and urinary output. A pregnant woman can lose nearly 1000 cc of blood before changing her resting pulse rate. A drop of 1200–1500 cc will cause orthostatic changes, and overt hypotension is seen with drops of 1800 cc or more. Remember that early signs and symptoms of shock will be tachycardia and increased BP! Urinary output may fall with total blood volume losses of 20–30 percent. A urometer measuring hourly outputs should be established.
- Two large bore IV catheters should be placed with a crystalloid replacement fluid such as normal saline or lactated ringers. IV rates should maintain blood pressure, uteroplacental perfusion, and urinary output > 30 cc/hr. Determination of usage of blood products, such as packed red blood cells, fresh frozen plasma or 50 cc albumin 25 percent, will be done on a case basis.
- Obtain lab values as soon as possible, especially hematocrit (HCT), blood type, and clotting studies. A clot retraction test can be performed in the aircraft by simply drawing 5 cc of blood into a red top tube and taping it upright to the side of the aircraft. If no clot develops within 6–12 minutes, abnormalities in clotting times should be suspected. Observe patient for petechiae, hematuria, bruising, or bleeding from IV sites indicating possible DIC.
- Administer tocolytic drugs with care. Terbutaline and ritodrine are often contraindicated in the presence of hemorrhage due to resultant maternal and fetal tachycardia. Provide supplemental oxygen, 100 percent via nonrebreather facemask, and monitor SaO2.

- **<u>Care and Considerations En Route</u>**

  - Assess vital signs and FHR every 15 minutes or more frequently as needed. Mark the height of the fundus upon initial assessment and observe for any increase in abdominal height that might indicate concealed bleeding. Monitor for signs of shock and progressing labor. If a MAST suit is available, apply suit but do not inflate unless hypotension and shock occur. Never inflate the abdominal portion on pregnant patients. Monitor blood loss by doing peri pad counts.

- Continuous external fetal monitoring is optimal, if available. Doppler evaluation of FHR is acceptable, preferably after contractions to assess for possible late decelerations.
- Expedite transfer to receiving facility. Notify the facility to prepare for an emergency C-section if the maternal or fetal condition deteriorates en route.
- Deciding when to say no to transferring a possible hemorrhaging patient is often difficult. Many referring facilities lack appropriate ultrasound equipment and personnel to make those decisions. It is often up to the transport team to decide, sometimes on the patient assessment alone, whether it is safe to move the patient. Very seldom can the decision be made on the initial report received from the referring facility.

HYPERTENSIVE DISORDERS OF PREGNANCY

Pregnancy Induced Hypertension

Pregnancy induced hypertension (PIH) is a term that is used to describe several variations of hypertension associated with pregnancy. This term encompasses pre-eclampsia, eclampsia, and hypertension with superimposed PIH. Pregnancy induced hypertension is one of the top five conditions requiring transport, and complicates 7–10 percent of all pregnancies. This hypertension occurs at or after 20 weeks of gestation, and may be seen for up to 6 weeks postpartum.

PIH is a significant cause of maternal and neonatal morbidity and mortality. Hypertensive complications of pregnancy are the second leading cause of maternal death, with over 50,000 women dying worldwide each year.

Many theories exist but the etiology of PIH remains unclear. The underlying pathophysiologic events include vasospasm and endothelial damage. The vasospasms restrict blood flow, causing an elevation in the arterial blood pressure. Vasospasms are associated with endothelial cell damage, and altered blood flow may result in hypoxic damage to vulnerable organs. PIH is a complex multisystem disease that may include life-threatening complications.
The clinical management goals of PIH are prompt diagnosis, blood pressure control, optimization of oxygen transport to mother and fetus, and knowledge of the proper time for delivery. The only “cure” for PIH is delivery of the fetus and placenta. Patients diagnosed with PIH require ongoing surveillance to assess for maternal and fetal well being, and should be managed by a facility capable of meeting the needs of both patients.

Hypertension with Superimposed PIH

Chronic hypertensive patients are diagnosed with underlying hypertension prior to the 20th week of pregnancy. These women are at an increased risk of developing superimposed PIH, abruptio placenta, intrauterine growth retardation (IUGR) and intrauterine fetal death (IUFD).

Pre-eclampsia

Pre-eclampsia is defined as the development of hypertension along with proteinuria, edema or both diagnosed after the 20th week of pregnancy. The diagnosis of hypertension in pregnancy is often controversial. The American College of Obstetricians and Gynecologists (ACOG) has provided definitions to allow for uniformity in diagnosis (Technical Bulletin # 91). The definitions are as follows:

- Hypertension
  - Diastolic BP of at least 90 mmHg or systolic of at least 140 mmHg
  - Rise in diastolic of at least 15 mmHg or in the systolic of 30 mmHg
  - These BPs should be recorded on separate occasions, 6 hours apart
- Proteinuria
  - The presence of 300 mg/l or more of protein in a 24-hour urine collection: or
  - Protein concentration of 1 g or more per liter in at least two random urine specimens collected at least 6 hours apart

- Edema
  - General accumulation of fluid greater than 1+ pitting edema noted after 24 hour bed rest
  - Weight gain of 5 pounds or more in one week

Pre-eclampsia is divided into two categories, mild or severe. Definitions include:

- Mild pre-eclampsia
  - Elevated BP readings on two separate occasions
  - Proteinuria
  - Edema noted in lower extremities, face or hands, brisk DTRs
  - Fetal growth retardation (IUGR) and possible placental abruption may be side effects of this disorder.

- Severe pre-eclampsia (one or more of the following should be present)

    - Systolic BP 160 mmHg or diastolic of 110 mmHg, BPs should be recorded on two separate occasions 6 hours apart (treatment should not be withheld during this time period)
    - Proteinuria of at least 5 g in a 24-hour urine collection (or a 3+ to 4+ on urine dipstick)
    - CNS disturbances to include any of the following: headache, blurred vision, spots before the eyes, altered LOC, brisk DTRs
    - Epigastric pain—may be accompanied by nausea and vomiting
    - Thrombocytopenia—caused by platelet aggregation
    - Impaired liver function
    - Intrauterine growth retardation (IUGR) or oligohydramnios
    - Pulmonary edema or cyanosis

Eclampsia

Eclampsia is defined as the occurrence of convulsions in a woman whose condition has met the criteria for pre-eclampsia. Cerebral vascular changes, hypoxia, and cerebral edema are serious life-threatening neurological complications of severe PIH. The patient with eclamptic seizures may lapse into a coma, have cerebral hemorrhages, and die from complications of eclampsia.

H.E.L.L.P. Syndrome

H.E.L.L.P. Syndrome is considered a complication of severe pre-eclampsia. It stands for Hemolysis, Elevated Liver enzymes, and Low Platelets. The incidence of this syndrome is reported in 2–12 percent of all pregnancies with a mortality range from 2–24 percent.

The proposed etiology of this disease is that it is caused by the vasospastic activity associated with pre-eclampsia. Damage of endothelial cells in the liver leads to platelet aggregation, adherence and fibrin deposits. Liver enzymes are grossly elevated and prothrombin times are prolonged. Hepatic vessel rupture and necrosis may lead to a subcapsular hematoma or hepatic rupture. Maternal morbidity and mortality associated with hepatic rupture are very high.

- **Signs and symptoms include**
    - Right upper quadrant or epigastric pain
    - Nausea and/or vomiting
    - Headache

- Diastolic BP above 110 mmHg (may be seen with lower BP)
- Proteinuria 2+ or above on dipstick
- Edema

- **Laboratory findings include:**
  - Hemolysis—Hemolytic anemia, increased bilirubin and increased LDH above 600 IU/l
  - Elevated liver enzymes—Increased SGOT, SGPT, and LDH
  - Low platelets—defined as less than 100,000 mm
  - Urine—tea colored

- **Management**

  Should include stabilization for transport and consideration of surgical intervention immediately. These patients become very unstable in a matter of hours to minutes with rapid decreases in platelets. Due to the hyper-coagulopathy, they are at increased risk for DIC, intercerebral hemorrhage, acute renal failure, congestive heart failure, ARDS and death. Patients with overt H.E.L.L.P. syndrome do not benefit from expectant management or delayed delivery.

  Stabilization of the PIH and H.E.L.L.P. syndrome patient is very challenging. Head-to-toe assessment must include information on maternal hemodynamics, respiratory and neurological status, intake and output, and fetal status.

- **Assessment Parameters*:***
  - Monitor BP every 15 minutes during stabilization and every 30 minutes during MgSO4 infusion; assess every 5–15 minutes during severe hypertensive episodes or when administering antihypertensive medications
  - Monitor SaO2 continuously or at least every 30 minutes. SaO2 must remain > 95 percent. Provide O2 via nonrebreather facemask as needed
  - Auscultate breath sounds every 2 hours. Monitor for s/s of pulmonary edema to include chest tightness, cough, shortness of breath, tachypnea, tachycardia, “crackles” for lung sounds
  - Maintain adequate intravascular volume; prevent fluid overload by continuous monitoring of I & Os hourly. All IVs must be regulated on an infusion pump. Total IVF 80–100 cc/hr. if possible
  - Insert urinary catheter with urometer to monitor accurate hourly output

- Assess DTRs and clonus every hour during MgSO4 infusion. Assess level of consciousness hourly. Assess for headache and blurred vision regularly (minimal every shift).
- Maintain right or left lateral uterine displacement position
- Provide continuous fetal and contraction monitoring during MgSO4 administration. Assessment and documentation of fetal status every 30 minutes (minimally) for nonlaboring patients and every 15 minutes for laboring patients.

- **<u>Medication therapy</u>**

  Magnesium Sulfate (MgSO4)
  - Preparation of solution may vary. A concentrated solution should be used when fluid intake is restricted. An example may be:
  - 50 grams MgSO4 in 500 cc D5W (yields 1 Gram/10 cc)
  - Infuse 4–6 gram loading dose over 15–30 minutes followed by maintenance drip of 1–3 grams/hour (use lower dose in the presence of decreased urine output)
  - Assess for s/s of MgSO4 toxicity such as absent DTRs, decreased level of consciousness, respirations of < 12/ min, urine output of < 30 cc/hr.
  - Antidote: for reversal of MgSO4 effect, calcium gluconate, 1 gram of 10 percent solution IVP slowly over 3 minutes

  Antihypertensives:
  Hydralazine (Apresoline)
  - Given to treat diastolic BP > 110 mmHg. Dosage 2–5 mg IVP, followed by 10 mg every 15–20 minutes until diastolic < 110 mmHg Total dosage 20–40 mg. max. (consult MD for standing orders)

  Labetalol
  - Given to treat diastolic BP > 110 mmHg. Dosage 10 mg over 2 minutes, followed by 20,40, 80 mg IVP. May be ordered every 10 minutes until total of 300 mg given or diastolic < 110 (Consult MD for standing order)

  Nitroglycerin
  - Given to treat diastolic BP > 110. Dosage 10 mg/min doubling the dose every 5 min until diastolic < 110 (consult MD for standing orders)

<u>Pulmonary Edema:</u>

A pregnant woman may exhibit signs and symptoms of interstitial lung fluid, including dyspnea.

- **Medication therapy**: If symptomatic for pulmonary edema , consider giving:
  Morphine sulfate 2–5 mg IVP for acute pulmonary edema symptoms such as dyspnea, chest pain, lung sounds—"crackles"
  Lasix: 20–40 mg slow IVP over 2–3 minutes for acute respiratory distress suggestive of pulmonary edema
  Oxygen: via nonrebreather face-mask @ 15 liters/min. Assist ventilation if necessary.

- **Care and Consideration En Route**
  - This type of maternal transport is challenging due to the degree of illness that is presented by this type of patient. This patient is often very unstable physically and can be emotionally unstable as well. It is imperative to properly assess and stabilize this patient prior to departure.
  - Although it is very difficult during transport, attempt to decrease unnecessary stimulus such as alarms and sirens. When possible, provide a dark environment or consider covering patient's eyes to avoid bright lights. When transporting in rotor-wing aircraft, shield patient from experiencing "flicker vertigo" caused by the rotors. If possible, provide a headset for the patient or consider carrying a portable cassette player with soothing music for her to listen to en route. It is imperative that this patient be shielded from additional CNS stimulation that could cause seizures.
  - Transport patient in a lateral recumbent position. Ensure access to patient airway, and have seizure precautions in place. Inform receiving facility of status of patient and the need for possible surgical intervention if patient status deteriorates en route. Provide emotional support and explanation of events to patient and family.

- **Other**
  Maternal conditions that may affect the fetus or precipitate delivery include but are not limited to:

  Diabetes—poorly controlled gestational diabetes or severe diabetes mellitus
  Rh isoimmunization
  Trauma
  Drug abuse
  Infection
  Heart disease
  Renal disease
  Surgical complications—trauma, acute abdomen, thoracic emergencies

- **Triage And Transport:**
  As a general guideline, the following patients should not be transported until delivery can be accomplished, bleeding slowed or hypotension resolved:
  - Maternal hypotension or shock
  - Fetal compromise (repetitive late decelerations, etc.)
  - Brisk or active hemorrhage

PSYCHOSOCIAL RESPONSES OF PATIENT

Emotional Preparation

Obstetrical patients being prepared for transport are very likely to be easily stressed. The normal physiological changes of the OB patient, emotional stress of the unknown with regard to the acute condition, and stresses of flight can combine to produce a very anxious patient.

It is very important during the physical preparation of the patient to encourage the patient and family to verbalize any fears and concerns that they are feeling. Procedures, medications, and equipment used should be explained prior to use so the patient can feel that she is a part of the decision making. This is an excellent time to offer encouragement and reassurance and ask if there are any questions.

A packet of information that includes directions to the receiving facility and contact phone numbers for family members is essential to alleviate anxiety. It is also helpful to provide information about the transport system and the receiving facility, as well as any maps to restaurants and hotels in the area. Sometimes, local hotels will offer discounted rates to the families of these patients.

Stress Factors

In addition to the emotional stress of a transport, the patient may be subjected to the stressors of flight. These include hypoxia, gas expansion and G forces.

As with any patient flown at high altitudes, the oxygen available to the mother decreases, thereby decreasing the amount of oxygen crossing the placenta to the fetus. The healthy fetus is usually able to compensate for about 30 minutes. The fetus has several mechanisms that allow for the compensation. These include the fact that the fetal blood has a greater number of RBCs than adult blood, thereby carrying more oxygen capacity. Fetal hemoglobin also has a greater affinity for oxygen, and the ability to redistribute the blood flow to vital organs.

Conditions that cause a severity in hypoxia include any bleeding disorders or maternal hemorrhage, pregnancy induced hypertension and eclampsia. It is imperative to closely monitor the SaO2 of maternal patients and provide supplemental oxygen at altitude.

A second stressor of flight is gas expansion. This is not only uncomfortable, but may cause a number of problems. Pressure from gas expansion in the bowels can cause an irritation of the uterus and aggravate or increase contractions. Gas expansion in the breast area can cause a release of oxytocin that stimulates uterine contractions. It also causes an increased permeability of the cell membrane, which may decrease gas exchange in the lungs and increase the risk of pulmonary edema.

It is wise to remember that gas expansion in the ears and sinus areas can aggravate any upper respiratory symptoms. Any tubes, such as a urinary catheter or ET tube, that have balloons should be deflated and filled with saline to prevent over expansion.

The third stressor of flight is G forces. G forces are the combination of speed, velocity and acceleration of the aircraft and the effect it exerts. With a patient in preterm labor or PROM, it is important to remember to position the patient in such a way as to minimize the G force effect. The patient should be positioned with the feet toward the front of the aircraft during take off.

Being aware of the potential stressors of fixed-wing flight and using a common sense approach to treat the patient prophylactically will certainly reduce the chances of encountering unforeseen difficulties at altitude.

EMERGENCY CHILDBIRTH

The goal of any maternal transport is to safely transport the mother to the final destination without delivery. However, occasionally a patient may stop responding to stabilization attempts, and an emergency delivery may become necessary. Careful consideration as to placement of equipment and personnel is vital when there may be a possibility of delivery.

Crew members should remember that they might have to deliver a sick or premature neonate in the confined space of a helicopter ambulance, or at altitude. Therefore, delivery and neonatal resuscitation equipment should be well within reach of crew members and available at all times. Crew members should also position themselves so that one is available to coach and support the patient, while also preparing for neonatal resuscitation. The other aids in the delivery of infant, and placenta, and cares for the mother during the recovery stage.

The following is a review of general delivery techniques:

Preparing for Delivery

- Remain calm, and constantly reassure mother and support person if available.
- Position patient supine with left lateral wedge to prevent vena cava compression (hypotension). Place pillow under patient hips to elevate them for ease of maneuvering infant during delivery.
- Drape the patient to allow for privacy, and place towels or chux under buttocks.
- Ensure universal precautions such as gloves, goggles or mask, etc. to prevent transmission of infectious disease through blood and body fluids.
- Monitor FHR via continuous fetal monitor or doptone at least every 5 minutes and following every contraction.
- Obtain IV access if time allows, and apply O2 via facemask if fetal distress noted.

Delivery of Infant

- Apply gentle but firm support to perineum as infant head begins to crown.
- Support infant head as it emerges to prevent explosive delivery; however, never pull or tug on infant head.
- Once head is delivered, gently turn head to side (toward mothers' thigh), and suction infant's mouth and nose with bulb syringe.
- Feel around infant's neck for the presence of the umbilical cord. If the cord is there, gently slip it over the head. If the cord is too tight to move, place two clamps on the cord side by side and cut in between to remove cord from neck.
- While supporting head, gently guide it downward to deliver anterior shoulder, then upward to deliver posterior shoulder. Do not use force. Infant's body should slip out upon delivery of both shoulders.
- Note time of delivery.
- Clamp cord with two clamps, approximately 6 inches apart, and cut cord. Leave at least 4–6 inches of cord between infant's umbilicus and first clamp.
- Dry and provide tactile stimulation to infant. Discard wet towels and blankets.
- Provide resuscitation as needed. (Refer to N.R.P. guidelines).
- Assign 1 and 5 minute APGAR scores.
- Wrap infant in dry blankets. Place ID band on baby with corresponding ID on mother.

Delivery of Placenta

The placenta normally delivers within 10 to 30 minutes after birth. A gush of blood and lengthening of the cord usually precede it. A gentle massage of the uterus may be necessary to help the uterus to contract and expel the placenta. As the placenta appears at the vagina, gently grasp it and guide it out. *Never pull on the umbilical cord in an attempt to deliver the placenta.*

Place the placenta and cord in a container or bag and bring to the hospital. Assess the amount of blood loss after delivery. Gentle uterine massage will assist the uterus to contract and reduce bleeding. If the infant is healthy, breast-feeding also helps to cause contraction of the uterus. Pitocin 10–20 units may be added to 1000 cc bag of lactated ringers after delivery of placenta, and rate adjusted to keep uterus firm and control bleeding.

Transfer of Care

Upon arrival at the receiving facility, turn over care of both patients to the on-duty staff. Provide an accurate report of the history, labor, delivery, resuscitation and delivery of placenta including an accurate time of birth and APGAR scores. Review the information on the ID band placed on the infant and mother. Check for accuracy with another staff or crew member.

COMPLICATED DELIVERIES

It is important to remember that a majority of normal healthy deliveries occur with or without the help of the crew members, as mother nature intended. It is very important to remain calm and reassuring despite the situation, so that the mother will clearly hear and understand directions. There are some occasional deliveries that require the utmost care and attention to prevent additional complications. The following are a few of the most common complications associated with vaginal deliveries.

Breech Presentation

A breech presentation is defined as the presentation of the infant's lower body parts first in the birth canal. There are three types of breech presentations:

- Frank breech—the presenting part is the buttocks with the thighs flexed onto the abdomen and the legs extended onto the chest
- Compete breech—the thighs are flexed onto the abdomen and the calves are doubled back onto the thighs
- Footling breech—one or both of the legs is extended at the knees and hips and the foot is the presenting part at the vagina

Complications of breech presentations include cord compression or prolapse, fetal birth trauma or asphyxia, and head entrapment. If at all possible, attempt delivery at a hospital capable of performing an emergency C-section.

Shoulder Dystocia

Shoulder dystocia is defined as the successful delivery of the head, but the shoulders become impacted above the pelvic brim. Some of the contributing factors include maternal obesity and diabetes, post-term pregnancy, and fetal macrosomia.

Complications for the fetus may include fetal anoxia, fractured humerus or clavicle, and fetal death. Some delivery maneuvers used to assist in the delivery of an impacted shoulder include:

- McRoberts' Maneuver—consists of sharply flexing mother's legs up onto her abdomen, thereby opening the pelvic outlet
- Suprapubic pressure—external pressure above the pubic bone to assist in dislodging the impacted shoulder
- Woods' Corkscrew Maneuver—progressively rotating the anterior shoulder 180 degrees like a corkscrew

Prolapsed Cord

A prolapsed cord is defined as the prolapse of the umbilical cord alongside or in front of the presenting part of the fetus. This is a true fetal emergency. Some contributing factors include breech presentation, unengaged fetal head, twin gestation, and transverse lie.

Complications include severe fetal distress, including variable decelerations, fetal bradycardia, and fetal death. The treatment plan is to relieve pressure of infant off the cord by insertion of gloved hand into vagina and holding presenting part away from cord. Placing the mother in a knee-chest position (when applicable) or elevated lithotomy position may help to relieve pressure on the cord. This solution is temporary until an emergency C-section is provided.

Postpartum Hemorrhage

A postpartum hemorrhage is defined as vaginal blood loss of more than 500 cc following delivery. This is a true maternal emergency, as a mother may lose a tremendous amount of blood in a very short period of time. Contributing factors include fetal macrosomia, uterine atony, partial remain of placenta fragments, and vaginal or cervical lacerations.

Rapid and aggressive treatment should include uterine massage, rapid IV infusion of lactated ringers or normal saline solution with 10–20 units of pitocin to each liter, addition of second large bore IV, administration of methergine 0.2 mg IM (unless contraindicated), Hemabate IM if available, blood or albumin products, and a foley catheter. If the patient is hemodynamically unstable, consider application of the MAST. suit.

The patient requires rapid transport to a medical facility to determine the cause of the bleeding and intervention as soon as possible.

REFERRAL FACILITY FOLLOW UP AND OUTREACH

Outreach education at the referral facility begins as soon as the initial call for referral is made. The team members should always keep in mind that the best opportunity to educate the outlying facility is during a transport. Public relations is vitally important to the continued success of all transport programs. The way that the transport team treats the referral staff and physician often determines whether they are invited back again.

The transport team should be trained extensively in public relations techniques, which should be implemented even before reaching the outlying facility. During telephone report, maintain a calming and reassuring voice and attitude. If, during report, it becomes obvious that aggressive stabilization would be useful, gently suggest that it be initiated to expedite the transport.

The nurses and doctors at the outlying facility are usually very stressed and anxious to get the patient out of their hospital as fast as they can. They need to be reassured that you will move rapidly to accomplish the transfer, but that you need time to assess the patient. It is difficult to remain calm and cool when you arrive and know that there are many things that they could have done differently. However, this is not the time to discuss faults or even give them strange looks. They tend to pick up on nonverbal body language. Find something positive to praise, and thank them for the referral.

Many times a transport team is viewed by the referral facility as either the “angels” or the “know it all people”. Many referring nurses feel that the team is a threat. It is often very difficult for the nurses taking care of the patient to turn them over to the team. Involve nurses in helping to package the patient to help them feel that they are a part of the team.

Once the patient is transferred, a follow up call should be made as soon as the patient is settled following the transport. The referring nurse or physician should be told how the patient tolerated the transport and any other findings that might have been noted. A follow-up letter and/or phone message should be sent within the week letting them know the patient progress and thanking them for the referral. Many teams also leave trinkets, such as candy or pens, as a gentle reminder to call again.

It is very important to provide educational opportunities to the referral facilities to enhance communications and collaboration. Providing outreach education allows every person involved in the transport to function as part of unified team providing patient care. Visit the referral facility during staff meetings so that any questions can be answered and problems verbalized in a nonthreatening environment. Invite the referral facility to educational opportunities that your team is involved in, or provide them with their own in-service training. Remind the team that everyone is working toward one common goal, QUALITY PATIENT CARE, provided in a facility equipped to meet patient needs.

SUMMARY

All air medical providers must be competent to assess and care for a pregnant patient with an acute illness or injury. They also must be competent in assessment, labor support, delivery and resuscitation of the term and near-term infant. Regardless of the number of maternal transports each team member does, the need to maintain competency is paramount, as each patient deserves the same high level of care.

There are many risk factors that raise the index of suspicion for the delivery of a sick or premature infant. The medical crew must be familiar with these factors and the best course of action to treat, transport or triage these patients. When it is known that the pregnant woman is acutely ill or injured and her condition is putting both her and the fetus at greater risk, or if she is at risk for a difficult or preterm delivery, a flight team that is familiar with this patient type, and which responds to these high-risk calls as part of their program mission and scope of practice, should be called to respond. Once the assessment, stabilization and appropriate transport have been initiated, the next step is to insure that the receiving hospital is the one best suited to care for this type of patient. A follow-up call should be made to the referral institution in an effort to maintain a mutual respect and excellent communication between the referral and receiving facilities. This will ensure continuity of patient care and encourage continued referrals.

The following exhibits accompany this module:

Exhibit 29-1: Suggested Equipment and Supplies for OB Care
Exhibit 29-2: General Maternal Transport Guidelines
Exhibit 29-3: Guidelines for High-Risk OB Transports

EXHIBIT 29-1: SUGGESTED EQUIPMENT AND SUPPLIES FOR OB CARE

This list is not complete and is intended to be an adjunct to equipment already used by the transport team. The program mission, scope of practice, and medical direction will determine the specific equipment and medications required.

Maternal Equipment

- Various IV solutions and IV start equipment
- Disposable sterile speculum, lubifax, sterile gloves, nitrazine paper, peri pads
- Doppler with microphone or headphones, conductive gel
- Fetal monitor with straps (optional)
- Emergency delivery kit
- Drug box to include:
  - Antibiotics
  - Antihypertensives
  - Anticonvulsants
  - Antinausea meds
  - Narcotics
  - Oxytoxic drugs
  - Tocolytics
- ACLS equipment
- ACLS medications
- Cardiac monitor/defibrillator
- SaO2 monitor
- Oxygen and suction equipment (portable p.r.n.)

Neonatal Equipment

- Disposable scalpel, cord clamps, bulb syringe
- Diapers, T-shirts, hat, baby blankets, and heat packs
- Feeding tubes, tape, liquid adhesive
- Neonatal respiratory equipment to include:
- ET tubes, laryngoscope, stylet
- O2/suction
  - Bag valve mask with O2 tubing
  - Neonatal emergency resuscitation medications

EXHIBIT 29-2: GENERAL MATERNAL TRANSPORT GUIDELINES

To be followed on all maternal transports

- Introduce team to patient, family, nursing staff and physician.
- Obtain updated report on patient status upon arrival to referral facility.
- Obtain copied chart and patient consent for transfer.
- Perform head to toe assessment including vital signs, IV site patency check, I & Os, DTRs, lung sounds, edema, etc.
- Review fetal monitor tracings from last several hours if available. Assess current contraction and fetal heart rate status by fetal monitor if available, or via fetoscope or doppler. Assess fundal height and palpate abdomen for position, presentation, and fetal size.
- Assess status of amniotic membranes and if ruptured, note color and confirmation via sterile speculum exam. If PROM, examine only if active labor with imminent delivery is expected. If not contraindicated, perform sterile vaginal exam.
- Administer medications per standing orders.
- Transport in left/right lateral uterine displacement position with safety straps secured below uterus.
- Monitor vital signs every 15 minutes or more frequent per specific conditions such as hypotension, hypertension, maternal tachycardia or bradycardia.
- Monitor fetal heart rate and uterine contractions a least every 15 minutes on stable patients and continuous, or during and after contractions on nonreassuring fetal heart rate tracings (and/or unstable mother).
- IV fluid rates not to exceed 100 cc/hour, unless specific conditions warrant.
- Foley catheter p.r.n. to monitor output or for urinary retention.
- Strict I & Os.
- Cardiac monitor, SaO_2 p.r.n.
- Oxygen p.r.n. (Titrate to maintain SaO_2 > 95 percent).
- Consider pre-medicating with anti-anxiety, anti-nausea medications.
- Anticonvulsant medication per medical director for seizure activity.
- Continually reassess patient and adjust treatment plan accordingly.

Notify medical director and receiving facility of worsening condition of mother or fetus during transport to ensure assistance upon arrival

EXHIBIT 29-3: GUIDELINES FOR SPECIALIZED OB TRANSPORT

To be followed on all high-risk transports. All treatments and interventions must be supported by written order, standing order, or physician-approved written protocols.

A. **Preterm Labor (PTL) and/or Premature Rupture of Membranes (PROM)**

- Follow general standing orders.
- If no preexisting condition, consider an IV fluid bolus for possible dehydration.
- Consult standing orders or medical direction for tocolytic choice (usually MgSO4 or Terbutaline).
- Assess continually for s/s of MgSO4 toxicity by monitoring DTRs, respiratory rate, and adequate urine output.
- Antidote to MgSO4 overdose: Calcium gluconate (dose per medical direction) Observe BP closely.

B. **Pregnancy Induced Hypertension (PIH) and/or Preeclampsia**

- Follow general standing orders.
- Maintain left lateral uterine displacement position.
- Mainline IV to titrate (total IVF <100 cc/hour).
- O2 via nonrebreather facemask @ 15 liters. Assist ventilation if necessary.
- Magnesium Sulfate (MgSO4), per medical direction—use with caution in decreased urine output.
- Foley catheter with urometer to monitor hourly I & O status.
- Antihypertensive medications per protocol.
- Monitor closely for s/s pulmonary edema.

C. **Eclampsia**

- Establish patent airway. Assist ventilations with bag/mask and intubate as needed to protect airway.
- Rebolus with MgSO4 per protocols.
- Notify medical director for additional antiseizure medication therapy.

D. **H.E.L.L.P. Syndrome**

- Follow chapter 2 preeclampsia guidelines.
- Ensure seizure prophylaxis protocol.
- Establish current platelet count, liver profile, and clotting panel.
- Expedite delivery to tertiary care center as these patients become unstable very rapidly.

E. **Maternal Hemorrhage**

- Primary assessment (BLS).
- Secondary assessment to include vital signs and FHR.
- O2 via nonrebreather facemask @ 15 liters.
- Assess contraction status and amount of blood loss.
- Maintain two patent large bore Ivs. Titrate to maintain adequate BP for maternal and fetal perfusion.
- Foley catheter—maintain urine output >30 cc/hr.
- Administer medications as ordered by medical direction. (Terbutaline contraindicated with vaginal bleeding).
- NO vaginal exams unless placenta previa is ruled out.
- Extremely rapid transport to the most appropriate facility to manage maternal/fetal emergency.

F. **Postpartum Hemorrhage**

- Primary survey.
- Secondary assessment to include vital signs and bleeding status. Repeat BP frequently and treat hypotension.
- O2 via FM @ 15 liters via nonrebreather facemask.
- Fundal massage—may be necessary to do continuous fundal massage if uterus becomes boggy.
- 2 large bore IVs with rapid infusion of IVF.
- Consult MD or protocols for medication choice.

A. **Bibliography**:

A.C.O.G. Technical Bulletin No. 219, *Hypertension in pregnancy*, January 1996.

A.C.O.G. Technical Bulletin No. 206, *Preterm Labor*, June 1995.

American College of Obstetricians and Gynecologists and American Academy of Pediatrics, *Guidelines for Perinatal Care*. 4th Ed., 1997.

Elliott, J. & Sipp, T, & Balazs, K., "Maternal Transport of patients with advanced cervical dilation—to fly or not to fly?" *Obstetrics & Gynecology*, Vol. 79, No. 3, March 1992.

Lee, G., *Flight Nursing Principles and Practice*, 1st ed., Mosby: St. Louis, 1991.

Mandeville, L. & Troiano, N., *High—Risk & Critical Care Intrapartum Nursing*, 2nd ed. J.B. Lippincott: Philadelphia, 1999.

National Flight Nurses Association, *Flight Nursing Core Curriculum* "Obstetrical Transport" Chapter 16 & " Neonatal Transport" Chapter 17: 1997.

Nelson, M., " The high-risk obstetric patient", *Air Medical Crew Core Curriculum*, p. 177–190. ASHBEAMS/US Department of Transportation: Pasadena.

Sibai, B. & Ramadian, M., "Maternal morbidity and mortality in 442 pregnancies with H.E.L.L.P. Syndrome". *American Journal Obstetrics & Gynecology*, v. 169, 1000–1006.

B. **Definitions of Keywords**:

Amniotic fluid—Fluid contained in the amniotic sac which the fetus floats in, serving as a cushion and maintaining constant body temperature

Clonus—Alternate muscular contraction and relaxation in rapid succession

Deep tendon reflexes (DTRs)—Elicited by a sharp tap on an appropriate tendon or muscle to induce brief stretch followed by contraction

Dilation—Stretched beyond the normal dimension. The measurement of cervical opening in pregnancy

Effacement—Thinning or obliteration of the cervix

Estimated date of confinement (EDC)—Approximate due date of fetus

Fetal well being—Reassurance of fetus doing well in uterus

Gravida—The number of times a woman has been pregnant

Para—Number of pregnancies resulting in a birth (viable or nonviable)

Last menstrual period (LMP)—The last menstruation prior to becoming pregnant

Nonreassuring fetal tracing—Insufficient blood flow and/or placental perfusion resulting in inability of FHR to have spontaneous accelerations

Presentation (fetal lie)—That portion of the fetus that is touched by the examining finger through the cervix

Station—Location of presenting part of fetus in birth canal (represented in numbers from –3 to +3) with 0 station at the ischial spines

Nonstress Test (NST)—A reactive NST is a reassuring sign that the infant has met the criteria of having accelerations of 15 beats per minute above the baseline lasting 15 seconds.

Contraction Stress Test (CST) Oxytocin Challenge Test (OCT)—CST or OCT requires the patient to have three spontaneous or induced contractions within 10 minutes.

Biophysical Profile (BPP)—fetal observation done during real time ultrasound

Test Questions:

1. Important information to obtain on a maternal transport should include:

   a. Gravida, Para, multiple gestation
   b. Estimated date of confinement (EDC)
   c. Cervical dilation, contraction status
   d. Maternal vital signs, Fetal heart rate pattern
   e. All of the above

2. H.E.L.L.P. Syndrome stands for

   a. Hemolysis, Extra Levels of Liver Proteins
   b. Hemolysis, Elevated Liver, Low Platelets
   c. Hemolysis, Edema Lower Extremities, Proteinuria
   d. None of the above

3. Fetal tachycardia is:

   a. Defined as a FHR > 160 for 10 minutes or more
   b. May occur with maternal fever or chorioamnionitis
   c. Both of the above
   d. None of the above

4. Which one of the following suggests a reassuring fetal heart rate pattern?

   a. FHR of less than 110 for longer than 10 minutes
   b. **Variable FHR between 110 and 160**
   a. FHR with no accelerations
   b. FHR decelerations that begin after the start of the contraction and remain below baseline until after the contraction is completed

5. During air transport, expansion of gas trapped with the maternal body may:

   a. Cause discomfort
   b. Aggravate or increase contractions
   c. Cause a release of oxytocin that stimulates uterine contractions
   d. All of the above

D. **Didactic Hours**: 16

E. **Skills Hours**: Teams that transport high-risk OB patients should have a competency checklist based on specific protocols, medical direction, program mission, and scope of practice. Skills labs hours should be sufficient to have team members develop skills on the checklist. Skills practice should be scheduled prior to any assigned patient care hours.

Examples:

- Taking an OB specific history
- Labor support and positioning
- Assessment of term obstetrical patient
- Fundal height measurement

- Leopold's Maneuvers/assessment of fetal lie
- Read FHT to assess rate and presence/absence of variability
- Packaging OB patient
- Term delivery
- Newborn resuscitation
- Review on-board OB and neonatal equipment and supplies

F. **Patient Care Hours**: 16–24, Ante-partum and/or Labor & Delivery

MODULE 30: NEONATAL CARE

Authors: Ms. Linda Meiner, RN, AirEvac Flight Services, Phoenix, AZ
Dr. Hal Kaftan, Children's Mercy Hospital, Kansas City, MO
Dr. Ralph Wynn, Children's Hospital of Buffalo, Buffalo, NY

Reviewers: Mr. Eric Smith, RN, Children's Mercy Hospital, Kansas City, MO
Ms. Sherri Dean, RN, Children's Mercy Hospital, Kansas City, MO
Ms. Cynthia Nedoba, RN, San Diego Children's Transport, San Diego CA
Dr. Sue Smith, Oregon Health Sciences University, Portland, Oregon

OBJECTIVES

Upon completion of this module, the student will be able to:

- Verbalize the differences between AGA, SGA and LGA
- Outline the steps performed in the initial neonatal patient assessment
- List 2 maternal and 2 fetal risk factors that may necessitate aggressive neonatal resuscitation
- Discuss the components of a thorough maternal history
- Describe supportive family care that should be provided prior to the transport of any infant

KEYWORDS

Acrocyanosis
Gestational age
AGA, LGA, SGA
IUGR
Meconium
Moro reflex
Plethora
Polyhydramnios
Neonate
Oligohydramnios

INTRODUCTION

Most air medical providers will not be called upon to care for high-risk neonates, although assisting in a delivery, caring for the newly born term or near-term infant may be required. For that reason, it is important that all air medical providers have a thorough knowledge of neonatal anatomy, physiology and common disease processes. Understanding maternal and neonatal risk factors will assist the provider in recognition and preparation for the difficult delivery and resuscitation.

TEAM CONFIGURATION

Although many well-trained air medical and ground teams specialize in the care of high-risk neonatal patients, all EMS providers and air medical crew members will, at some time, be asked to transport a pregnant medical, trauma or laboring patient with the possibility of en route delivery. For that reason, training must be conducted to prepare **all** air medical providers to respond appropriately to neonatal emergencies. Neonatal resuscitation, recognition of the high-risk neonate, emergency neonatal care and transport management must be included. Triage schemes based on team preparation and availability must be in place to address all levels of neonatal patient acuity. The Air Medical Physician Handbook outlines suggested triage schemes based on team preparation and availability. Regardless of the initial telephone triage report, it must be assumed that the expected patient acuity may change for the worse before the arrival of the transport team.

When a flight program accepts the responsibility of caring for high-risk neonatal patients as part of their Program Mission and Scope of Practice, all transports of this type must be staffed with team members capable of meeting the needs of the most critical neonatal patient.

FLIGHT NURSING INITIAL ASSESSMENT

There are multiple components of an initial neonatal assessment. In essence, the air medical provider must conduct an assessment of two patients, the mother and infant. The maternal “assessment” is done by a thorough review of pre-natal history, past medical history and delivery history. This information must be reviewed and evaluated in terms of the birth information, resuscitation and continued needs of the newborn. When the air medical provider has information from all of these sources, informed treatment decisions can then be made.

Prenatal History

Include maternal age, significant family history, maternal medical history, reproductive history, reported as **G, P** to include number of pregnancies (G) and number of deliveries at or beyond 20 weeks (P), or as **G/TPAL** to include number of pregnancies (G), term deliveries (T), preterm deliveries (P), abortions (A) and living children (L). Include last menstrual period (LMP) and estimated date of delivery (EDD) as well as prenatal care and prenatal testing results (blood type, Rh factor, antibody screen, ultrasounds, genetic screening, syphilis serology, screening tests results for rubella, hepatitis B, human immunodeficiency virus, drugs, and group B streptococcus).

Perinatal Risk Factors

Risk factors that are associated with the need for neonatal resuscitation are identified in the following table.

Perinatal Risk Factors	
Maternal	**Uterine**
Age—<16, >35 years	Abnormal fetal presentation
Anemia	Cesarean section
Acute life-threatening disease	Chorioamnionitis
Diabetes	Fundal height inconsistent with dates
Drug therapy—Lithium carbonate, magnesium, excessive analgesia, anesthesia	Multiple gestation
	Polyhydramnios/Oligohydramnios
Hypertension—pregnancy induced or chronic	Precipitous labor
Hypotension, dehydration	Preterm labor (< 37 weeks)
Infections	Prolonged labor
No or poor prenatal care	Prolonged rupture of membranes
Previous fetal or neonatal death	
Rh sensitization	**Umbilical**
Substance abuse, smoking	Cord accidents—prolapse, knots
	Cord compression
Placental	Cord rupture
Abruptio placentae	
Placenta previa	**Fetal**
Placental insufficiency	Decreased fetal activity
Post-term pregnancy	Fetal bradycardia
	Forceps or vacuum assisted delivery
	Nonreassuring fetal heart rate patterns
	Meconium stained amniotic fluid

Labor and Delivery History

Include onset of labor (time as well as spontaneous versus induced). Note any maternal complications such as preterm labor, pregnancy induced hypertension, HELLP Syndrome, vaginal bleeding, abruption, or eclampsia. Note any fetal complications such as abnormal presentation, multiple gestation, or fetal stress (bradycardia, tachycardia, decreased variability, decelerations). Remember that any of the above maternal or fetal risk factors can necessitate a more aggressive neonatal resuscitation. Obtain history on rupture of membranes (time from rupture until delivery as well as spontaneous versus artificial rupture) and appearance of fluid (amount, color and odor). Describe type of delivery (vaginal, cesarean, use of forceps or vacuum, anesthesia and analgesia).

A simple chart that will aid in obtaining the prenatal and perinatal history follows below.

Maternal History: _____y.o. G__ / now T__, P__, A__, L__
Bld Type:___ PNC: ☐yes ☐no ☐limited(<3 visits) EDC:_____
Serology: ☐pos ☐neg ☐unk Rubella: ☐imm ☐non-im ☐unk
Hep B: ☐pos ☐neg ☐unk HIV: ☐pos ☐neg ☐unk
Drug Screen: ☐pos ☐neg ☐unk GBS: ☐pos ☐neg ☐unk
☐SROM ☐AROM @________ Fluid________________
Delivery: ☐Vag ☐C/S ☐Forceps ☐Vacuum ☐Nuchal Cord x__
Mat Risks: ☐None ☐PTL ☐PIH ☐HEELP ☐Vag Bldg
☐Abruption ☐Eclampsia ☐Other______________________
Fetal Risks: ☐None ☐Bradycardia ☐Tachycardia
☐↓variability ☐Fetal Distress ☐Abn Present ☐Post Dates
☐Mult gest ☐Other ___________________________________
Add'l Notes: ____
____
____
____

RECOGNITION OF THE HIGH RISK NEONATE

In addition to evaluation of the perinatal history, identification of the high-risk neonate is accomplished through complete and ongoing assessment of the infant's condition.

Indications for specialized care include:

- Birth ashyxia or depression
- Congenital anomalies including abnormal proportions
- Congenital infections
- Hypoglycemia

ASSESSMENT OF THE NEONATE

Assessment of the neonate must include perinatal history, including prenatal, labor, delivery and resuscitation history. Physical assessment must include an initial assessment to evaluate the infant's need for immediate interventions. After immediate needs are addressed, a detailed assessment should include a complete physical exam and estimation of gestational age. The detailed assessment will assist in evaluating the infant's response to interventions as well as identify other potential needs and allow for timely initiation of treatment.

During a normal transition to extra-uterine life, infants exhibit the following characteristics*:*

- Heart rate—120–160 bpm
- Respiratory rate—40–60/min, may be regular or irregular

- Color—generally pink, acrocyanosis not uncommon during 1st 24 hours
- Perfusion—strong palpable pulses (mean blood pressure at least equal to gestational age), capillary refill 2–3 seconds
- Mild respiratory distress for the first 15–20 minutes may be seen (occasional grunting, flaring, mild retractions, tachypnea)

Resuscitation History

Obtain assigned APGAR scores. The APGAR score is very useful in describing the neonate's condition at birth and its initial response to extra-uterine life and resuscitation. Note any resuscitation interventions and responses.

APGAR Score

	Score = 0	Score = 1	Score = 2
Activity—Muscle Tone	Flaccid	Some flexion of extremities	Well flexed, or active movements of extremitie
Pulse—Heart rate	Absent	Below 100	Above 100
Grimace—Reflex Irritability	No response	Grimace or weak cry	Good cry, sneezes, coughs, pulls away
Appearance—Color	Cyanotic or pale over entire body	Acrocyanosis	Pink over entire body
Respiratory Effort	Absent	Weak, irregular or gasping	Good, crying

Initial Assessment

The initial assessment should be performed quickly in order to determine the immediate needs of the neonate. Initial assessment can be remembered using an A-B-C-D-E approach and should include vital signs such as: heart rate, respiratory rate, color, quality of respiratory effort, temperature, pulse oximetry and activity level. During this assessment, if problems are identified, air medical crew should take appropriate steps to correct the identified problem.

- **Airway**—Assess infant's ability to maintain an open and adequate airway. Listen for sounds of obstruction. Proper positioning of infant's head is important. Hyperextension or flexion can easily occlude the airway. Position infant on back or side with head slightly extended in a "sniffing" position. If the infant is positioned on their back, a blanket or towel roll placed under the shoulders (not the neck) will help maintain correct positioning. Clear secretions, if necessary, using bulb syringe for oral and nasal secretions. To prevent a vagal response with resultant bradycardia, deep mid-line suctioning should be avoided. For excessive and thick secretions, use of suction catheters and wall suction (approximately

100 mm Hg) may be required. If meconium was present at delivery, the infant should have been suctioned on the perineum. If this infant was depressed at birth (poor respiratory effort, poor tone or heart rate less than 100 bpm), direct tracheal suctioning should have been performed to attempt to clear meconium prior to initiation of ventilation.

- **Breathing**—Assess infant's ability to maintain adequate ventilation. Evaluate the infant's respiratory effort and rate. Assess for adequacy and symmetry of breath sounds and chest excursion. Assess color and O2 saturation via pulse oximetry. Work of breathing can be assessed by evaluating nasal flaring, retractions and grunting. If the infant is apneic, in distress, or unable to maintain a heart rate greater than 100 bpm, immediate interventions are necessary. Appropriate interventions may include stimulation, supplemental oxygen, bag/mask CPAP or ventilation, intubation, decompression of pneumothorax and/or gastric decompression.

- **Circulation**—Assess infant's ability to maintain adequate circulation. Evaluate the infant's heart rate, color, central and peripheral pulses, capillary refill, blood pressure, activity level and urine output. Interventions to correct inadequate circulation include establishment of IV access, administration of volume expanders, and medications such as epinephrine, sodium bicarbonate, dopamine and/or chest compressions.

- **Dextrose (and other drugs)**—Assess the infant's need for administration of dextrose or other drugs such as antibiotics. Infants at high risk for hypoglycemia include premature and postmature infants, small (SGA) or large (LGA) for gestational age infants, infants of diabetic mothers (IDM), and infants who are stressed with asphyxia, shock, sepsis or hypothermia. Blood glucose levels should be measured for all at-risk infants. Glucose levels of less than 40 mg/dl can be treated with a bolus of D10W 2 ml/kg IV. Infants with a glucose level greater than 40 may only require a maintenance infusion of D10 W at 80 cc/kg/day (3.3 cc/kg/hr). Infants at risk for infection may require early dosing with antibiotics. When possible, a blood culture should be drawn prior to antibiotic administration. Ampicillin and Gentamicin are commonly used.

- **Environment**—Throughout all phases of neonatal care, attention must be paid to providing the infant with a dry, warm and safe environment. Assess the infant's temperature. Every neonate is at risk for hypothermia. Successful resuscitation is delayed if the neonate becomes hypothermic. Hypothermia increases oxygen and glucose consumption and can lead to acidosis. Heat loss can occur through convection, conduction, evaporation and radiation. Necessary interventions include drying the infant, protection from cold stress (hat, pre-warmed transport incubator and blankets) and provision of heat source (incubator, unobstructed radiant heat, and chemical heat mattress). Avoid hyperthermia by careful monitoring of infant's temperature. Maintain skin or axillary temperature between 36 and 37 degrees centigrade.

Detailed Assessment

The detailed assessment should be performed after immediate needs identified during the initial assessment are met. This should also include review of any available X-rays, blood gases and laboratory results. Air medical crew should be familiar with available tools to assess the gestational age of a newborn. One such tool is the "New Ballard Score" developed by J. L. Ballard (1991). Familiarity and practice with this tool during clinical training will allow air medical crew members to confirm or assign an estimate of gestational age during a transport. Gestational age assessment assists in identifying probable and potential risks, and predicting morbidity and mortality risk. An Infant Assessment Checklist is located in the Appendices. This form can be used as a guide for the documentation of a detailed assessment. Portions of this assessment may be deferred or completed en route when indicated by the acuity of the infant.

CONDITIONS WARRENTING TRANSPORT

Almost without exception, neonatal transports originate at a facility with fewer perinatal and neonatal resources than the receiving high-risk center. The neonatal team leader must demonstrate competency and leadership in the overall management of the high-risk neonate and the transport environment. The following conditions usually require an urgent or emergent transfer by ground or air.

Respiratory Conditions

- Respiratory Distress Syndrome (RDS)

  Respiratory distress syndrome is caused by insufficient production of surfactant in the immature lung. RDS presents at or within hours after birth, and is characterized by tachypnea, expiratory grunting, nasal flaring and retractions (i.e. breath sounds are diminished bilaterally). Supplemental oxygen is necessary to prevent cyanosis. The chest x-ray typically shows poorly expanded lungs with a granular or ground glass appearance. Air bronchograms are also commonly seen on the chest x-ray.

The incidence of RDS increases with decreasing gestational age. Other factors associated with an increased incidence of respiratory distress syndrome include maternal diabetes, cesarean section without labor, perinatal asphyxia and being the second born of twins.

The treatment of neonates with RDS focuses on maintaining adequate oxygenation and carbon dioxide levels. Initial treatment is to provide supplemental oxygen to maintain a PaO_2 of 50–80 mmHg. Intubation and mechanical ventilation are indicated if the PaO_2 is less than 50 mmHg with an F_IO_2 greater than 0.60 or if the $PaCO_2$ is greater than 50 mmHg.

The treatment for RDS is exogenous surfactant administered via the endotracheal tube. There are several commercially available surfactant preparations. Exogenous surfactant should be given to intubated neonates with RDS but only with guidance from experienced personnel.

It is important to remember that pulmonary compliance can change rapidly after administration of surfactant. Blood gases and patient response must be closely monitored to ensure that ventilator adjustments are made in a timely manner.

- **Transient Tachypnea of the Newborn (TTN)**

Transient tachypnea of the newborn is generally believed to be the result of delayed resorption of the fetal lung fluid at the time of birth. It typically occurs in term or near term infants and is more common when the delivery is precipitous or the delivery is via C-section without a trial of labor.

The infant with TTN usually presents shortly after birth with a respiratory rate grater than 60. He may have mild retractions and mild nasal flaring. Air exchange is generally good, often with wet rales or rhonchi. Supplemental oxygen may be required to maintain oxygen saturation greater than 92 percent. If the patient is requiring greater than 40 percent oxygen or has increasing respiratory distress, other diagnoses should be considered. The chest x-ray will show mild perihilar streakiness and possibly fluid in the minor fissure.

The acute management consists of supplemental oxygen. If the respiratory rate is greater than 60 the baby should be NPO and given IV fluids at 60–80 cc/kg/day. TTN typically resolves by 24 hours of age. Placement of a nasal or oral gastric tube to vent may decrease gastric dilatation.

- **Meconium Aspiration Syndrome (MAS)**

Meconium passage in utero occurs in 8–20 percent of all deliveries. It is most common in the presence of conditions that lead to fetal hypoxemia such as cord or utero-placental compromise. It is observed predominately in postdates and SGA/IUGR infants.

Careful and thorough suctioning of the oropharynx before delivery of the thorax, and endotracheal suctioning of the neonate with cardiorespiratory depression, has decreased but not eliminated this condition. Aspiration of meconium-stained amniotic fluid may occur in utero.

The infant with MAS has the typical signs and symptoms of respiratory distress. In addition, the chest is often observed to appear hyper-inflated. Unilaterally decreased breath sounds, or distant heart sounds, should make one consider associated complications of pneumothorax or pneumomediastinum. The chest x-ray shows irregular, patchy, course areas of density. Evidence of an air leak might be present.

The acute management consists of supplemental oxygen to maintain a high SpO2 greater than 95 percent. Antibiotics should be considered as part of the therapy. As these infants are often labile and at risk for spontaneous air leak, minimal stimulation and/or sedation might be helpful. Be prepared to manage a pneumothorax. These patients are also at risk for developing persistent pulmonary hypertension and might need endotracheal ventilation, nitric oxide or ECMO.

CARDIOVASCULAR DISEASE

- **Congenital Heart Disease (CHD)**

The incidence of congenital heart disease is approximately one per 250 live births. The initial presentation and the prognosis vary widely depending upon the nature of the structural heart defect. The most obvious sign of congenital heart disease is cyanosis in the absence of any respiratory distress. However, infants may also present with tachypnea and dyspnea, poor perfusion, a heart murmur, poor feeding and various degrees of congestive heart failure.

Cyanosis is the most common sign of congenital heart disease in the newborn. The specific lesions that present in this way in the first week of life are transposition of the great arteries, hypoplastic left heart syndrome, tetralogy of Fallot, truncus arteriosus, tricuspid atresia and total anomalous pulmonary venous return.

In evaluating the cyanotic infant, several simple diagnostic tests should be obtained to differentiate cardiac from respiratory disorders. A chest x-ray will quickly rule out pulmonary causes such as RDS, pneumonia or a pneumothorax. Four extremity blood pressures should be obtained. A systolic BP that is greater than 10 mmHg higher in the upper extremities when compared to the legs suggests the baby may have a coarctation of the aorta.

The hyperoxia test provides additional useful information. This test is done by placing the infant in 100 percent oxygen and obtaining an arterial blood gas. A PaO_2 less than 100 in the absence of significant lung disease is highly suggestive of a structural heart lesion.

Stabilization prior to transport should focus on obtaining and maintaining a stable airway. Reliable vascular access should be established. This typically requires placement of a UVC. A prostaglandin E_1 (PGE_1) drip at 0.1 mcg/kg/min should be started until an echocardiogram can be obtained and the importance of ductal patency assessed. Many infants with CHD develop severe clinical signs when the PDA closes as is normally expected. A PGE_1 drip may correct or prevent deterioration by maintaining patency of the ductus arteriosus. The transport personnel should be prepared to intubate the patient on PGE_1 as it commonly causes apnea.

- **Rhythm Disturbances**

Supraventricular tachycardia (SVT) is the most common symptomatic dysrhythmia in newborns. SVT typically has a rate >200. The onset and the resolution of SVT are sudden. Distinguishing SVT from sinus tachycardia is helped by the fact that SVT has very little variation in the heart rate. Variation of the rate with crying or feeding suggests a sinus tachycardia. Neonates are frequently asymptomatic initially but will develop congestive heart failure if the dysrhythmia is not corrected.

In the hemodynamically stable infant, SVT can be treated with vagal maneuvers such as inducing a gag or an ice compress to the face. If these measures fail the treatment of choice is IV adenosine. Adenosine is given as a rapid IV bolus with starting a dose of 0.05 mg/kg. If there is no response the dose should be doubled and repeated. The majority of infants with SVT will respond to adenosine. Some patients may require synchronized cardioversion. If possible, an electrocardiogram (EKG) should be obtained prior to treatment and repeated after the patient has been converted to a sinus rhythm. The EKG will help determine the underlying cause of SVT.

- **Persistent Pulmonary Hypertension in the Newborn**

Previously called “persistent fetal circulation”, this condition causes the blood returning to the heart to by-pass the pulmonary circulation through physiologic shunts that existed in the fetus. While before birth the placenta is the organ of gas exchange, after birth sufficient blood must pass through the lungs for uptake of oxygen. When the pulmonary vessels remain constricted as in utero and blood cannot flow through the lungs, significant hypoxemia results.

Many neonatal problems can result in the delayed relaxation of the pulmonary vascular bed including congenital diaphragmatic hernia (CDH), meconium aspiration, perinatal asphyxia and pneumonia/sepsis. In utero premature closure of the ductus arteriosus is also suspected as a cause.

Management must be aggressively directed at treating hypoxemia, acidosis and maintenance of systemic blood pressure. If the patient has a condition associated with surfactant deficiency (RDS, CDH) or inactivation (MAS), exogenous surfactant should be administered. If historical, physical exam or laboratory and/or radiographic data indicate the possibility of sepsis or pneumonia, antibiotics should be initiated. As these patients are usually labile, sedation and minimal stimulation is also indicated.

Initial therapy includes intubation (with sedation) and a ventilation strategy to produce a pO2 > 100 and a pH 7.45 or slightly greater. Often a high-frequency ventilator is required to achieve this goal. This oxygenation and mild alkalosis can enhance relaxation of the pulmonary vessels. It is also important to maintain a mean arterial blood pressure that is at least equal to the newborn’s gestational age in weeks. Since the cause of the shunting of blood away from the lungs in hypertension in the pulmonary vessels, one must attempt to achieve a higher systemic blood pressure. A vasopressor such as dopamine or epinephrine is often needed.

Specific pharmacologic therapy is now available with nitric oxide (NO). This inhaled gas selectively can produce relaxation of the smooth muscles in the pulmonary vessels. A special delivery device and consideration must be given to accumulation of spent gas in a closed working environment such as the closed cabin of a pressurized aircraft. The use of NO in PPHN has been shown to reduce the need for extracorporeal membrane oxygenation (ECMO) by up to 40 percent.

NEUROLOGICAL DISORDERS

Seizures

A seizure is not a disease but a sign of a malfunctioning central nervous system. Unlike older infants, neonatal seizures do not have typical well-organized tonic-clonic patterns. Neonatal seizures can be divided into the following categories:

- **Subtle:** Tonic deviation of eyes, sustained eye-opening, repetitive eyelid blinking, sucking, swimming/rowing/ pedaling movements, tonic posturing of a limb and apnea. Subtle seizures account for 30 percent of seizures in newborns.

- **Tonic:** These seizures may resemble the posturing seen in older children after a CNS insult. The movements are frequently associated with eye deviation. They may be either focal or generalized. They account for 20 percent of neonatal seizures.

- **Clonic:** Consist of slow synchronous rhythmic jerking movements. These may have a single focus or may be multifocal. They account for 25 percent of seizures in neonates.

- **Myoclonic:** Random rapid contractions of the flexor muscles of the upper or lower extremities. They can be focal, multifocal or generalized and account for about 25 percent of the seizures in newborns.

The etiology of seizures in the neonate is diverse. Potential causes include hypoxic-ischemic encephalopathy, intracranial hemorrhage, hypoglycemia, electrolyte abnormalities, inborn errors of metabolism and infection. The initial evaluation starts with obtaining a complete history and physical assessment. Neonatal seizures cannot be attributed to hypoxic-ischemic encephalopathy without direct evidence of hypoxia and ischemia.

Hypoglycemia, hypocalcemia, hypomagnesemia, hyponatremia, or hypernatremia should be considered, and stat glucose, electrolytes, Ca and Mg levels obtained. The risk of infection should be assessed by history and a screening CBC and blood culture obtained. If the etiology of the seizures is not readily apparent, a head imaging study is warranted.

Treatment should focus on maintaining adequate oxygenation and ventilation. The underlying disease should be corrected if possible (e.g. hypoglycemia, hypocalcemia). If pharmacological intervention is required Phenobarbital (20 mg/kg IV) should be given slowly. BP and respiratory status need to be closely monitored. If seizure activity is not controlled a

2nd dose of 10 mg/kg may be indicated. Phenytoin, lorazepam and diazepam also may be considered for the treatment of seizures. The acute treatment goal for neonatal seizures is to stop seizure activity and to prevent it from recurring.

A vital component of taking care of a neonate with seizures is documentation. It is important to document the onset, duration, location and any vital sign changes that occur before, during and following the seizure activity. Many neonatal seizures are very subtle and require close observation of the patient. Infants can have jittery movements that may mimic seizures. Differentiation between the two can be done by holding the affected extremity; if the jerking motion continues despite manual immobilization, the action is considered seizure activity. Likewise, it is usually impossible to cause seizure activity by external stimuli. Eye movements often accompany seizures but not benign neonatal jitteriness.

Intraventricular Hemorrhage (IVH)

This form of intracranial bleeding occurs primarily in premature infants. Its incidence is inversely correlated with the gestational age of the infant. It usually occurs within the first two to three days of life. The bleeding comes from a very vascular complex of vessels in the center of the brain. The blood can remain localized or extended into the ventricles and/or brain tissue. If this occurs there can be long-term sequelae including hydrocephalus and/or neurodevelopmental disabilities such as cerebral palsy.

The major etiology of this disorder is prematurity. Decreasing fluctuations in cerebral perfusion pressure through use of indomethacin, sedation for procedures and minimal stimulation. Once the bleeding has occurred there is no medical therapy.

At the time of the bleed, the infant often becomes hypotensive, hypoxemic, acidotic and can have a seizure. Initial therapy includes support of ventilation and oxygenation, volume replacement with blood or normal saline, correction of the acidosis, and administration of Phenobarbital as needed

- **Hydrocephalus**

  This term refers to an enlarged brain resulting from an increase in the size of the fluid filled ventricular system. It results from the partial or complete obstruction of flow and drainage of the cerebral spinal fluid. The blockage can be congenital from a brain malformation, or acquired as occurs post-hemorrhagic following an IVH in some infants or associated with some cases of meningitis.

Decompression of the hydrocephalus by serial ventricular or lumbar taps, or placement of a shunt, is the treatment.

Neural Tube Defects

- **Meningomylocele/spina bifida**

  Neural tube defects occur when there is incomplete closure of the neural tube. This process takes place between the 18th and 28th day of gestation. The most common neural tube defect is the meningomyelocele. This defect involves protrusion of meningeal and neural structures through the bone and soft tissue of the posterior spine. The defect is most commonly found in the lumbosacral area but may occur at any spinal level. The defect is usually not covered by skin and may be leaking CSF.

  The initial management of these infants can have profound long-term effects. Prevention of infection plays a key role in outcome. The infant should remain in a prone position. The defect should be covered with sterile, saline-soaked gauze. This serves to protect against bacterial contamination and prevents damage secondary to dehydration of the defect. Prophylactic antibiotics should be started. All equipment and supplies should be latex free due to the increased risk of latex allergy in these patients.

  The one year survival rate for children with meningomyelocele is >95 percent. Lower lesions, less severe hydrocephalus and avoidance of CNS infections are all associated with improved cognitive and motor outcome.

- **Encephalocele**

  This represents another form of a neural tube defect, usually in the occipital region of the posterior skull. A portion of the underlying area of brain tissue protrudes through the defect. These infants commonly have associated hydrocephalus and other associated malformations.

  The initial management is the same of for a meningomyelocele. The location, amount of brain tissue involved and other associated malformations contribute to an approximate 40 percent mortality rate and a wide variation in outcome of survivors.

- **Anencephaly**

  Failure of the anterior portion of the neural tube results in this defect. It is relatively common, however 75 percent are stillbirths. These infants lack the development of all, or the majority, of the cerebral cortex but usually have an intact brain stem.

  Without intensive care, few infants survive beyond 7 days. Compassionate care of the infant and family, and referral for recurrence risk counseling, are indicated approaches to management.

METABOLIC DISORDERS

Hypoglycemia

In utero glucose is supplied to the fetus via the placenta. This supply is abruptly cut off at delivery. The cord blood has a glucose level that is approximately 75 percent that of the maternal serum. The newborn infant's glucose level drops after delivery and reaches a nadir by 2 hours of age. It is generally agreed that a serum glucose level greater than 40 is acceptable during the first day of life.

Large for gestational age infants, especially infants of diabetic mothers, have an increased incidence of hypoglycemia. The cause is related to elevated insulin levels in the neonate in response to hyperglycemia in the diabetic mother.

Growth restricted infants and premature infants are also at increased risk for hypoglycemia. In this case, it is primarily related to decreased glycogen stores. All acutely ill infants, whether the cause is respiratory distress syndrome, perinatal asphyxia or infection, are at risk for developing low blood glucose levels.

The clinical signs associated with hypoglycemia are nonspecific. Newborns are often asymptomatic, but when they occur, they include jitteriness, hypothermia, lethargy, poor feeding, hypotonia, apnea and seizures.

Screening of all healthy term newborns for hypoglycemia may not be warranted and policies vary from one nursery to the next. In high-risk infants, symptomatic infants, preterm and systemically ill infants, the monitoring of serum glucose levels should be made a priority. This likely will include most neonates involved in medical transports. Screening should be performed hourly during the first four hours, every four hours during the first 24 hours, and every eight hours up to 72 hours. Bedside screening is acceptable but abnormal values should be confirmed by serum measurements.

Treatment consists of either enteral or parenteral glucose administration. In near term (>36 week gestation) asymptomatic infants with no signs of systemic illness, breast milk, formula or 5 percent dextrose may be offered. If this fails to improve the glucose level, a 2-cc/kg bolus of IV $D_{10}W$ should be given followed by 60 cc/kg/day continuous infusion. In symptomatic infants or those less than 36 weeks gestation, treatment consists of a 2 cc/kg bolus of $D_{10}W$ followed by a continuous infusion of $D_{10}W$ at a rate of 60 cc/kg/day. Infusion rates of glucose should be adjusted based upon accurate determinations of the glucose level. Often a higher concentration of glucose is required than can be given via a peripheral IV. This necessitates placement of an umbilical venous catheter or other large vein route of administration.

Acidosis

An arterial pH < 7.35 constitutes acidosis. Acidosis can be respiratory or metabolic in origin. In the clinical setting there is often partial, or complete, compensation or a combined respiratory and metabolic acidosis.

Respiratory acidosis results from hypoventilation and has an arterial pCO2 > 45. The treatment for respiratory acidosis is to assist and/or increase the support of the minute ventilation.

Metabolic acidosis results from tissue hypoxia of a variety of causes including poor perfusion, shock, hypoxemia, sepsis, buffer loss in the urine or GI tract and inborn errors of metabolism. In this form of acidosis, the pCO2 is within the normal range of 35–45 but the bicarbonate level is decreased and the calculated base excess (BE) is reported as a “negative” value. The treatment for metabolic acidosis is to treat the underlying cause, and if the pH in < 7.20 – 7.25 to give sodium bicarbonate to partially correct the acidosis.

Hypocalcemia

In utero, calcium is actively transported across the placenta. At birth, this constant supply is interrupted and there is a physiological decrease in the newborn’s serum calcium in the first hours of life and continuing for 1–2 days. Calcium as reported by most clinical labs is the “total” calcium with a normal level in the first days of life between 8.0 and 9.0 mg/dL. The level rises by one week of age to about 10.0 mg/dL. The physiologically active form of calcium is the “ionized” fraction and reliably shows correlation with symptoms when less than 2.5–3.0 mg/dL.

Hypocalcemia is frequently asymptomatic but causes jitteriness, twitching and convulsions. The Chvostek sign occurs in about 20 percent of full term infants but is also seen in normocalcemic infants. It is commonly separated into two groups based upon the usual time of onset.

Early onset hypocalcemia occurs in the first days of life. The pathogenesis is a failure of homeostatic control between the bone stores and serum calcium. Risk factors include maternal diabetes, perinatal distress, prematurity, neonatal illness and metabolic acidosis.

Late onset hypocalcemia is often referred to as "classic neonatal tetany". The etiology of this disorder relates to an imbalance of the ratio of calcium and phosphorous and occurs around one week of age or later. It is rarely seen today with improvements in the commercially available infant formula. When seen, parathyroid disorders must be considered.

Initial therapy for symptomatic hypocalcemia is to give 10–20 mg/kg of elemental calcium diluted in an appropriate fluid by slow IV infusion over 10–20 minutes while monitoring the heart rate for evidence of bradycardia. Note that calcium is incompatible with numerous other medications including sodium bicarbonate, dopamine and dobutamine.

SURGICAL EMERGENCIES

Omphalocele

An omphalocele results from incomplete closure of the abdominal wall during the first trimester. Loops of bowel and the liver may herniate through the defect. The abdominal contents are contained in a sac that is continuous with the umbilical cord. Approximately 50 percent of infants with an omphalocele have associated anomalies including trisomies, cardiac disease and other gastrointestinal malformations.

Management primarily focuses on maintaining a normal temperature, fluid balance and serum glucose. Hypothermia and fluid loss is a concern (and particularly so) if the sac is ruptured. The defect should be covered with saline-soaked, sterile, nonstick pads. A plastic covering should then be placed over the defect to minimize heat and water loss. Peripheral IV access should be obtained and fluids at 1–1.5 times maintenance started. A nasogastric tube should be placed to minimize accumulation of air in the intestines. If possible, the tube should be placed to suction. During all of this manipulation, care should be taken to avoid twisting and kinking the mesenteric vessels.

Gastroschisis

Gastroschisis is also a defect of the abdominal wall. The bowel is always exposed and there is risk of significant fluid loss as well as temperature loss. This defect is usually not associated with other anomalies. Unlike omphalocele, it does not involve the umbilical cord and does not have a covering sac.

Acute management is directed at fluid replacement and prevention of further heat loss. A fluid bolus may be necessary followed by maintenance fluid at 100–200 ml/kg/day. The defect should be covered in warm, moist, sterile, nonstick pads and wrapped in dry gauze noting bowel viability prior to wrapping. A plastic covering should be placed over the defect to minimize heat and water loss. An NG tube should be placed and treatment with broad-spectrum antibiotics should be considered. If possible, the tube should be placed to suction.

Malrotation

Malrotation results from incomplete rotation and fixation of the developing intestine during the late first trimester. This allows the intestine to twist on itself and produce a midgut volvulus. The infant may present with sudden bilious emesis, abdominal tenderness and distention, and possibly grossly blood stools, all of which may lead to shock and cardiorespiratory compromise.

Infants presenting with these symptoms must be evaluated emergently and malrotation with midgut volvulus must be ruled out. In addition to surgical consultation, an upper gastrointestinal series by a pediatric radiologist should be done. Plain abdominal radiographs will often miss the diagnosis and therefore are inadequate.

Acute management in the newborn with suspected malrotation is directed at volume resuscitation and correction of acid-base imbalance. A blood culture needs to be obtained and broad-spectrum antibiotics started. The stomach should be decompressed using a nasogastric tube. Emergent surgical evaluation is indicated.

Necrotizing Enterocolitis (NEC)

Necrotizing enterocolitis is a term used to describe one of the most serious gastrointestinal disorders seen in neonates. The etiology is multifactorial. Hypoxic-ischemic-reperfusion injury, bacteria and enteral alimentation combine to cause acute intestinal necrosis. Ninety percent of cases occur in premature infants and the greater the degree of prematurity, the higher the incidence of NEC.

The clinical presentation is variable. Signs may include abdominal distension, increased gastric residuals, emesis, discoloration and tenderness of the abdomen and bloody stools. The most seriously effected infants develop hypotension, acidosis and pulmonary failure. The mortality is approximately 25–30 percent. The diagnosis is based on the presence of clinical signs combined with radiographic findings. The most severe cases will show pneumatosis intestinalis (air within the wall of the bowel) and/or pneumoperitoneum.

Treatment includes stopping enteral feeding and placing an NG tube for decompression of the intestines. Blood culture(s) should be obtained and broad-spectrum antibiotics (e.g. ampicillin and gentamicin) started. Anaerobic bacterial coverage should also be considered. Volume resuscitation, vasopressor therapy and respiratory support may be indicated. Emergent surgical evaluation is warranted.

Tracheoesophageal Fistula (TEF)

Esophageal atresia occurs in 1/3000 live births. In 85 percent of cases there is an associated tracheoesophageal fistula (TEF). The diagnosis should be suspected in an infant who presents in the first hours of life with excessive oral secretions. The oral secretions will cause coughing, choking and respiratory distress. There is often a perinatal history of polyhydramnios.

This diagnosis is made by carefully passing a 5 French feeding tube orally or nasally and obtaining an x-ray. The feeding tube will be coiled in the esophageal pouch in the upper chest. There will usually be air in the intestines as a result of the associated distal TEF.

Initial management includes stopping feedings and starting IV fluids. Continuous suctioning of the proximal pouch with a multiple end-hole suction catheter should be started. The goal is to keep the pouch drained of secretions to prevent choking. The head of the bed should be elevated to further decrease the risk of reflux and aspiration.

Congenital Diaphragmatic Hernia

The diaphragm is formed by the 10th week of gestation. Congenital diaphragmatic hernia (CDH) occurs when the formation of the diaphragm is interrupted during the first trimester and the abdominal contents are displaced into the thorax. The incidence of CDH is between 1/2000 and 1/10000. The defect in the diaphragm is most often on the left side. Approximately 50 percent of infants with CDH will have associated anomalies.

Infants with a large CDH will present at birth with respiratory distress, cyanosis and a scaphoid abdomen. Breath sounds will be decreased on the affected side and bowel sounds may be present. Heart sounds will be displaced to the side opposite the defect. The diagnosis is confirmed by obtaining a CXR that shows air filled bowel in the thorax.

Initial management usually requires intubation and mechanical ventilation. A multiple end hole suction catheter should be placed in the stomach with the goal of eliminating swallowed air. This is done because further distension of the intestines will compress the heart and lungs. Patients commonly require sedation and paralysis to improve the response to mechanical ventilation.

Patients with CDH commonly have pulmonary hypertension, which can be helped by maintenance of systemic blood pressure with volume and/or inotropes. Prevention of either a metabolic or respiratory acidosis will minimize the severity of pulmonary hypertension. Other therapies include exogenous surfactant and nitric oxide. Many patients have severe pulmonary hypoplasia and are at risk for barotrauma, which can be minimized by high-frequency ventilation. ECMO is another modality sometimes used in the stabilization of these infants. Approximately one-third of infants with CDH will not survive.

CONGENITAL INFECTIONS/SEPSIS

Bacterial sepsis is a major cause of morbidity and mortality in the neonate. Early diagnosis and treatment will lead to improved outcome. Maternal risk factors, laboratory studies and neonatal signs are useful in diagnosing sepsis in the neonate.

Maternal factors that increase the risk of infection include prolonged rupture of the membrane (>18 hours), premature rupture of membranes and preterm labor (<37 weeks gestation), chorioamnionitis or fever. If the mom is group B Strep (GBS) positive, there is further risk to the neonate.

Viral illnesses and maternal sexually transmitted diseases (STDs) must also be considered during the differential diagnosis of neonatal sepsis. A detailed medical history and pregnancy history is crucial to identification and proper treatment of any neonatal infection.

The septic neonate typically presents with nonspecific signs of infection. The most common sign is respiratory distress and the clinical picture is sometimes difficult to distinguish from TTN or RDS. Lethargy, poor feeding, hypo or hyperglycemia, temperature instability, and hypotension with poor perfusion are frequently present. Apnea and metabolic acidosis may occur as sepsis progresses.

Infants with clinical signs of sepsis should be treated with antibiotics after obtaining a blood culture. Infants with maternal risk factors and/or questionable clinical signs of sepsis may be screened by a CBC + blood cultures. In questionable situations an abnormal CBC (WBC >30,000 or <5000, ANC <1500 and I/T ratio >0.2) increases the probability of infection. In fact an abnormal screening CBC should lead to treatment with antibiotics. A lumbar puncture should be done in neonates with signs consistent with sepsis. However, the administration of antibiotics should not be delayed if obtaining CSF is not possible due to clinical instability or lack of a physician experienced in performing the procedure.

FLUIDS, ELECTROLYES and VASCULAR ACCESS

Fluids and Electrolytes

The fluid and electrolyte requirements in neonates vary greatly depending upon the gestational age, birth weight and postnatal age of the infant. Fluid and electrolyte administration must therefore be individualized.

Newborns have a relative excess of total body water. Term infants typically lose up to 5 percent of their birth weight during the first 3–4 days of life. Extremely preterm infants may lose up to 15 percent of their birth weight during first several days of life.
Infants lose water mainly via the skin, lungs, and urine. The maturity of these organ systems greatly affects fluid requirements.

The table below outlines approximate fluid requirements based on birth weight.

IV Requirement in cc/kg/d Based on Birth Weight

Birth Weight	Day 1	Day 2	Day 3	Day 4	Day 5
Term infants or Preterm infants with BW> 2kg	60	80	100	125	150
1200–2000 g	80	100–120	120–150		
800–1199 g	90–100				
<800 g	100–120				

The fluid requirements of an individual baby can vary significantly. Fluid management subsequent to the first day of life will require adjustments based on the baby's urine output, change in weight, and electrolyte status.

The fluid requirements of preterm infants increase with decreasing gestational age. This is due to increased fluid losses. The immaturity of the skin and the increased body surface area, lead to increased evaporative water loss. The immature kidney is unable to concentrate urine and therefore excretes an increased volume of free water.

During the first 24 hours of life, D_5W or $D_{10}W$ without electrolytes is the most appropriate IV fluid. As urine output increases, the neonate requires Na and K. Typically, 2–4 mEq/kg/day of Na and 1–2 mEq/kg/day of K are added to the IV fluid on the second or third day of life.

Neonatal Vascular Access

- **Peripheral IV**

  Peripheral intravenous insertion is a widely used method for vascular access in the neonate. Over-the-needle catheters, Butterfly straight needles and PICC lines (peripherally inserted central catheters) are used depending on local preference, skill level and medical direction. The size and fragility of neonatal veins necessitates catheters as small as 27 gauge be used in some circumstances.

- **Intraosseous**

  Intraosseous needle placement may be a consideration in the prehospital environment. The technique and skill must be supported by program medical direction, policy and protocol.

- **UAC/UVC**

  Umbilical vein catheterization is used for emergency vascular access and when central access is required for the infusion of vasopressors or hypertonic solutions. Placement of an umbilical vein catheter is done using sterile technique. The cord and adjacent area are prepped with an antiseptic solution and the area is draped with sterile towels. Umbilical tape is placed at the base of the cord and gently tightened. The umbilical cord is then transected one to one-half centimeter above the skin. If bleeding occurs the umbilical tape should be tightened gently until hemostasis is attained. The single umbilical vein's larger lumen and narrower wall help distinguish it from the two umbilical arteries. A 3.5 French or 5 French saline filled single or double lumen catheter may be used. After the umbilical vein has been identified, a closed iris forcep is inserted into the lumen and allowed to open. This will dilate the lumen of the vein. The forcep is then removed and the umbilical catheter is inserted while gentle traction is held on the cord. When the catheter is placed for emergency access it should be advanced until good blood return is established (2–4 cm).

  Under nonemergent circumstances, measuring, in centimeters, the length between the infant's shoulder and umbilical cord and subtracting three centimeters determine the distance of insertion. Proper placement of the UVC in the inferior vena cava at a level just above the diaphragm should be confirmed by x-ray.

VENTILATORY SUPPORT

Mechanical ventilation can be accomplished in various modes depending on the specific needs of the neonatal patient. In addition to the commonly used pressure limited ventilation and the less commonly used volume limited ventilation, the following specialty modes are used in the intensive care setting and with increasing frequency in the transport environment.

- ECMO
- High-frequency ventilation
- Nitric Oxide

Module 36 on mechanical ventilation provides additional information about ventilatory support.

CARE OF THE NEONATE ON TRANSPORT

Once the air medical crew has completed its assessments and has intervened to meet the infant’s immediate needs, then final preparation for transport can be accomplished. Care should be focused on optimizing the infant’s ventilation, oxygenation, temperature, blood pressure, perfusion and glucose levels. More simply put, keep them pink, warm, and sweet! The final preparation involves communication, special considerations, transfer to transport equipment and family support. En route care and follow up communication are additional items to consider.

Communications

Consultation with the transport medical director may be indicated to discuss infant’s condition and management plan. A call to the receiving facility with a current report and an estimated time of arrival will allow for advance preparation for the infant’s admission. Copies of the referring facility’s records, x-rays, laboratory, and blood gas results should be obtained and taken with the infant to the receiving facility. An ID band should be on the infant at the time of transport.

Special Considerations

The transport environment necessitates some special considerations during preparation. The movement and vibration inherent in transport and the difficulty in access to an infant during transport demand that stabilization occur at the referring facility rather than en route. Ideally, a well-prepared infant will not require anything more than visual monitoring during the travel portion of the transport.

An important consideration involves the presence of any trapped air. Because any air will expand with an increase in altitude, it is important to allow for evacuation. A feeding tube placed to the stomach of a neonate who has air in the stomach will allow for decompression and decrease diaphragmatic compromise. This is even more critical with a suspected GI or bowel obstruction. Any pneumothorax suspected or seen should be carefully evaluated prior to departure from the referring facility.

If considerable time will pass before arrival at the receiving facility, air medical crew should ensure that the infant has received appropriate prophylactic treatments. This may include erythromycin ointments to the eyes and vitamin K administration. Defer special treatment of the umbilical cord on any infant at risk, the cord should be clamped and kept dry during transport to allow for umbilical catheterization at the receiving facility should the need arise.

Care should be taken to provide the appropriate thermal environment for the infant during transport. The infant can be protected from cold by keeping the incubator closed and by insulating the incubator with additional cover in cold extremes. In heat extremes, the incubator must be protected from sunlight; the “greenhouse” effect will rapidly over-warm an incubator and the infant.

Transport Equipment

Monitoring functions will need to be transferred to the transport monitors. This will include heart rate, respiratory rate, temperature, blood pressure monitoring and pulse oximetry. Respiratory support will need to be switched to the transport ventilator or oxygen delivery system. It is important to monitor the infant’s response to these changes. All intravenous infusions should be transferred to transport infusion pumps ensuring there are adequate volumes to last through the course of the transport.

The infant should be placed either on its side or back in the incubator with safety straps that will hold the infant securely on the mattress. Blanket rolls can be used to provide a nest without compromising the air medical crew’s view of the infant during transport. Soft limb restraints may be necessary to prevent an active infant from pulling on lines or tubes. Ear and eye protection may be indicated for sensitive or labile infants. Some medical conditions may call for special position considerations (i.e. an infant with Pierre Robin syndrome may require prone positioning to maintain an airway).

Family Support

Time should be spent with the family prior to departure. This is best accomplished after the infant is in the incubator and ready to leave the referring facility. The air medical crew can accompany the infant to the parent's location. An update on the infant's condition, reason for transport, and a discussion of anticipated care concerns and treatment plans can take place. Informed transport consents can be obtained after this discussion. Information about the receiving facility, including the location, phone numbers, and name of the admitting physician, should be provided to the parents. When possible and appropriate, the parents should be offered an opportunity to touch or to hold their infant. An instant picture of the infant should be taken and left with the parents. Information about the parent's understanding, reaction to the transport, and their plans to visit should be noted and communicated to the receiving facility staff.

En Route Care

With appropriate and effective assessment, stabilization and preparation for transport, the air medical crew's focus while on transport will be ongoing visual assessment and monitoring. The infant's condition should be documented at regular intervals during the transport. The crew should be prepared to intervene should an emergent condition become apparent. A bag and appropriate sized mask should be immediately available during transport. A plan to deal with any anticipated en route problems should be developed by the air medical crew.

Follow Up

On arrival at the receiving facility, the infant and care will be transferred. A planned transfer approach between the air medical crew and the receiving facility staff will help avoid adverse events during the transfer (clinical deterioration, dislodged tube or catheter). All records should be left with the infants. A complete report should be given to the admitting medical and nursing staff. Any special needs of the family should be passed on at this time.

A follow up phone call to the parents and sending facility, informing them of the infant's arrival and current condition should be made.

NEONATAL RESUSCITATION

Most infants who will require more than routine care at birth can be identified prior to delivery. Information regarding medical history, maternal history, labor, delivery, and the presence of high-risk factors will enable the air medical crew to anticipate the needs of the neonate. Some infants who require resuscitation may not have recognized risk factors in the perinatal history, so it is critical that any air medical crew caring for a neonate or actively laboring woman, be adequately prepared to provide full resuscitation of an infant.

Overview and Principles of Resuscitation

The American Academy of Pediatrics (AAP) and The American Heart Association (AHA) detail the relationship between resuscitation interventions and their frequency of use in the Neonatal Resuscitation Program (2000). About 10 percent of all newborns require some assistance with breathing at birth. Extensive resuscitation is required about 1 percent of the time. Considering the characteristics of the transported infant population, these frequencies will increase on neonatal transports.

Neonatal Resuscitation Procedures

Both the Neonatal Resuscitation Program (AAP/AHA, 2000) and Pediatric Advanced Life Support Program (AHA, 2000) provide structured educational programs covering the essential components of neonatal resuscitation. Although the focus of the Neonatal Resuscitation Program (NRP) is on the newly born infant, its approach to resuscitation has application throughout the neonatal period. Air medical crew members that anticipate caring for neonatal patients should complete one or both of these programs.

SUMMARY

Although the need for most high-risk neonatal transports is identified prior to the departure of the responding air medical crew, the nature and acuity of the call is sometimes unclear. It is for this reason that **all** air medical crew members must be prepared to respond to the needs of the delivering mother or unstable newborn. Adequate didactic material combined with frequent skills lab opportunities and clinical time in the newborn nursery and/or newborn intensive care should be included in all air medical initial training and continuing education programs.

Associated with this module are:

Exhibit 30-1: Infant Assessment Checklist
Exhibit 30-2: Suggested Equipment, Supplies, and Neonatal Care
Exhibit 30-3: General Neonatal Transport Guidelines
Exhibit 30-4: Guidelines for Specialized Neonatal Transports

EXHIBIT 30-1: INFANT ASSESSMENT CHECKLIST

General
Anterior Fontanel: □open □soft □closed □flat □sunken □bulging
Sutures: □aligned □overriding □separated
Eyes: □clear □drainage □eyelids fused
Pupils: □equal □dilated □fixed □not examined
Ears: □normal □small □low set □skin tags
Nares: □patent □clear □drainage
Palate: □intact □cleft □not examined
Anomalies: □no obvious anomalies noted □yes (describe)
Comments:____

____

Respiratory
Breath Sounds R: □clear □equal □rales (□fine □moderate □coarse) □decreased □rhonchi □absent
Breath Sounds L: □clear □equal □rales (□fine □moderate □coarse) □decreased □rhonchi □absent
Quality: □easy □grunting+__ □flaring+__ □retract+__ □tachypneic □shallow □stridor □periodic
Chest Expansion: □equal □unequal □adequate □decreased □hyperexpanded □adequate air entry
Oxygen: □ETT__ at __cm □secured □no air over abdomen □hood __ percent □blow by __l/m □room air
Comments:____

____

Cardiovascular
Heart Sounds: □regular □irregular □murmur __/__ □distant □tachycardic
PMI: □active □hyperactive □position normal □position abnormal
Pulses: □+1 □+2 □+3 □absent □equal bilateral □equal upper/lower
Capillary refill: □2 □3 □4 □5 □6 or more seconds
Comments:____

____

Abdomen
Appearance: □soft □round □nondistended □distended □flat □firm □tense □shiny □scaphoid □loops □discolored
Umbilicus: □3 vessel □2 vessel □clamped □dry and intact □moist □cord gone □catheters in place
Catheters: □UAC __fr at __cm □secure □blood return
□UVC __fr at __cm □secure □blood return
Bowel Sounds: □present □absent □increased □decreased
Liver: RCM ↓__ cm □exam deferred
Comments:____

____

Skin/Appearance

Skin: ☐warm ☐dry ☐intact ☐cool ☐diaphoretic ☐meconium stained
Edema: ☐none ☐periorbital ☐face ☐trunk ☐extremities ☐generalized
Turgor: ☐supple ☐taut ☐tenting
Texture: ☐smooth ☐dry and peeling ☐gelatinous
Other: ☐rash ☐ecchymosis ☐petechiae ☐lesions
Color: ☐pink ☐pale ☐plethoric ☐mottled ☐jaundiced ☐dusky ☐gray
Cyanosis: ☐none ☐acrocyanosis ☐circumoral ☐circum-orbital ☐generalized
IV Site: ☐soft ☐flat ☐patent ☐secure ☐reddened ☐edematous
Location:____
Comments:____
____

GU/Anus

Genitalia: ☐male ☐female ☐normal ☐ abnormal ☐ambiguous
Testes descend: ☐yes ☐no ☐not applicable
Anus: ☐patent ☐imperforate ☐not examined
Voided: ☐yes ☐no Bowel Movement: ☐yes ☐no
Comments:____
____

Neurological

Voluntary Movement: ☐right arm ☐left arm ☐right leg ☐left leg
Tone: ☐normal flexion for gestational age ☐hypotonic ☐hypertonic
☐ unresponsive ☐paralyzed (drug induced)
Activity: ☐sleeping ☐quiet ☐active with stimulation ☐active ☐alert ☐crying ☐irritable
☐jittery ☐lethargic ☐+suck ☐+moro ☐+palmar grasp ☐seizures (describe)
Comments:____
____

Notes:____
____

EXHIBIT 30-2: SUGGESTED EQUIPMENT, SUPPLIES, AND MEDICATION FOR NEONATAL CARE

This list is not comprehensive, and is intended to be an adjunct to equipment already used by the air medical team. The program mission, Scope of Practice and Medical Direction will determine the specific equipment and medications required.

The size of equipment and supplies is critical to the provision of appropriate neonatal care. Any air medical program that may be called to respond to a neonatal patient or potential delivery should have size and age-appropriate neonatal transport equipment. Inventories can be organized according to the familiar A-B-C approach, or may be categorized by color as part of a larger pediatric response kit. Equipment must be maintained in a ready and operational state. All equipment must be secured in the transport environment to provide for both infant and air medical crew safety. Electronic equipment must have dependable power sources (inverter access and/or batteries).

Airway Support

- Bulb syringe
- Suction catheters (5, 6.5, 8, 10 fr)
- Oral airways (0,1)
- Respiratory saline irrigant
- Meconium aspirator
- Mucous suction trap
- Mechanical suction (wall and portable) with regulator, canister and tubing

Breathing Support

- Neonatal flow-inflating (anesthesia) bag
- Neonatal self-inflating bag
- Face masks (premie, newborn, infant)
- Pressure manometer
- Feeding tube (5, 8 fr)
- Replogle tube (10 fr)
- Laryngoscope handle with Miller blades (0, 1)
- Spare batteries and bulbs
- Neonatal stylette
- Endotracheal tubes (2.0, 2.5, 3.0, 3.5, 4.0)
- ET Tube holder, tape
- Heat/moisture exchanger (artificial nose)
- Pedi-cap
- Nasal CPAP prong set-up (XS, S, L)
- Oxygen hood
- Thoracentesis kit
    - 21 g butterfly
    - 3-way stopcock
    - 60 cc syringe
    - Betadine, alcohol preps
- Thoracotomy kit (umbilical cath kit used for surgical drapes, betadine swabs, instruments and sutures)
    - Chest tubes (10, 12 fr)
    - Heimlich Valves

- Neonatal transport ventilator with 50+ psi O2 source
- Ventilator monitor with alarms, oxygen analyzer
- Oxygen source (with system back up)
- Air source (tank or compressor)
- Blender capability
- Flow meter, O2 nipple adapter
- O2 tank key

Circulation Support

- IV catheters (22,24g)
- Scalp vein needles (23, 25g)
- T-connectors
- Stopcocks
- Bio-occlusive dressing
- Extension tubing
- Syringes (assorted 1–60 cc's)
- Assorted needles
- Tape
- Infusion pump with appropriate tubing (2–5 line capability)
- Rubber bands, cotton, safety pins
- Armboards (premie, newborn)
- Alcohol preps
- Umbilical Catheter Tray (sterile tray with drapes, iris forceps, curved forceps, scissors, needle holder, 2 × 2's, umbilical tape, 4.0 silk suture with curved needle, scalpel and blade, tape measure)
- Umbilical catheters (3.5,5.0)
- Cloth limb restraints
- Surgical masks, cap, gloves
- Intraosseous Needles

Monitoring/Miscellaneous

- Cardiac, respiratory, temperature monitor with appropriate supplies (neonatal electrodes. lead wires, tape, recorder paper)
- Invasive and noninvasive BP monitor with supplies (pressure transducer, BP cuffs –2.5, 3, 4, 5)
- Pulse oximetry with disposable probes
- Blood glucose monitoring strips, lancets, cotton, Band-Aids
- Neonatal stethoscope
- Portable transilluminator
- Personal protection supplies (gloves, antimicrobial wipes, waterless hand wash, gowns, masks, eyeshields, trash bag, sharps containers)

Environment

- Transport incubator with installed safety straps
- Infant blankets (warmed and sufficient enough to provide for nesting rolls)
- Disposable diapers
- Chemical heat mattress
- Infant hat
- Thermometer
- ViDrape© (useful for protection of open defects)

- Face mask, ear protection for sensitive neonates
- Infant safety seat or infant restraint device for term infants who do not need thermal support

Family Support, Facilitation of Continuity of Care

- Instant camera, film
- Parent info
- Facility phone numbers, maps/directions
- Transport consent forms
- Documentation supplies (chart forms)

MEDICATIONS FOR NEONATAL CARE

Resuscitation Medications

- Epinephrine 1:10,000 (0.1 mg/ml)
- Normal saline or Ringer's Lactate-volume
- Sodium bicarbonate 4.2 percent (5mEq/10ml)
- Naloxone hydrochloride 0.4 mg/ml or 1.0 mg.ml
- Normal saline (without preservatives)vials—IV flush
- Dextrose 10 percent (D10W)

Additional Neonatal Medications

- Dopamine
- Dobutamine
- 5 percent Albumin
- Furosemide
- Digoxin
- Adenosine
- Calcium chloride 10 percent or calcium gluconate
- Ampicillin
- Gentamicin
- Cefotaxime
- Sterile water (without preservative)—diluent
- Erythromycin ointment (eye prophylaxis)
- Phytonadione (vitamin K)
- Heparin (100u/ml)
- Albuterol
- Dextrose 5 percent (D5W)
- Dextrose 25 or 50 percent (D25, D50)
- Morphine Sulfate
- Phenobarbital
- Diazepam
- Versed
- Midazolam
- Fentanyl
- Vecuronium or pancuronium
- Prostaglandin E1
- Exogenous surfactant
- Xylocaine 1 percent

Miscellaneous Medication Supplies

- Neonatal code card references
- Calculator
- Medication labels
- Filter needles

EXHIBIT 30-3: GENERAL NEONATAL TRANSPORT GUIDELINE

To be followed on all neonatal transports:

- Introduction to referring nursing staff and physician.
- Obtain updated report on patient status upon arrival to referral facility.
- Obtain copied chart including maternal history and any available X-Rays.
- Perform head to toe assessment including estimation of gestational age.
- Establish radio or telephone contact with the on-call Neonatologist; report any changes in clinical picture, make recommendations for treatment and obtain specific care orders.
- Assist with or perform any ordered treatments or interventions.
- Once initial assessment and immediate stabilization of the infant has been completed, at least one team member should meet with parent(s) and family to obtain consents required for transport.
- Answer family questions, provide information on receiving facility, directions and telephone numbers, accepting Neonatologist and anticipated en route care of the infant.
- Re-assess and package patient for transport, with special attention paid to:
    - Maintaining neutral thermal environment
    - Airway and ventilation support
    - Oxygen titrated according to blood gas results, pulse oximetry trends and evidence of perfusion (maintain $SaO_2 > 95$ percent)
    - Circulatory support including line placement, fluid maintenance, glucose management, supportive medications as needed
- Allow mother to hold, touch or view infant as condition permits.
- Answer any final question from family and staff.
- Reassess patient airway, breathing, and line security after each transfer in and out of the transport incubator and/or EMS vehicle.
- En route Care should consist of:
    - Monitor vital signs every 15 minutes or more frequently as needed; HR, RR, BP, SaO_2; capillary refill; lung sounds, work of breathing etc.
    - Provide weight appropriate fluid management; supplement with fluid bolus as needed and ordered; 100 cc/kg/24 hours or bolus 10 cc/kg;
    - Continue/initiate medications, blood products or other supportive treatments as ordered
    - Anticipate and monitor for changes related to altitude and potential gas expansion
- Continually reassess patient and adjust treatment plan accordingly.
- Notify Neonatologist and receiving facility of changes in patient condition
- Upon arrival at receiving facility, provide verbal and written report to accepting nursing and physician staff; contact referring hospital to notify the staff of safe arrival and thanking them for their assistance.
- Contact mother and family to update them on infant’s condition.

EXHIBIT 30-4: GUIDELINES FOR SPECIALIZED NEONATAL TRANSPORTS

To be followed on all high-risk transports. All treatments and interventions must be supported by written order; standing order, or physician approved written protocols.

A. RESPIRATORY CONDITIONS

- Follow standing orders or disease specific patient care protocols
- Maintain optimal airway position; utilize advanced airway adjuncts such as endotracheal intubation or nasal CPAP as needed.
- Provide BVM, anesthesia bag or mechanical ventilatory assistance as needed
- Titrate oxygen to maintain target SaO2 >95 percent
- Initiate IV therapy to prevent hypotension, improve major organ perfusion and maintain blood glucose within normal range
- Maintain neutral thermal environment utilizing available adjuncts and treatments (i.e.: space blankets, chemical packs, warmed IV bags etc.)
- Administer medications targeting underlying cause of respiratory distress or failure (i.e.: sufactant for prematurity, antibiotics for sepsis etc.)

B. CARDIOVASCULAR DISEASE

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing, and Circulation
- Obtain completed diagnostic information (i.e.: EKG, Echo cardiogram etc.)
- Assess heart sounds: rate, rhythm, murmur, additional sounds
- Assess peripheral pulses: rate quality, differences between upper and lower extremities
- Assess perfusion: color of mucous membranes, capillary refill time, unexplained color changes
- Evaluate CXR: overall lung picture, heart size, shape, position
- Report findings to Neonatologist on-call to determine course of treatment
- Administer Oxygen, as ordered, to relieve cyanosis unless duct dependant cardiac lesion suspected
- Administer Prostaglandin (PGE1), to slow closure of ductus arteriosus, when duct dependant cardiac lesion suspected

C. NEUROLOGICAL DISORDERS

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing, and Circulation
- Assess overall appearance: tone, activity, response to stimulation, cry
- Obtain completed diagnostic information (i.e.: head CT, etc.)
- Assess head size and appearance: circumference, shape, symmetry, cephalo-hemotomas, caput, moulding, prominent forehead, position of ears
- Assess eyes: size, shape, pupil response, “doll’s eye" or "sunset” movements
- Assess fontanel’s: presence/absence of anterior and posterior; size; quality: bulging, flat, depressed
- Assess suture lines: approximated, split, stenosis present, overlapping
- Assess for seizure activity: unilateral, bilateral, jittery; repetitive blinking, sucking, jerking; inappropriate reflexes; onset, frequency
- Assess for cause of seizure activity or altered response: birth history, asphyxia, cord or placental insufficiency, nonreassuring FHT; infection; hypoglycemia etc.
- Treat underlying cause when possible (i.e.: glucose, oxygen etc.)
- Minimize environmental stimulation to decrease infant’s response to stress and lower ICP
- Administer anti-seizure medications as appropriate

D. METABOLIC DISORDERS

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing, and Circulation
- Review previously ordered lab results
- Assess for signs and symptoms of hypo- or hyper-glycemia, -natremia, -calcemia, -magnesemia
- Assess for signs and symptoms of inborn errors of metabolism, thyroid diseases, adrenal gland disorders, pituitary disorders etc.
- Treat underlying cause, when possible (i.e.: glucose, potassium, calcium etc.)

E. SURGICAL EMERGENCIES

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing, and Circulation
- Assess patient for signs, symptoms and presentation
- Review maternal history for causal relationship to the abnormality or surgical emergency
- Review diagnostic results as available (i.e.: CXR, ultrasound etc.)
- Provide supportive care per standing orders or on-call Neonatologist (i.e.: Tracheo-esophageal Fistula-place OG tube; Abdominal wall defect-cover with sterile, moisture and heat retaining cover (bowel-bag); Neural-tube defect-cover with sterile, moist dressing and plastic barrier)
- Administer adequate fluids to counter-balance heat and moisture loss

F. CONGENITAL INFECTIONS/SEPSIS

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing, and Circulation
- Review maternal record for indications of maternal infection and any treatment received
- Assess overall appearance, color, activity, tone, increasing respiratory distress, rash, pettichiae, lesions
- Review lab results for indicators of infection (i.e.: increased WBC, Increased bands, positive cultures etc.)
- Monitor for worsening multisystem failure (i.e.: increased respiratory distress, temperature instability, clotting or bleeding disorders, feeding intolerance etc.)
- Treat underlying cause, when possible (i.e.: antibiotics, fluids, blood products etc.)

A. **BIBLIOGRAPHY**

Ballard, J.L., Khoury, J.C., Wedig, K., et. al.: New Ballard score, expanded to include extremely premature infants. *Journal of Pediatrics*, 119(3):418. 1991.

Care and Transport of the Neonate (1996). In R. S. Holleran, (Ed.) *Flight Nursing: Principles and Practice, 2nd ed.* St. Louis, Mosby.

Deacon, J. and O'Neill, P. (1999). *Core Curriculum for Neonatal Intensive Care Nursing, 2nd ed*. Philadelphia: W. B. Saunders Company.

Karlsen, K.A. (2000). *S.T.A.B.L.E.: Transport Education Program, Learner's Manual, 2000 ed*. Park City: S.T.A.B.L.E. Transport Education Program.

Kattwinkel, J. (2000). *Textbook of Neonatal Resuscitation, 4th ed*. Elk Grove Village: American Academy of Pediatrics and American Heart Association.

Little, D., Riddle, B. and Soule, C. The power in our hands: Integrating developmental care into neonatal transport. *Neonatal Network*, 13(7): 19–22. 1994.

National Association of Neonatal Nurses. (1998). *Neonatal Nursing Transport Standards*. Petaluma, California.

Neonatal Transport (1997). In National Flight Nurses Association: *Flight Nursing Core Curriculum.* Park Ridge: National Flight Nurses Association.

Ranaroff, A.A., Martin, R.J: *Neonatal-Perinatal Medicine: Diseases of the Fetus and Infant* 7th edition, Mosby, St. Louis, 2002.

Task Force on Interhospital Transport (1999). *Guidelines for Air and Ground Transport of Neonatal and Pediatric Patients, 2nd ed.* Elk Grove Village: American Academy of Pediatrics.

Whitfield, J. M. (1995). Neonatal Transport. In K. A. L. McCloskey, R. A. Orr (Eds.). *Pediatric Transport Medicine.* St. Louis, Mosby.

Young, T.E., and Mangum, O.B.(1996) *NeoFax: A Manual of Drugs Used in Neonatal Care, 9th ed*. Raleigh, N.C., Acorn Publishing, 1996.

B. DEFINITIONS of KEYWORDS:

Acrocyanosis—Cyanosis limited to the hands and feet, central color is pink

AGA—The appropriate for gestational age infant's weight, length and head circumference fall between the 10th and 90th percentile

Gestational age—Normal length of gestation for full fetal development is 40 weeks from the first day of the mother's last menstrual period (LMP)

IUGR—Intrauterine growth restricted infants can be classified into two groups:

- Symmetrical IUGR—growth restriction usually occurs earlier in gestation, prior to 28 weeks, associated with poorer prognosis; Weight, length and head circumference are all below the 10th percentile.
- Asymmetrical IUGR—growth restriction occurs later in gestation, after 28 weeks, associated with better prognosis; The length and head circumference are still above the 10th percentile.

LGA—The large for gestational age infant's weight falls above the 90th percentile when compared to infants with the same gestational age

Meconium—Fetal stool, when present in the amniotic fluid may indicate fetal hypoxia; it is also commonly passed before birth in postdates infants and those presenting breech

Moro reflex—Abduction and extension of all four extremities in response to sudden stimulus (loud noise, camera flash)

Neonate—An infant from the time of birth to 1 month of age

Oligohydramnios—Decreased amounts of amniotic fluid, can be caused by amniotic leaking (undetected rupture of the membranes), or abnormalities of the fetal kidneys, associated with renal agenesis, urinary tract obstruction, polycystic kidneys, pulmonary hypoplasia, or from insufficiency of utero-placental blood flow in conditions such as maternal hypertension and postdates pregnancy.

Plethora—Deep ruddy skin tone exhibited by infant; may be indicative of polycythemia (excess of circulating red blood cells); hematocrit greater than 60 percent may lead to decreased blood flow to organs due to the increase in viscosity

Polyhydramnios—Increased amounts of amniotic fluid; may be associated with fetal GI tract obstruction, neuromuscular disorders, multiple gestation, fetal hydrops

SGA—The small for gestational age infant's weight falls below the 10^{th} percentile when compared to infants with the same gestational age

C. **Test Questions**:

1. **G/TPAL** is an abbreviation commonly used to describe:

    a. **G**ravida, **T**ype of blood, number of **P**regnancies, **A**bortions, total **L**iving children
    b. **Gravida, Term deliveries, Preterm deliveries, Abortions, Last menstrual period**
    c. Number of pregnancies (**G**), **T**ests completed, **P**renatal care, **A**bortions, **L**ast menstrual period
    d. **G**estational age, **T**erm deliveries, **P**reterm deliveries, **A**bortions, **L**ast meal

2. Which of the following are characteristics of a term, small for gestational age (SGA) infant?

    a. Plantar creases covering 2/3 of the bottom of the foot
    b. Wasting/decreased body fat
    c. Well-formed ear cartilage
    d. **All of the above**

3. An infant with an initial (1 minute) APGAR score of 5 could exhibit the following characteristics:

    a. Appearance-pale; Pulse <100; Grimace-no response; Activity-some flexion; Respirations-slow
    b. Appearance-centrally pink; Pulse->100; Grimace-cough; Activity-active; Respirations-crying
    c. **Appearance-acrocyanotic; Pulse <100; Grimace-present; Activity-some flexion; Respirations-irregular**
    d. Appearance-pink; Pulse-<100; Grimace-sneeze; Activity-active; Repirations-irregular

4. Although a supine or side-lying position is preferred for most infants, which condition may necessitate a prone position to protect the airway?

    a. **Pierre Robin Syndrome**
    b. IUGR
    c. Down Syndrome
    d. SGA

5. Which of the following is **not** a priority when providing supportive family care prior to a neonatal transport?

    a. Providing directions to and information about the receiving facility
    b. Giving the family a receiving physician name and contact information
    c. **Approaching the family about organ donor status**
    d. Leaving an instant picture of the transported infant

Didactic Hours: 16

Skills Hours: Skills Competency Checklists should be based on program specific protocols, medical direction, Program Mission and Scope of Practice. Skills practice should be scheduled prior to any assigned Patient Care Hours. Skills lab hours should be scheduled as needed to complete the Program Specific Skills Competency Checklists.

Examples:

- Assessment/estimation of gestational age
- Newborn resuscitation per NRP and or PALS
- Maintenance of neutral thermal environment
- Intravenous line placement and fluid management
- Familiarity with age and size appropriate equipment

F. **Patient Care Hours**: 16–24; Newborn nursery and/or Neonatal Intensive Care

MODULE 31: PEDIATRIC CARE

Authors: Mr. Christopher Wagner, RN, University of Michigan Medical Center, Ann Arbor, MI
Dr. Joseph Wright, Maryland Institute of Emergency Medical Services, Baltimore, MD

Reviewer: Mr. Mark Holcomb, RN, MA, Director of Transport Services, Children's Critical Care Transport, Children's Mercy Hospital, Kansas City, MO

OBJECTIVES

Upon completion of this module, crew members will be able to:

- Discuss the developmental milestones and age-appropriate behavior for infants < 1 year; toddlers 2–3 years; pre-school age 4–6; elementary school age 6–12 years; and adolescents 13–18 years
- Describe the similarities and differences between adult and pediatric airways
- List 4 of the most common pediatric respiratory illnesses
- Explain common injury patterns in pediatric trauma
- List 3 of the most common medical emergencies seen in the pediatric population

KEYWORDS

Croup
Epiglottitis
Bronchiolitis
Cyanotic lesion
Fontanels
CSHCN
PEG

INTRODUCTION

Pediatric EMS calls quite often generate a high level of anxiety for the responding providers. This is due in part to the infrequency of such calls and the specialized skills and equipment required. Although it has long been recognized that children are not "little adults", the skills of establishing and maintaining an airway, providing adequate oxygenation and ventilation, and ensuring central and peripheral circulation remain a priority for both adults and children. The differences in pediatric anatomy and physiology and the need for age-appropriate equipment require that pediatric patients be transferred to trauma centers with Pediatric ED capability and/or comprehensive pediatric care centers for critical care services. For these reasons, both air and ground ALS providers must complete initial training and frequent continuing education on pediatric emergencies. There are situations however, that demand the additional expertise of ALS personnel trained in pediatric critical care response.

TEAM CONFIGURATION

Although specially trained pediatric transport teams are available in many areas of the country, that is not universally true. All air medical crew members must have a thorough understanding of growth and development, age-specific behaviors, illnesses, injury patterns and size-appropriate treatments. However, when a flight program accepts the responsibility of caring for critically ill or injured pediatric patients as part of their program mission and scope of practice, all transports of this type must be staffed with team members capable of meeting the needs of the most critical patient.

GROWTH AND DEVELOPMENT

A working knowledge of growth and development and age-appropriate behaviors is crucial for all air medical providers. This information should then be correlated with age-specific illnesses and injuries for a complete picture of the pediatric patient. Common groupings of pediatric patients are as follows:

- Infants < 1 year
- Toddlers 2–3 years
- Pre-school age 4–6
- Elementary school age 6–12 years
- Adolescents 13–18 years.

PEDIATRIC ASSESSMENT

It is imperative for the air medical provider to understand the anatomy, physiology, and psychological differences in the pediatric population and their effects on clinical assessment and intervention.

Of primary concern is the ability of the air medical crew member to perform a complete pediatric initial and detailed survey. The initial survey should follow the ABCDE mnemonic for Airway, Breathing, Circulation, Disability, and Exposure, regardless of the illness or injury.

Clinical findings and treatments unique to children should be the focus of the pediatric initial survey:

- **A**irway control with concomitant cervical spine control
- **B**reathing assessment for the presence of respiratory distress
- **C**irculatory assessment and intervention
- **D**isability or neurological assessment
- **E**nvironment or exposure, including temperature regulation

Airway

Pediatric airway management instruction should emphasize that airway management in children is the cornerstone for effective clinical intervention in almost every pediatric emergency. Of particular importance is the positioning of the child’s head and shoulders to optimize the airway. This is a critical intervention due to the anatomic differences and relative size of a child’s head.

Breathing

Appropriate ventilation rates, volumes and pressures that provide equal rise and fall of the chest, equal breath sounds, ample time for expiration, and adequate oxygenation as determined by pulse oximetry or central perfusion, must be maintained for the duration of any transport. This may be as noninvasive as a nasal cannula or simple-mask or as invasive as endotracheal intubation or crichothyrotomy.

Circulation

Physical assessment of a child’s circulatory status and the interpretation of pediatric vital signs should be discussed. For transport, the interpretation of blood gases, laboratory results and diagnostic tests that reflect circulatory status should also be reviewed. Both traumatic and medical causes of circulatory compromise should be reviewed. Treatments and the desired responses to these treatments should be reviewed as well.

Disability

The neurological assessment including early GCS and pupil exams should be considered part of the initial survey. Age appropriate physical characteristics, developmental versus chronological age and emotional response must be included in this phase of assessment. Disability may be determined by the acute illness or injury or by a past medical diagnosis or condition. Whenever a parent or caregiver is available, a detailed history should be obtained to assess for any deviations from the child’s’ “usual” behavior or response.

Environment

Exposing a patient is important in an effort to visualize any bleeding, bruising, deformities or abnormalities. This is also true for pediatric patients, but age and development play a part in the psychological and emotional response of the child or young adult. Understanding the age-appropriate concerns regarding modesty and body image is important for all air medical crew members. In addition to exposure, temperature regulation is also of great concern, although primarily in children under the age of 3. Maintaining a “neutral-thermal” environment, in which the pediatric patient expends the least amount of energy maintaining his body temperature, will minimize the effects of temperature on the respiratory and metabolic systems.

CONDITIONS WARRANTING TRANSPORT

Pediatric patients present particular challenges to the air medical provider. Many of the diseases seen within the neonatal period are also seen in young infants. In addition, most adult illnesses and injuries are also seen within the pediatric population. These two ranges of diagnoses, combined with the age-specific illnesses and injuries, make the pediatric patient one of the most challenging to manage. Given the scope and breadth of possible pediatric diagnoses and treatments potentially encountered by the ALS air medical provider, only a brief review of the most common problems will be included in this text. Supplemental information should be utilized to more completely cover the details of assessment, treatment and triage of critically ill or injured pediatric patients.

RESPIRATORY CONDITIONS

Didactic education should include assessment and treatment of the following conditions, in which respiratory distress may be the chief complaint:

Foreign body airway obstruction (FBAO-upper and lower airway)

FBAO is most common in the 6-month to toddler age group. Their innate curiosity and propensity to place everything in their mouths, places this age group at very high risk. Another complicating factor is the size and position of the child’s airway. Small, anterior tracheas that narrow below the vocal cords make aspiration more likely, especially when the objects placed in the child’s mouth are usually small, solid and unlikely to disintegrate. Common objects include hard candies, buttons, coins, beads, nuts and small plastic building pieces.

Upper airway conditions

- **Croup:** An inflammation of the sub-glottic airway primarily caused by viral agents. Symptoms include fever and a "barky" cough. Treatment includes oxygen support and steroids. Racemic epinepherine aeresols may also alleviate symptoms.

- **Epiglottitis**: Inflammation and edema of the epiglottis. Symptoms include respiratory distress, difficulty controlling oral secretions, and tripod positioning in an attempt to increase air exchange. With the advent of H. influenza vaccinations the incidence of this disorder in pediatric patients is decreasing. Treatment includes endotracheal intubation (preferably in an OR setting) to protect the airway and antibiotic therapy to treat the infectious agent.

- **Tracheitis**: An inflammation of the trachea (primarily supraglottic) that can be caused by a variety of bacterial agents. Signs and symptoms are similar to epiglottitis but are of slower onset. Some authors argue that tracheitis is bacterial colonization of the trachea of a child with croup. This remains a fairly rare infection in the pediatric population

- **Retropharyngeal abscess**: An infection of the space between the deep cervical and prevertebral fascia often caused by group A Streptococcus or Staph aureus. Symptoms include facial swelling stridor, dyspnea. drooling, dysphagia and changes in voice. Treatment includes airway protection, antibiotic therapy and possibly surgical incision and drainage.

Lower airway conditions

- **Asthma:** Characterized by recurrent bronchospasm and inflammation that manifests itself clinically with shortness of breath, coughing and wheezing (particularly in the morning and evening). Therapy consists of beta-adrenergic agents and anti-inflammatory agents (steroids) for both acute and chronic care. Current advances in pharmacology have produced promising medications that stabilize mast cells and block leukotriene pathways.

- **Bronchiolitis/RSV:** Bronchiolitis is a broad term that describes a number of communicable infectious diseases of the pediatric airway that often first present in infancy. Symptoms include wheezing, fever, coryza, and retractions. Although many viral and bacterial agents have been described as causing bronchiolitis, the predominate organism appears to be respiratory syncytial virus (RSV). Treatment of bronchiolitis is primarily supportive but some studies have shown that ribovirin therapy may ameliorate its course.

- **Pneumonia:** Pneumonia describes inflammation of the lung tissue that can be caused by many bacterial, viral, and fungal pathogens. As with epiglottitis, the advent of H. influenzae vaccination has decreased some of the cases previously seen in children. Symptoms run a wide gamut that can include fever, cough, dyspnea, sputum production, rigors, chest pain and malaise. The onset and durations of symptoms vary dependent on causative agent, age of the patient, and underlying medical condition. Treatment varies dependent on the agent and severity of infection but includes support of the airway and oxygenation, treatment of associated symptoms, and antibiotic therapy when indicated.

Traumatic Injury to the Head, Neck and Face

Although traumatic injury occurs in all age groups, differences in pediatric anatomy and physiology affect the injury patterns and severity. Not only do children have a relatively large body surface area, they have a proportionately larger head and less developed neck muscles. When a young child falls or is thrown from a vehicle, the weight of their head leads the trajectory, causing a higher incidence of traumatic head and brain injuries.

Scalp lacerations often bleed profusely, even when the underlying injury is minor. This bleeding may distract the Provider from more subtle yet life-threatening injuries. In addition, the child, parents or bystanders may make the assumption that the bleeding is more significant than it is, causing alarm and concern.

CARDIOVASCULAR EMERGENCIES

Circulatory compromise can be the result of many illnesses and injuries in the pediatric patient. Congenital abnormalities, pediatric differences in fluid volumes, perfusion pressures, cardiac output and response to cardiovascular deterioration must be the focus when learning to care for the ill or injured pediatric patient. The following is a partial list of cardiovascular emergencies that may be seen in children.

Cardiogenic shock as a result of primary ischemic cardiac disease is rare in children. However, advances in pediatric cardiology and cardiovascular surgery have generated a population of children with structural heart disease that are surviving and thriving. These children not only frequently require critical pharmacologic and procedural interventions to manage their cardiac disease, but are subject to the same concurrent illnesses as the rest of the pediatric population, albeit with potentially higher morbidity risk. Knowledge of the etiologic classification of the common pediatric cardiovascular disorders and their therapies should include the following topics:

Congenital Heart Disease

- **Cyanotic (ductal dependent lesions)**

    - **Tetralogy of Fallot**: Characterized by 4 distinct cardiac anomalies, including a ventricular septal defect, an overriding aorta, right ventricular hypertrophy, and partial or complete obstruction of blood flow from the right ventricle (most often from pulmonary stenosis). Patients also suffer from hypoxic spells ("Tet spells") characterized by increasing cyanosis hyperpnea and irritability. This may lead to unconsciousness, seizures, and/or cardiac arrest. These hypoxic spells are treated with sedation (preferably morphine), oxygen, volume support, sodium bicarb, and knee to chest positioning. Pre-op treatment includes oxygen and the use of prostaglandins to maintain a patent ductus arteriosus to allow for mixing of blood.

    - **Transposition of the Great Arteries:** Characterized by the aorta arising from the right ventricle while the pulmonary artery originates above the left ventricle, creating parallel circulations. There is often an atrial-septal defect or patent foramen ovale present as well. Pre-op treatment includes oxygen and the use of prostaglandins to maintain a patent ductus arteriosus to allow for mixing of blood.

- **Acyanotic (present with congestive heart failure or cardiogenic shock)**

    - **Ventricular Septal Defect:** The most common cardiac anomaly, characterized by communication between the right and left ventricle via an opening in the septal wall. A patients' symptoms are often dependent on the size of the defect. Treatment varies from non-surgical to surgical related to the size of the defect and associated cardiac dysfunction.

    - **Coarctation of the Aorta:** Characterized by narrowing of the aorta (almost always distal to the left subclavian artery) creating increased pressures proximally and decreased pressure distally. Symptoms are related to the level/extent of coarctation but often patients have higher upper extremity blood pressures when compared to lower extremities. Lower extremity pulses are also weaker or absent when compared to upper extremities. The lower extremities may also exhibit cyanosis while the upper extremities remain pink. Pre-op treatment includes oxygen and the use of prostaglandins to maintain a patent ductus arteriosus to allow for mixing of blood. These patients may also require inotropic support and epinepherine, dopamine, and dobutamine may be used.

- **Hypoplastic Left Heart:** Characterized by underdevelopment or absence of the left ventricle. Hypoplasia of the aorta is also present. The pulmonary artery is enlarged and stenosis or atresia of the aortic and mitral valves may also be present. A coarctation of the aorta is also often present. Pre-op treatment includes prostaglandin therapy. Supplemental oxygen should only be given for severe hypoxia (SaO2 <60%)

    - **Prostaglandin infusion**Prostaglandin infusion is provided in a dose range of 0.05 mcg–0.1 mcg/kg/min. Using 0.6 ml of prostaglandin (500mcg/ml) added to 99.4 ml of IV fluid will yield a solution concentration of 3mcg/ml for calculation for continuous infusion.

Cardiomyopathies

- **Dilated**

  Cardiomyopathy characterized by dilatation of the ventricle resulting in decreased cardiac contractility. This decrease in contractility can progress to cardiogenic shock or failure

- **Hypertrophic**

  Cardiomyopathy characterized by increase in the muscle mass of the ventricle leading to obstruction to systolic outflow or poor diastolic filling. This may also lead to cardiogenic shock or failure.

  Cardiomyopathy may be caused by infectious agents, autoimmune disorders, or secondarily from metabolic disorders. Cardiomyopathies may also be caused by infiltrative disease (i.e. Pompe disease), ischemia, and in some cases no clear causative agent can be identified (idiopathic). The treatment of cardiomyopathy varies greatly dependent on the causative factors and clinical manifestations. Some patients may require treatment for congestive heart failure and/or inotropic support. Beta blockade may also be beneficial to some patients. Oxygen and supportive therapy of clinical symptoms remain the mainstay of transport care.

Dysrythmias

- **Tachydysrhythmias**

    - **Supraventricular tachycardia:** SVT describes a number of dysrythymias found in infants and children. SVT is considered when the EKG shows a ventricular rate > 220bpm in infants and> 180 bpm in children. Other factors associated with SVT include a heart rate not variable with activity, abrupt rate changes, and absent or abnormal P waves. Clinical conditions that may cause SVT/V-tach in children include hypoxemia, hypovolemia, hypothermia, hyperthermia, elevated and low serum potassium levels, pericardial tamponade, tension pneumothorax poisonings, thromboembolism and rarely pain. These diagnoses should be evaluated and treated. After providing oxygen and ventilatory support, initial treatment for SVT includes vagal maneuvers. If these are unsuccessful or impractical, adenosine 0.1mg/kg may be given rapid IV/IO push (close to the IV/IO hub with a rapid fluid bolus following medication administration). The maximum initial dose in children is 6mg. If this does not provide rate slowing, the dose may be doubled and repeated. The maximum second dose is 12mg. If adenosine therapy is unsuccessful or at any time the patient becomes hemodynamically unstable (mental status changes, hypotension, symptoms of cardiac failure) synchronized cardioversion should be provided. The initial cardioversion joules energy is 0.5–1.0 joules/kg. This may be increased to 2 joules/kg if unsuccessful. Sedation if permissible by patient status should be provided prior to cardioversion. Verapamil is strongly discouraged in infants and young children.

- **Ventricular tachycardia:** Pulsatile ventricular tachycardia is considered in children when a tachyarrythmia is associated with a widened QRS complex of greater than 0.08 seconds per EKG. As with any dysrythmia, oxygen and ventilatory support should be promptly provided. Ventricular tachycardia is extremely difficult to differentiate from some SVT rhythms with conduction aberrancy. Pediatric cardiology consultation is highly encouraged when considering this diagnosis. Clinical conditions that may cause SVT/V-tach (as listed above) should be considered and treated if present. Medications used for the treatment of pulsatile V-tach without hemodynamic compromise include Amiodarone 5mg/kg IV/IO over 20–60 minutes. Other possible medications include procainamide 15mg/kg IV/IO 0ver 30–60 minutes, or lidocaine 1mg/kg, IV/IO bolus. If medication administration is not successful or the patient becomes unstable cardioversion as discussed above may also be utilized. Consultation with a pediatric cardiologist may prove invaluable in treating these dysrythmias in the pediatric population.

- **Ventricular fibrillation:** Venticular fibrillation (or pulseless V-tach) when diagnosed by EKG, is immediately treated with asynchronous cardioverion (defibrillation). Initial defibrillation may be given 3 times if needed at energy levels of 2 joules/kg, 2–4joules/kg and 4 joules/kg respectively. If defibrillation is unsuccessful, epinephrine is given IV/IO 1:10,000 concentration at a dose of 0.1ml/kg. If given via the endotracheal tube, the 1:1000 concentration should be used at a dose of 0.1ml/kg. Following epinephrine administration the resuscitation will follow a "drug-shock-drug-shock" pattern. All defibrillations will be provided at 4 joules/kg after the initial 3 defibrillations. Epinephrine will be provided every 3–5 minutes through the resuscitation. After the initial dose of epinephrine, the use of the 1:1000 concentration should be considered for all subsequent doses. If v-fib continues after epinephrine and subsequent defibrillation, an anti-arrythmic should be administered. Amiodarone 5mg/kg, Lidocaine 1mg/kg or Magnesium 25–50 mg/kg (with Torsades or hypomagnesemia) are all acceptable agents. The clinical diagnoses listed for SVT and V-tach can also cause V-fib and should be considered and treated. The decision to discontinue unsuccessful resuscitation is difficult and case dependent. Until the algorithm has been fully explored without return of perfusion or the rhythm degenerates to asystole, resuscitation should continue.

- **Bradydysrhythmias**

  - **Sinus bradycardia:** Sinus bradycardia is defined as a heart rate lower than 60 bpm. Bradycardia in infants and children should first be treated with oxygenation and ventilation. This can be accomplished with high flow O2 by mask or bag valve mask ventilation dependent on patient condition. If the heart rate remains below 60 and the patient remains poorly perfused, hypotensive, with respiratory difficulty or altered consciousness (infants and children) after adequate oxygenation and ventilation, chest compressions should be performed. Initial medication for treatment of symptomatic bradycardia is epinephrine 0.1ml/kg of 1:10,000 concentration IV/IO. I f the endotracheal tube is used 0.1ml/kg of 1:1000 concentration should be utilized. These doses may be repeated every 3–5 minutes at the same dose

    Clinical diagnoses that may cause bradycardia include; hypoxemia, hypothermia, head injury, heart block, and toxins/poisons/drugs. All bradycardic children should be assessed for these and treated appropriately. Along with epinephrine Atropine 0.02mg/kg may be given IV/IO/ET with a minimum dose of 0.1mg, this dose may be repeated once. If oxygenation, epinepherine and atropine do not relieve symptomatic bradycardia cardiac pacing and the use of dopamine and epinephrine infusions should be considered. If at any time the patient becomes pulseless, the treatment for asystole should be followed. Patients who are bradycardic but without cardio-respiratory compromise should be provided with oxygen, IV access and transported to an ALS facility. Frequent assessment of patients with asymptomatic bradycardia is essential for prompt treatment of complications.

- **Asystole:** Asystole or pulseless rhythms in children should initially be treated with CPR and provision of oxygen and ventilation. A cardiac monitor should then be placed for rhythm interpretation. Asystole should be confirmed in more than one lead (V-fib and pulseless V-tach are discussed above). If patient is asystolic or in pulseless electrical activity (PEA) epinephrine may be given at a dose of 0.1 ml/kg of 1:10,000 concentration IV/IO If given per ET the dose is 0.1ml/kg of 1:1000 concentration. While CPR continues causes of asystole / PEA should be assessed and treated if present. These include hypoxemia, hypovolemia, hypothermia, hyper/hypokalemia, cardiac tamponade, tension pneumothorax, poisonings with toxins or drugs and thromboembolism. Epinephrine can be given every 3–5 minutes. Subsequent doses may be increased to 0.1ml/kg of 1:1000 concentration. Vasopressors may be considered but may be of little value. Asystole and PEA are extremely difficult rhythms to successfully resuscitate and once all potential causes have been addressed, consideration should be given to terminating the resuscitation.

Pericardial tamponade

Children who suffer from blunt or penetrating thoracic trauma are at risk of developing pericardial tamponade as a result of bleeding from the heart, great vessels, or pericardial vessels. This accumulation of blood in the pericardial sac restricts cardiac activity and results in obstructive cardiogenic shock. Symptoms of tamponade include hypotension /PEA, distended neck veins, and muffled heart tones. Initial treatment includes intravenous fluid bolus in an attempt to raise venous pressure and improve cardiac output. If this is unsuccessful, a pericardiocentesis should be performed by someone trained in this technique. Removal of as little as 15–20 ml of blood may greatly improve hemodynamic function.

Myocardial contusion

Myocardial contusion should be suspected in any child receiving blunt traumatic injury to the thorax. The symptoms may be difficult to differentiate from other conditions but include chest pain, hypotension, cardiac dysrythmias and EKG changes. All pediatric patients supected of having a myocardial contusion should be monitored for 24 hours with support of hypotension and dysrhythmias as outlined above.

Aortic disruption

Aortic disruption commonly causes sudden death in rapid deceleration injuries. A high index of suspicion for this injury should be maintained in children suffering from blunt trauma as survival is linked to early recognition. Symptoms are not sensitive but include recurrent unexplained hypotension and chest pain. The aortagram continues to be the gold standard for diagnosis. Either surgical or radiologic intervention is often necessary

Hemo/pneumo-thorax

Hemothoraces and pneumothoraces may be caused by both blunt and penetrating injuries. A hemothorax describes free blood in the pleural cavity while a pneumothorax describes free air. Symptoms of both include dyspnea, decreased breath sounds on the affected side, and possibly crepitus. Additionally hypotension may result from hemothorax. Tube thoracostomy is the treatment for both injuries especially in the presence of positive pressure ventilation. A hemothorax may also require fluid resuscitation or operative management dependent on blood loss. A life threatening complication of a pneumothorax is the development of a tension pneumothorax. A tension pneumothorax occurs when air is forced into the thoracic cavity without a means of escape. This is often occurs when providing positive pressure ventilation to children with a simple pneumothorax. It can also be caused by blunt or penetrating trauma or puncture of the lung during central line placement Tension pneumothorax is characterized by chest pain, dyspnea, absent breath sounds on the affected side, hypotension, and neck vein distention, Cyanosis and tracheal deviation are late signs of tension pneumothorax. Tension pneumothorax is a clinical diagnosis and should not be diagnosed radiographically. Treatment is emergent and involves decompression of the tension on the affected side. Initial placement of a 14 gauge catheter in the second intercostal space at the mid-clavicular line, should precede the definitive treatment of a tube thoracostomy.

Internal/external hemorrhage

As outlined in the shock module, hemorrhage control is an important component of management in all trauma patients. Of particular concern in pediatric patients is bleeding from head injuries. Vascular injuries to the heads of infants and small children may cause life-threatening hemorrhage. Anticipation and rapid treatment of this blood loss is critical in this age group. Children often have an exaggerated response to catecholamines, causing the child to suffer life-threatening hemorrhage without hypotension. Assessment of heart rate, skin color, mental status, and urine output are the cornerstones of fluid therapy. This is particularly true since there is not a clear correlation between blood pressure measurement and pediatric fluid requirements. The signs and symptoms of shock and its treatment are outlined in the shock module.

Pelvic/femur fractures

All orthopedic injuries cause blood loss. Pelvic fractures and femur fractures are of particular concern because blood loss from these fractures may be life threatening. Rapid immobilization of these fractures and fluid resuscitation as outlined in the shock chapter can prevent many of the complications from these injuries. MAST trousers remain controversial in the literature but may be of some benefit in temporizing blood loss during transport.

MEDICAL EMERGENCIES

This module should focus on specific medical emergencies commonly encountered in the pediatric population. The transport provider must possess a working familiarity with the myriad of critical medical conditions that typically affect multiple organ systems. This section should concentrate on therapies to maintain physiologic stability of the following conditions:

Metabolic

- Fluids and electrolytes
  - Hypernatremia
  - Hyponatremia
  - Hyperkalemia
- Glucose
  - Hypoglycemia
  - Diabetic ketoacidosis

Toxic Exposures/Ingestions and Envenomations

- **Toxidromes**
- **Antidotes**
- **Common Ingestions**
  - Acetominophen
  - Alcohols
  - Anticholinergics
  - Caustics
  - Clonidine
  - Cyanide
  - Cyclic antidepressants
  - Iron
  - Opioids
  - Organophosphates
  - Salicylates

- **Inhalations**
  - Carbon monoxide
- **Infectious Conditions**
  - Sepsis
  - Meningitis
- **Allergic Conditions**
  - Anaphylaxis
- **Envenomations**
  - Snake bites
  - Spider bites
  - Scorpion stings
  - Bee stings
- **Sudden Infant Death Syndrome**
- **Environmental conditions**
  - Hypothermia
  - Heatstroke
  - Near drowning

NEUROLOGIC CONDITIONS

The assessment of altered mental status in children can be challenging. The contributing conditions are diverse and an organized etiologic approach is necessary. The transport provider should be introduced to the categorical disease entities associated with altered level of consciousness through the AEIOU TIPS mnemonic. Distinguishing metabolic from structural coma and out-of-hospital management of seizures should be handled as distinct topics.

Common neurologic injuries/conditions:

- Altered Level of Consciousness
- Etiologic approach (AEIOU TIPS mnemonic)
- Evaluating coma
- Metabolic
- Structural
- Seizures
- Status epilepticus

Anatomic differences in children:

- Disproportionate head size
- Open fontanels and cranial sutures
- Poorly developed head and neck muscles

Neurological assessment parameters:

- Level of consciousness
- Pupil response
- Motor response (to include descriptions of decorticate and decerebrate posturing)
- Pediatric Glasgow Coma scoring

Treatment strategies:

- Airway management and ventilation strategies
- Mean arterial pressure support with fluid and vasopressors
- The role of diuresis
- Seizure control
- Positioning to aid in the control of ICP
- Environmental control (noise/temperature)
- The importance of frequent re-evaluation
- Methylprednisolone therapy should also be outlined.

Spinal cord injuries and immobilization techniques:

- Proper padding of the long spinal board
- Proper fit of the cervical collar
- Proper restraint of children on a long spine board
- Removal of a child from a car seat to a long spinal board
- Proper removal of helmets while maintaining C-spine alignment

SHOCK AND SHOCK MANAGEMENT

Shock

Shock is defined as cardiac output inadequate to meet metabolic demands. Classically, the clinical picture includes tachycardia, poor perfusion, oliguria and hypotension. However the full constellation of these signs constitutes a decompensated shock state associated with cardiovascular failure. It is incumbent upon the transport provider to identify the early signs of impending and compensated shock states. These clinical features can be subtle and require a high level of vigilance and clinical acumen. Cardiac output in young children is rate dependent and the development of tachycardia is the most sensitive sign of an impending shock state.

Children are extremely vasoactive and can maintain stroke volume via systemic vascular resistance mechanisms for prolonged periods; therefore the appearance of hypotension is a late and grave sign.

A discussion of specific shock states in the critical pediatric patient should include the following knowledge points:

- Early (compensated):
    - Tachycardia
    - Absence of hypotension
    - Tachypnea, grunting
    - Cool, mottled extremities
    - Mild oliguria
    - Subtle CNS changes, i.e. restlessness, agitation
    - Mild metabolic acidosis with normal pH (respiratory compensation)
- Classic (decompensated):
    - Tachycardia
    - Hypotension, weak distal pulses
    - Tachypnea, hyperpnea
    - Pale to cyanotic extremities
    - Oliguria
    - Depressed level of responsiveness
    - Significant metabolic acidosis with near normal pH (respiratory compensation)
- Late (pre-arrest)
    - Tachycardia → bradycardia
    - Profound hypotension, weak to thready pulses
    - Tachypnea → bradypnea
    - Cold extremities
    - Anuria
    - Profoundly depressed level of consciousness → coma
    - Severe metabolic acidosis with low pH (uncompensated); multisystem organ failure

<u>Treatment for Shock</u>

- Crystalloid/colloid resuscitation
- The role and timing of transfusion therapy
- The role of inotropic support as well as pediatric dosages and preparations (dopamine, epinepherine, norepinepherine, and dobutamine)
- The calculation of maintenance IV fluids
- Treatment of cardiac rhythm disturbances
- Hypoglycemia assessment and treatment
- Treatment of metabolic acidosis

Re-evaluation of patient status

Etiologies of hypovolemic, cardiogenic, obstructive, and distributive shock should be discussed. History taking and physical exam of the pediatric shock patient should be included as well. Diagnostic aids in diagnosing and differentiating between shock etiologies should include:

- Cardiac monitor
- Pulse oximeter
- Urinary catheter
- Chest radiograph
- Invasive pressure interpretation
- Laboratory studies/ Urinalysis

TRAUMATIC INJURIES

Traumatic injury is a common occurrence within the pediatric age group. Trauma can be divided into two distinct categories; nonintentional or accidental trauma, and intentional trauma that includes both abuse and neglect. The assessment skills required to identify the sometimes subtle signs of pediatric trauma are a critical component of the air medical provider's knowledge base.

Nonintentional Pediatric Trauma (Accidental)

Trauma is the leading cause of mortality in children and the source of significant morbidity. With the advent of pediatric trauma centers and regionalized pediatric systems of care, it is highly likely that the air medical provider will be called upon to transport from the field, or another facility, a critically injured child. Unique anatomic and physiologic aspects of children play a major role in the assessment of the trauma victim. Overt evidence of major internal injury may be subtle or not immediately evident. It behooves the transport provider to maintain a high index of suspicion and perform frequent reassessments when dealing with a pediatric trauma patient.

Initial discussion of pediatric trauma should emphasize the avoidable nature of the majority of these injuries. Safety education for parents, caregivers, and children is an aspect of pediatric trauma care that is often overlooked. Although the mechanisms of injury may be the same for adults and children, the resulting types of injuries vary due to the physiologic differences unique to children. The chronological age and developmental age of the pediatric patient often determines the nature or origin of the injury or illness as well as the child's emotional response to that event. The following topics must be thoroughly reviewed as they pertain to the care of pediatric trauma patients:

- Differences in size/ body surface area
- Differences in skeletal structure
- Intracranial/inter-cerebral bleeds
- Diffuse axonal injuries
- Cervical spine injuries
- SCIWORA (spinal cord injury without radiographic abnormality)
- Pneumothorax/ Hemothorax
- Thoracic injuries including flail chest
- Pulmonary contusion
- Diaphragmatic rupture
- Abdominal: solid organ injuries (liver, spleen, stomach, pancreas, duodenum) Hollow viscous injuries (duodenal hematoma, bladder disruption)
- Genitourinary injuries (kidney/bladder)
- Orthopedic injuries including extremity crush injuries and risk for compartment syndrome
- Nonoperative injuries and traumatic conditions not requiring immediate surgical intervention but warrant monitoring in a pediatric critical care setting:

<u>Nonaccidental Trauma/Abuse/Neglect</u>

This section should provide information on the assessment and intervention in children with suspected or actual nonaccidental trauma. Information provided should include:

- Historical findings that may indicate maltreatment
- Clinical signs and symptoms of maltreatment
- Bruise assessment
- Burn assessment
- Bite mark assessment
- Specific clinical presentations (traction alopecia, shaken baby syndrome, wounds in various stages of healing, spiral fractures, and fractures of bones not commonly injured.)
- Signs and symptoms of sexual abuse
- Psychological support of patient's and families
- Legal issues

CHILDREN WITH SPECIAL HEALTH CARE NEEDS (CSHCN)

In the transport environment, problem solving with CSHCN usually focuses on the technological assistance that many of these children are dependent upon. This group of patients generally has parents or caregivers that are very well informed about the child's' limitations and abilities. Their assessment of what is "normal" or "abnormal" behavior for that particular child should be taken seriously, since no other individual will know that child as well as they do. Utilize their expertise and assistance when assessing and treating these special children. Cognitive and psychomotor proficiency with the following topics is essential for trouble-shooting with CSHCN:

Fluid Administration and Medications

In children, hypovolemia is the most common etiology for shock. Therefore aggressive volume resuscitation is typically the mainstay of acute therapy. However, a significant number of critically ill pediatric patients have cardiogenic or septic shock and may require the support of vasoactive medications. It is important that transport providers readily recognize these conditions and be prepared to initiate appropriate therapy, lest continued fluid administration precipitate an irreversible state. This approach, in addition to indications, dosages and infusion rates of the standard resuscitation and post-resuscitation medications should be reviewed.

Vascular Access

Establishing and maintaining vascular access can be especially challenging in critical care patients, particularly in states of hemodynamic instability. It is important to identify alternative peripheral vascular access sites and techniques for the pediatric patient.

- Saphenous vein
- External jugular vein
- Scalp veins
- Intraosseous infusion
- Umbilical vein catheterization
- Indwelling lines
- PICC (peripherally inserted central catheters)
- Central venous catheters

VENTILATORY SUPPORT

Mechanical Ventilation and Blood Gas Interpretation

Discussion should focus on indications for ventilation modalities, mechanical settings and their adjustment based on pulse oximetry and blood gas analysis. Detailed information in the Mechanical Ventilation module

- Manual ventilation
- Mechanical ventilation
    - Pressure controlled ventilation
    - Volume controlled ventilation

- Positive end expiratory pressure (PEEP)
- Neuromuscular blockade and sedation
- 3 "golden rules" of blood gas interpretation
    - Target values pH, PaO2, PaCO2

PSYCHOLOGICAL NEEDS OF PATIENT AND FAMILY

Many psychological issues must be addressed when caring for sick children. There are three perspectives that must be considered as having an impact on the situational dynamics that occur when a child is seriously ill or severely injured. First and foremost is the perspective of the child. The child may be in pain, scared, afraid of being in trouble, insecure in an unfamiliar environment, or uncomfortable with strangers. The parent's perspective is second. The parent might be injured as well, feeling guilty for leaving the child unattended, angry at the child for breaking the rules, uncomfortable with the medical and law enforcement providers or even fearful that conditions of abuse or neglect will be discovered. The third perspective is that of the provider. The EMS provider may feel inadequate in addressing the needs of a child, may be uncomfortable in dealing with children, they may have lost their objectivity because they too have children, or they feel anger at the parent or perpetrator for allowing harm to come to the child.

When a child is in need of an air medical transport, the situation is usually grave and tensions high. The unknown outcome, the distance being transported and the unfamiliarity of a receiving hospital and staff in a different community all add to the stressors experienced by the child, parent and provider.

The air medical provider must be trained and practiced at dealing with families in crisis, thus making this topic extremely important for Initial Training as well as continuing education.

SUMMARY

It is important to reinforce the necessity of including critical anatomic, physiologic, and psychological differences unique to children in both the assessment and treatment of their illnesses and injuries. Preventive education must be stressed as an integral part of an air medical program's community relations and community service role. This activity has the potential to decrease un-intentional injuries, provide a service to the community, create EMS role-models for community youth as well as provide a marketing tool for the air medical program.

Exhibits accompanying this module are:

EXHIBIT 31-1: SUGGESTED EQUIPMENT AND SUPPLIES FOR PEDIATRIC ALS CARE

Nonrebreather oxygen mask with reservoir—infant, child, and adult
Oral airways, sizes 0–5
Nasopharyngeal airways with lubricant, sizes 12–30F
Bag-valve-mask unit 500cc with reservoir
Clear face masks in neonate, infant, child, and adult sizes
Suction catheters—6,8,10,12, and 14 Fr.
Stethescope—pediatric size
Doppler (*for SEMSV only)
Blood pressure cuffs: infant/child/adult
Pediatric sized backboard
Child/Infant car seat
C-spine immobilization device
Rigid extrication collars, infant–adult
Pediatric sized limb splints
Femur traction splint (Hare or Sager) designed for pediatric patient
Warming device/thermal blanket and head cover
Equipment/drug dosage sizing tape or equipment/drug age/weight chart
Pediatric trauma score reference
Poison control resource phone number
Pacifiers
Plastic baby bottle with nipple for glucose feeding
Transport monitor—battery operated with 3–4 lead wires
Defibrillator with 4.25 and 8cm paddles (or adaptors) settings should allow for dial down to pediatric specific w/s dosages
Monitoring electrodes—peds/adult
Laryngoscope handle, with extra batteries and bulbs
Laryngoscope blades, straight/curved—sizes 0,1,2,3
Sytlettes—peds/adult
Endotracheal Tubes—sizes: uncuffed: 3.0–5.5, cuffed: 5.0–8.0
Pulse oximeter with pediatric sensor
End tidal CO2 detector (disposable)
Magill foreceps—pediatric sized
Lubrication (water soluble)
Nasogastric tubes—sizes 5–18F
Glucose monitoring strip or glucometer
IV infusion pump
IV catheters—sizes 24–16g
Intraosseous needles—16 and 18g
Tourniquet/rubber bands
3-way stopcock or adaptor that allows administration of additional fluids or medications
Syringes—various sizes
Blood collection tubes
IV tubing micro and macrodrip
Buretrol
TB syringes

Medications
.9 Normal saline or lactated ringers for intravenous infusion
Sodium chloride—bacteriostatic for injection
Water—bacteriostatic for injection
Activated charcoal
Adenosine
Atropine sulfate
Sodium bicarbonate—8.4 percent (1.0 mEq/mL)
Benzodiazepine (of choice)
Epinephrine—1:1000 (1mg/mL)
Epinephrine—1:10,000 (.1mg/kg)
Racemic epinephrine
Lidocaine—(10mg/mL)
Naloxone—(1.0mg/mL)
Flumazenil
Lorazepam
Diazepam
Midazolam
Phenytoin
Phosphenytoin
Paraldehyde
Pain medication per medical control
50 percent dextrose in water
25 percent dextrose in water
Inhalent beta adrenergic agent of choice
Nebulizer

Information Provided by Illinois EMSC Grant Project

EXHIBIT 31-2: GENERAL PEDIATRIC TRANSPORT GUIDELINES

To be followed on all pediatric interfacility transports.

- Provide introductions to patient, family, nursing staff and physician.
- Obtain updated report on patient status upon arrival to referral facility.
- Obtain copied chart and parent’s consent for transfer.
- Obtain information on immunization status
- Assess for disease exposure
- Perform head to toe assessment, focusing on the similarity or disparity between chronological and developmental age of patient
- Obtain information from parent or caregiver as to the “normal” or “usual” behavior for this child
- Note any unusual or remarkable physical findings or unanticipated psycho-social responses from child
- Assess for family dynamics and support
- Contact receiving physician or on-line medical control to discuss assessment findings and plan of care
- Complete urgent treatments or procedures
- Administer fluids and medications per verbal or standing orders
- Package patient for transport
- Discuss transport process with patient and family as appropriate and time allows
- Provide family with receiving facility and physician information, directions and phone numbers
- Provide age appropriate support to patient
- Maintain neutral thermal environment for infants and young children
- While en route, monitor vital signs every 15 minutes or more frequent
- Deliver IV fluids with syringe pump or micro-drip set with buretrol;
- Add 3-way stopcock in-line to administer medications and fluid boluses
- Fluid rates 100 cc /kg/day; bolus 20cc/kg
- Foley catheter p.r.n. or diaper counts to monitor output.
- Strict I & O’s.
- Fingerstick Blood Glucose on all patients under 3 years and any patient with suspected metabolic condition
- Cardio-respiratory monitor for infants and small children
- Blood pressures and/or pulse quality on all 4 extremities
- Oxygen p.r.n. (Titrate to maintain SaO_2 > 95 percent)
- Continually reassess patient and adjust treatment plan accordingly.
- Notify medical director and receiving facility of worsening condition during transport to ensure assistance upon arrival.

EXHIBIT 31-3: GUIDELINES FOR SPECIALIZED TRANSPORTS

These guidelines should be followed on all high-risk pediatric transports. All treatments and interventions must be supported by written order, standing order, or physician-approved written protocols.

RESPIRATORY EMERGENCIES

- Follow standing orders or disease specific patient care protocols
- Maintain optimal airway position; utilize advanced airway adjuncts such as endotracheal intubation or nasal CPAP as needed.
- Provide BVM, anesthesia bag or mechanical ventilatory assistance as needed
- Titrate oxygen to maintain target SaO2 >95 percent
- Initiate IV therapy to prevent hypotension, improve major organ perfusion and maintain blood glucose within normal range
- Maintain neutral thermal environment utilizing available adjuncts and treatments (ie: space blankets, chemical packs, warmed IV bags etc.)
- Evaluate for underlying cause of respiratory difficulty (ie: ingestion, envenomation, inhalants, infection, asthma etc.)
- Administer medications targeting underlying cause of respiratory distress or failure (ie: nebulizer treatments for asthma or reactive airway disease; narcan for narcotic overdose etc.)

CARDIOVASCULAR

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing, and Circulation
- Obtain completed diagnostic information (i.e.: EKG, Echo cardiogram etc.)
- Assess heart sounds: rate, rhythm, murmur, additional sounds
- Assess peripheral pulses: rate quality, differences between upper and lower extremities
- Assess perfusion: color of mucous membranes, capillary refill time, unexplained color changes
- Evaluate CXR: overall lung picture, heart size, shape, position
- Report findings to receiving physician to determine course of treatment
- Administer Oxygen, as ordered, to relieve cyanosis
- Evaluate and treat whenever possible the underlying cause (ie: dysrythmias; medication overdose; anaphylactic reaction)

MEDICAL

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing and Circulation
- Assess overall appearance, color, activity, tone, increasing respiratory distress, rash, pettichiae, lesions, unusual patterns of injury
- Assess for signs and symptoms of metabolic abnormalities and treat underlying cause, when possible (ie: glucose, potassium, calcium etc.)
- Review previously ordered lab results for indicators of infection (ie: increased WBC, Increased bands, positive cultures etc.)
- Review drug screen if applicable
- Review diagnostic results as available (ie: CXR, CT or MRI etc.)
- Monitor for worsening multisystem failure (ie: increased respiratory distress, temperature instability, clotting or bleeding disorders, mental status changes, hypotention etc.)

NEUROLOGICAL

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing and Circulation
- Assess overall appearance: tone, activity, LOC, pupil exam, GCS, visual acuity
- Assess for injuries, deformities or unusual appearance of head/neck/face
- Children under 18 months, assess fontanel's: presence/absence of anterior and posterior; size; quality: bulging, flat, depressed
- Assess suture lines: approximated, split, stenosis present, overlapping
- Assess for seizure activity/posturing: unilateral, bilateral, jittery; repetitive blinking, sucking, jerking; inappropriate reflexes; tonic, clonic, decorticate, decerebrate; onset, frequency, duration
- Assess for cause of seizure activity or altered response: trauma, drugs, DKA, dehydration, hypoglycemia etc.
- Assess for past medical history such as hydrocephalus with VP shunt; assess for shunt failure
- Obtain completed diagnostic information (ie: head CT, etc.)
- Treat underlying causes when possible (ie: glucose, oxygen, anti-seizure medications etc.)
- For TBI, maintain oxygen saturation >90 , systolic BP >90 and SaO2 >90

SHOCK

- Follow standing orders or disease specific patient care protocols
- Assess, treat and support Airway, Breathing and Circulation
- Review previously ordered lab results
- Cardiac monitor and pulse oximetry
- Invasive pressure monitoring when available
- Assess for early signs and symptoms of shock
- Assess for underlying hypoglycemia
- Review CXR for evidence of CHF or atelectasis
- Treat with isotonic crystalloid bolus and maintenance fluids
- Provide inotropic support
- Treat cardiac rhythm disturbances

TRAUMA

- Follow standing orders or injury specific patient care protocols
- Assess, treat and support Airway, Breathing and Circulation
- Head to toe assessment including major life threats, location and degree of bleeding and deformity,
- Assess for mechanism and patterns of injury appropriate for child's age and developmental abilities
- Assess for evidence of earlier injuries in various stages of healing
- Make special note and report to receiving center if the child has been transported before for similar injuries
- Assess appropriateness of parents or caregiver

EXHIBIT 31-4: PEDIATRIC GLASGOW COMA SCORE

Assessment area	Score
• **Eye opening**	
• Spontaneous	4
• To speech	3
• To pain	2
• None	1
• **Best motor response**	
• Spontaneous movement	5
• Localizes pain	4
• Flexion-withdrawal	3
• Flexion abnormal	2
• (decorticate)	
• Extension (decerebrate)	1
• **Best verbal response 0–23 months**	
• Smiles and coos	5
• Cries and is inconsolable	4
• Persistent inappropriate crying	3
• or screaming	
• Grunts, agitated or restless	2
• No response	1
• **Best Verbal response 2–5 years**	
• Appropriate words/phrases	5
• Inappropriate words	4
• Persistent cries and screams	3
• Grunts	2
• No response	1

A. **Bibliography**:

Fleisher, G.R., Ludwig, S. *Pediatric Emergency Medicine*, 4th ed. Philadelphia: Lippincott, Willliams & Wilkins.

American College of Surgeons,Committee on Trauma. Pediatric trauma. *Advanced Trauma Life Support: Student Manual*. 6th ed. American College of Surgeons. Chicago, IL. 1997.

Emergency Nurses Association. *Emergency Nurse Pediatric Course: Provider Manual*. 2nd ed. Emergency Nurses Association. Park Ridge, IL. 1998.

American Academy of Pediatrics and American Heart Association. *Pediatric Advanced Life Support:Provider Manual*. American Heart Association. Dallas,TX. 1997.

Sanders, M.J. *Mosby's Paramedic Textbook*. Mosby-Year Book Inc. St. Louis, MO. 1994.

B. **Definitions of Keywords**:

Croup—Upper airway obstruction from inflammation of the larynx, pharynx or trachea that produces a harsh cough

Epiglottitis—Upper airway obstruction involving severe inflammation and swelling of the epiglottis

Bronchiolitis—Lower airway obstruction involving irritation and inflammation of the bronchioles

Cyanotic lesion—Congenital heart disease with left-to-right shunt

Fontanel—A membranous space at the intersection of cranial bones on an infant

CSHCN—Children with Special Health Care Needs

PEG—Percutaneous endoscopic gastrostomy

C. **Test Questions**:

1. Which of the following is **not** typical of a 3-month old infant?

    a. Social smile
    b. Recognizes caregivers
    c. Tracks faces
    d. **Stranger anxiety**

2. Which of the following can be described as an upper airway obstruction?

    a. Asthma
    b. **Tracheitis**
    c. Pneumonia
    d. Bronchiolitis

3. Which defect is considered a cyanotic heart lesion?

    a. Ventricular Septal Defect
    b. Coarctation of the Aorta
    c. **Tetralogy of Fallot**
    d. Hypoplastic Left Heart

4. Early or compensated shock presents with all of the following, except:

    a. Tachycardia
    b. **Hypotension**
    c. Tachypnea
    d. Restlessness,

5. Three perspectives that must be considered when a child is ill or injured, include:

    a. Child, Parent, Provider
    b. Parent, Child, Bystander
    c. Bystander, Child, Provider
    d. Child, Parent, Sibling

D. **Didactic Hours**: 16

E. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples:

1. Oropharyngeal and nasopharyngeal airways
2. Endotracheal intubation
3. Removing and replacing a tracheostomy tube
4. Intraosseous needle insertion
5. Orogastric and nasogastric intubation
6. Spinal immobilization
7. Needle thoracostomy
8. Bronchodilator therapy
9. Endotracheal drug delivery

F. **Patient Care Hours**: 16–24

CHAPTER 9: HIGH-RISK AND CRITICAL CARE PATIENTS

MODULE 32: HIGH-RISK OBSTETRICS AND HIGH-RISK DELIVERIES

Author: Ms. Pamela Adams, RN, OB-STAT Consulting, Arden, NC

Reviewers: Dr. Robert (BJ) Johnson, Phoenix Perinatal Assoc., Phoenix, AZ

OBJECTIVES

Upon completion of this module, the student will be able to:

- Perform in a secondary team or team leader role with documented proficiency
- Serve as a content expert and resource for other air medical crew members on the topics of obstetrics, childbirth, neonatal resuscitation and stabilization and high-risk obstetrical care

INTRODUCTION

The majority of maternal transports are carried out due to concern for a potentially compromised fetus, thereby necessitating advance skill and competency in the care of both mothers and infants.

Air medical programs accepting the responsibility of caring for high-risk obstetrical and/or complicated delivery situations, as part of their mission and scope of practice must provide this critical-level of care on all transports regardless of mode or distance traveled.

The maternal transport team shall consist of a group of highly specialized health care providers trained to assess, stabilize, and transport the high risk obstetrical patient to the most appropriate medical facility. All transported patients shall receive continuity of care meeting or exceeding that received at the referral facility.

The initial training and continuing education of these specialized team members shall exceed the knowledge and competencies described in Module 29, Obstetrics and Childbirth, and focus on the management of critical or potentially unstable obstetric patients.

TEAM QUALIFICATIONS

The configuration of the team may vary based on local and state guidelines, as well as facility medical direction. There must be a core crew consisting of two team members meeting the minimal qualifications, with the team leader meeting both minimal and optimal team qualifications.

Minimal Maternal Transport Team Qualifications (Team leader and secondary team member requirements)

- Registered nurse, paramedic, respiratory therapist and/or EMT certified or licensed in the state of the base of operation
- BLS (Basic Life Support) Provider
- NRP (Neonatal Resuscitation Program) and/or PALS (Pediatric Advanced Life Support) Provider
- Successful completion of a flight training program, that meets or exceeds the recommendations of the *Guidelines for Accreditation of Medical Transport Services* (CAMTS) and of any relevant state or regional agency.
- Successful completion of a ground transport orientation that complies with state guidelines and program policies.
- Additional team members such as: obstetrician, OB fellow, certified nurse midwife, OB nurse practitioner, or critical care transport nurse may be added to the core transport team on a case-specific basis.

Optimal Maternal Transport Team Qualifications (Team Leader requirements)

- Registered nurse and/or Paramedic licensed in the state of the base of operation.
- Completion of a high risk obstetrical transport course and skills lab.
- Proficient completion of a maternal-specific competency checklist
- ACLS Provider

Basis for Team Configuration

- Established local and state guidelines
- Legal scope of practice of team members
- Program policies and protocols
- Medical director approval

CRITICAL COMPETENCIES

Team leader

Must be proficient in all aspects of high-risk maternal transport. Proficiency shall be based on individual performance of the following:

- Technical and clinical competencies
- Critical thinking and leadership skills
- Competency in community relations and interpersonal communication

Secondary Team Member

Must be capable of assisting the team leader with assessment, stabilization, invasive procedures, obtaining consents, and interaction with families and referring staff, as well as capable of assuming care of the mother or neonate in the event of an emergency delivery.

Maternal Transport Team

All teams responding to the request for a high-risk maternal transport must demonstrate competency in the following skills, and any others deemed necessary by the program medical director.

- Pre-transport stabilization and patient packaging
- Performance of a complete maternal physical exam
- Advanced airway management including intubation
- IV access
- Fluid support and administration of maternal specific medications
  - Tocolytics-determined by scope of practice and program medical direction
- Advanced cardiac life support skills
- Accurate vaginal exams, including sterile speculum exams
- Testing of amniotic fluid for nitrazine and ferning
- Ultrasound identification for fetal positioning
- Manual assessment of fetal position
- Fetal heart rate monitoring and interpretation
- Proficiency in neonatal resuscitation
- UVC insertion
- Emergency delivery in confined space and/or at altitude, including:
  - Breech presentation
  - Shoulder dystocia
  - Umbilical cord prolapse
  - Meconium stained amniotic fluid delivery
  - Prolonged fetal distress
  - Nuchal cord
  - Post partum hemorrhage
  - Uterine inversion
  - Uterine rupture
  - Multiple births

CONTINUING EDUCATION

The transport coordinator and/or medical director of the transport team shall evaluate the skills and clinical competencies of all team members. Yearly reassessment of team member skills and knowledge must be accomplished and documented. Methods of evaluation and documentation may include any or all of the following:

- Written examination
- Skills labs
- Case presentations with oral exam

ASSESSMENT AND EVALUATION

The initial and detailed assessment of maternal and fetal patients should follow the guidelines presented in Module 29, Obstetrics and Childbirth. The evaluation and treatment of high-risk or unstable patients is best accomplished by trained maternal team members who possess expanded knowledge and skill in the interpretation of ante-partum test results and treatment of specific high-risk conditions.

INTERPRETATION OF ANTE-PARTUM TESTING

While most transport teams will not be called upon to interpret or review the results of antepartum testing, the maternal transport team must possess the knowledge and ability to determine fetal well-being as reflected by results of the Nonstress Test (NST), Contraction Stress Test (CST), Oxytocin Challenge Test (OCT), and the Biophysical Profile (BPP).

CONDITIONS WARRANTING TRANSPORT

The majority of maternal transports will be carried out due to concern for a potentially compromised fetus. The maternal team leader must demonstrate competency and leadership in the overall management of the high-risk mother, newly born infant, and the transport environment. A skilled maternal team should transport the following conditions to a regional center for continuing high-risk care:

Complications of Labor

- Preterm labor (PTL)
- Premature rupture of membranes (PROM)

Bleeding Disorders

- Placenta previa
- Abruptio placenta

Hypertensive Disorders

- Pregnancy induced Hypertension (PIH)
- Hypertension With Superimposed Pregnancy Induced Hypertension (PIH)

- Pre-Eclampsia
- Eclampsia
- H.E.L.L.P. Syndrome
- Pulmonary Edema
- Other maternal conditions that may affect the fetus or precipitate delivery include but are not limited to:

  Diabetes—poorly controlled gestational diabetes or severe diabetes mellitus
  Rh isoimmunization
  Trauma
  Drug abuse
  Infection
  Heart disease
  Renal disease
  Surgical complications—trauma, acute abdomen, thoracic emergencies

Triage and Transport

As a general guideline, the following patients should not be transported until delivery can be accomplished, bleeding slowed, or hypotension resolved:

- Maternal hypotension or shock
- Fetal compromise (repetitive late decelerations, etc.)
- Brisk or active hemorrhage

SUMMARY

The physical and emotional well-being of both the high-risk mother and infant are the primary responsibility of the maternal team leader and the secondary team member. In addition to routine labor support, delivery care and neonatal stabilization, the high-risk maternal team must be prepared to respond to any number of critical and/or life-threatening conditions. The team scope of practice is determined by licensure and program medical direction. Didactic training, skills competency and continuing education must be commensurate with the mission and scope of practice as stated by the air medical program.

The following exhibit accompanies this module:

Exhibit 32-1: Competencies for High-Risk Maternal Teams

EXHIBIT 32-1: COMPETENCIES FOR HIGH-RISK MATERNAL TEAMS

The following competencies are required for any team accepting the responsibility of high-risk maternal transport as part of their program mission and scope of practice. Team leaders must demonstrate competency in all of the areas listed on the competency checklist. Secondary team members must be working toward completion of competencies appropriate for their position on the team.

A. Triage
- Accept verbal report from sending facility.
- Categorize transport according to severity and mode of transport.
- Estimate E.T.A. for referral facility.
- Activate appropriate transport personnel and vehicle.
- Notify medical director, N.I.C.U., perinatal center of new admission.
- Prepare appropriate equipment for departure.

B. Vaginal exams
- Perform vaginal exams on laboring women in controlled setting with a preceptor. Differentiate between normal and abnormal rate of cervical dilation, effacement, and descent of presenting part.
- Must show competency by consistently demonstrating a 90 percent accuracy when determining dilation, effacement, and station as well as fetal presentation and position.
- Exam competency includes showing proficiency in determining all dilation stages from a closed/thick cervix to complete dilation.

C. Speculum exams for PROM
- Demonstrate proficiency in proper insertion of speculum.
- Assess color, amount and odor of amniotic fluid.
- Visualize cervix to assess dilation when applicable.
- Confirm rupture of membranes with nitrazine or fern test.

D. Ultrasound identification of fetal position
- Proficiency in utilizing ultrasound exam to determine fetal position (in accordance with institutional policy and nurse practice act).
- Confirmation of correct fetal position vital prior to transport.

E. Fetal heart rate monitoring and interpretation
- Completion of basic fetal monitoring course or equivalent.
- Passing of fetal monitoring test with 90 percent or higher.
- Recognize normal and abnormal fetal heart rate patterns and identify nonreassuring tracings.
- Promptly initiate appropriate nursing interventions for nonreassuring FHR tracings and notify appropriate physician.
- Recognize normal and abnormal contraction patterns.
- Initiate appropriate nursing interventions for abnormal contraction status and notify appropriate physician.
- Apply direct fetal monitoring devices in accordance with nurse practice act, institution policy and medical direction when necessary.

F. Obstetrical pharmacology administration
- Competency validation of medication knowledge including medication desired effect, route, dosage, adverse effect, interactions, and considerations.
- Monitor mother and fetus for desired and deleterious effects of administered medications. Prepare for medication discontinuance and reversal if necessary.

G. Medical directing standing orders
- Competency validation of knowledge of standing orders.
- Requesting of further orders from medical direction when completion of standing orders achieved if needed.

H. Equipment
- Competency validation of safe usage of equipment in multiple transport settings.
- Yearly or more frequent equipment updates or inservices.

I. Neonatal resuscitation procedures
- Current neonatal resuscitation procedure—(NRP) certification.
- Advanced procedures—Intubation, UVC insertion, medication administration in accordance with medical direction, institution policy, and nurse practice act.

J. Transport vehicle safety competency
- Safety orientation of ground vehicle or air ambulance to include location of emergency exits, fire extinguishers, securing of self and equipment, life vests and floats, emergency oxygen, survival kits, radio usage and ELT activation for air ambulance.
- Function as air crew member with rotor-wing transport using safety instruction such as rotor safety, obstacle watch, participation in take off and landing safety checklist, etc.
- Knowledge and adherence to safety rules for each type of transport vehicle.
- Location of vehicle oxygen, suction, and emergency telecommunication transmitting ability.

A. **Bibliography**:

A.C.O.G. Technical Bulletin No. 219, *Hypertension in pregnancy*, January 1996.

A.C.O.G. Technical Bulletin No. 206, *Preterm Labor*, June 1995.

American College of Obstetricians and Gynecologists and American Academy of Pediatrics, *Guidelines for Perinatal Care*. 4th Ed., 1997.

Elliott, J. & Sipp, T, & Balazs, K., "Maternal Transport of patients with advanced cervical dilation—to fly or not to fly?", *Obstetrics & Gynecology*, Vol. 79, No. 3, March 1992.

Lee, G., *Flight Nursing Principles and Practice*, 1st ed., Mosby: St. Louis, 1991.

Mandeville, L. & Troiano, N., *High—Risk & Critical Care Intrapartum Nursing*, 2nd ed. J.B. Lippincott: Philadelphia, 1999.

National Flight Nurses Association, *Flight Nursing Core Curriculum* "Obstetrical Transport" Chapter 16 & " Neonatal Transport" Chapter 17: 1997.

Nelson, M., " The high-risk obstetric patient", *Air Medical Crew Core Curriculum*, p. 177–190. ASHBEAMS/US Department of Transportation: Pasadena.

Sibai, B. & Ramadian, M., "Maternal morbidity and mortality in 442 pregnancies with H.E.L.L.P. Syndrome". *American Journal Obstetrics & Gynecology*, v. 169, 1000–1006.

B. **Didactic Hours**: 16

C. **Skills Hours**: As needed to acquire the Competencies for High-Risk Material Team prior to the assigned clinical hours

D. **Patient Care Hours**: 72–144

MODULE 33: HIGH-RISK NEONATAL CARE

Authors: Dr. Hal Kaftan, Children's Mercy Hospital, Kansas City, MO
Dr. Ralph J. Wynn, Children's Hospital of Buffalo, Buffalo, NY
Ms. Linda Meiner, RN, Air Evac Flight Services, Phoenix, AZ

Reviewers: Dr. Sue Ann Smith, OR Health Sciences University, Portland, OR
Ms. Cynthia Neboda, RN, San Diego Children's Transport, San Diego, CA
Mr. Eric Smith, RN; Children's Mercy Hospital, Kansas City, MO
Ms. Sherri Dean, RN, Children's Mercy Hospital, Kansas City, MO

OBJECTIVES

Upon completion of this module, the student will be able to:

- Perform in a secondary team or team leader role with documented proficiency
- Serve as a content expert and resource for other air medical crew members on the topics of obstetrics, childbirth, neonatal resuscitation and stabilization and high-risk neonatal care

INTRODUCTION

Air medical programs accepting the responsibility of caring for the high-risk neonatal patient as part of their program mission and scope of practice must provide this critical level of care on all transports regardless of mode or distance traveled.

The neonatal transport team shall consist of a group of highly specialized health care providers trained to assess, stabilize, and transport the high-risk newborn patient to the most appropriate medical facility. All transported patients shall receive continuity of care meeting or exceeding that provided at the referral center.

The initial training and continuing education of these specialized team members shall exceed the knowledge and competencies described in Module 33, Neonatal Care, and focus on the management of unstable or potentially unstable disease entities.

TEAM QUALIFICATIONS

The configuration of the neonatal team may vary based on local and state guidelines, as well as program medical direction. There must be a core crew consisting of two team members meeting the minimum qualifications, with the team leader meeting both minimal and optimal team qualifications.

Minimal Neonatal Transport Team Qualifications (team leader and secondary team member requirements)

- Registered nurse, paramedic, respiratory therapist and/or EMT-certified or licensed in the state of the base of operation
- BLS (Basic Life Support) provider
- NRP (neonatal resuscitation program) and/or PALS (Pediatric Advanced Life Support) provider
- Successful completion of a flight training program that meets or exceeds the recommendations of the *Guidelines for Accreditation of Medical Transport Services* (CAMTS) and any relevant state or regional agency
- Successful completion of a Ground Transport Orientation that complies with state guidelines and program policies
- Additional team members, such as a neonatologist, neonatal fellow, pediatrician, pediatric resident, neonatal nurse practitioner, or critical care transport nurse, may be added to the core transport team on a case specific basis

Optimal Neonatal Transport Team Qualifications (team leader requirements)

- Registered nurse licensed in the state of the base of operation
- Completion of a high-risk neonatal transport course and skills lab
- Proficient completion of a neonatal-specific competency checklist
- NRP provider

Basis for Team Configuration

- Established local and state guidelines.
- Legal scope of practice of team members.
- Program policies and protocols.
- Medical director approval.

CRITICAL COMPETENCIES

Team Leader

Must be proficient in all aspects of high-risk neonatal transport. Proficiency shall be based on individual performance of the following:

- Technical and clinical competencies.
- Critical thinking and leadership skills.
- Competency in community relations and interpersonal communication.

Secondary Team Member

Must be capable of assisting the team leader with assessment, stabilization, invasive procedures, obtaining consents and interacting or communicating with families and referring staff.

Neonatal Transport Team

All teams responding to the request for a high-risk neonatal transport must demonstrate competency in the following skills, and any others deemed necessary by the program medical director.

- Pre-transport stabilization and patient packaging
- Initial and detailed neonatal assessment
- Advanced airway management, including oral and/or nasal intubation
- Umbilical artery and umbilical vein catheterization
- Peripheral venous catheter placement
- Needle thoracostomy
- Chest tube insertion
- Chest x-ray interpretation
- Initial management of surgical emergencies
- Mechanical ventilation, including ECMO, jet, oscillation, and nitric oxide as appropriate for program mission and scope of practice
- Special considerations in the care of the VLBW (<1000 Gm.) infant
- Neonatal resuscitation and delivery room stabilization skills
- Fluid support and administration of neonatal specific medications:

  PGE1
  Surfactant
  Nitric Oxide

CONTINUING EDUCATION:

The transport coordinator and/or medical director of the transport team shall evaluate the skills and clinical competencies of all team members. Yearly reassessment of team member skills and knowledge must be accomplished and documented. Methods of evaluation and documentation may include any or all of the following:

- Written examination
- Skills labs
- Case presentations with oral exam

ASSESSMENT AND EVALUATION

The initial and detailed assessment and care should follow the guidelines presented in Module 30. The assessment and transport of high-risk neonates is best accomplished by trained neonatal team members, possessing expanded knowledge and skills.

CONDITIONS WARRANTING TRANSPORT

Almost without exception, neonatal transports originate at a facility with fewer perinatal and neonatal resources than the receiving high-risk center. The neonatal team leader must demonstrate competency and leadership in the overall management of the high-risk neonate and the transport environment. The following conditions usually require an urgent or emergent transfer by ground or air with a specialized neonatal transport team.

Respiratory Conditions

- Respiratory distress syndrome (RDS)
- Transient tachypnea of the newborn (TTN)
- Meconium aspiration syndrome (MAS)

Cardiovascular Disease

- Congenital heart disease (CHD)
- Rhythm disturbances
- Persistent pulmonary hypertension in the newborn

Neurological Disorders

- Seizures
- Intraventricular hemorrhage (IVH)
- Hydrocephalus
- Neural tube defects
    - Meningomylocele/spina bifida
    - Encephalocele
    - Anencephaly

Metabolic Disorders

- Hypoglycemia
- Acidosis
- Hypocalcemia

Surgical Emergencies

- Omphalocele
- Gastroschisis
- Malrotation
- Necrotizing Enterocolitis (NEC)
- Tracheoesophageal Fistula (TEF)
- Congenital Diaphragmatic Hernia

Congenital Infections/Sepsis

TRIAGE AND TRANSPORT

As a general guideline, any newborn requiring transport for medical or surgical reasons should be assessed and transported by a neonatal transport team specializing in the care of high-risk neonates. On occasion, an urgent or emergent field delivery may necessitate the transport of the newly born infant, in which case, all ALS providers should be prepared to support the ventilatory and circulatory needs of the neonatal patient.

SUMMARY

The physical care of the newborn and the emotional support of the mother and family are the responsibilities of the neonatal transport team members. Because the emergent transport of a newborn is unexpected and difficult to plan for, the families require and deserve detailed information and emotional support from the transport team and referring facility. This transition of care must be handled professionally and with empathy and serves as a critical link between the parents and receiving facility. The team scope of practice should be dictated by licensure and program medical direction. Didactic training, skills competency and continuing education must be commensurate with the mission and scope of practice a stated by the air medical program.

Accompanying this module is Exhibit 33-1: Guidelines for High-Risk Neonatal Team Competencies.

EXHIBIT 33-1: GUIDELINES FOR HIGH-RISK NEONATAL TEAM COMPETENCY

The following competencies are required for any team accepting the responsibility of high-risk maternal transport as part of their program mission and scope of practice. Team leaders must demonstrate competency in all of the areas listed on the competency checklist. Secondary team members must be working toward completion of competencies appropriate for their position on the team.

Triage

- Accept verbal report from sending facility
- Categorize transport according to severity and mode of transport
- Estimate E.T.A. for referral facility.
- Activate appropriate transport personnel and vehicle.
- Notify medical director, N.I.C.U., perinatal center of new admission.
- Prepare appropriate equipment for departure.

Respiratory Support

- Provide supplemental oxygen and assisted ventilation including: anesthesia bag, BVM, oxyhood, nasal cannula, nasal CPAP, oral and/or nasal intubation and mechanical ventilation; titration of oxygen based on pulse-oximetry trends, blood gas analysis and central perfusion

Vital Signs/Monitoring

- Perform visual and/or electronic monitoring of heart rate and rhythm; respiratory rate, quality depth and effectiveness; blood pressure, perfusion, pulse quality, capillary refill; Oxygen saturation and central perfusion

Fluid and Glucose Management

- Initiate intravenous therapy via peripheral, arterial or venous umbilical lines and Intraosseous (as determined by Program Medical Director)
- Titration of fluid IV maintenance, fluid boluses and glucose maintenance
- Administration of blood and blood products

Neonate-specific Medication Administration

Competency validation of medication knowledge including medication desired effect, route, dosage, adverse effect, interactions, and considerations; medication discontinuance and reversal if necessary

- Exogenous Surfactant
- Prostaglandin (PGE1)
- Antimicrobials
- Diuretics
- Cardiovascular (digitalis glycosides; sympathomimetics; antihypertensives; vasodilators; antiarrythmics)
- Analgesic
- Anesthetics
- Sedatives

Neonatal resuscitation procedures

Competency validation in skills lab and/or patient care settings:

- Maintain current NRP certification
- Oral intubation
- UAC/UVC insertion
- Peripheral IV insertion; PICC lines per medical direction

- Needle thoracostomy
- Chest tube insertion
- Arterial blood gases
- OG/NG placement
- Trach replacement and care
- Suctioning-oral, nasal, endotracheal

Lab results
Competency validation in recognition of normal and critical threshold lab values; including electrolytes; hematology/clotting panel; and blood gases

Equipment
Competency validation of safe usage of equipment in multiple transport settings. Must include all equipment used by the neonatal transport team, including, but not limited to:
- Transport incubator
- Transport monitor
- Transport ventilator
- Pulse oximetry
- Cardio-respiratory and blood pressure monitors

Transport Vehicles
Competency validation to including but not limited to:
- Safety orientation of ground vehicle or air ambulance to include location of emergency exits, fire extinguishers, securing of self and equipment, life vests and floats, emergency oxygen, survival kits, radio usage and ELT activation for air ambulance.
- Function as air crew member with rotor-wing transport using safety instruction such as rotor safety, obstacle watch, participation in take off and landing safety checklist, etc.
- Knowledge and adherence to safety rules for each type of transport vehicle, location of vehicle oxygen, suction, and emergency telecommunication transmitting ability.

A. **Didactic Hours**: 16

B. **Patient Care Hours**: 72–144; newborn intensive care

C. **Skills Hours**: Skills competency checklists should be based on program specific protocols, medical direction, program mission and scope of practice. Skills practice should be scheduled prior to any assigned patient care hours. Skills lab hours should be scheduled as needed to complete the program specific skills competency checklists.

MODULE 34: CRITICAL CARE PEDIATRICS

Author: Dr. Joseph L. Wright, MPH,
Maryland Institute of Emergency Medical Services, Baltimore, MD

Reviewer: Mr. Christopher Wagner, RN, University of Michigan Medical Center, Ann Arbor, MI

INTRODUCTION

Air medical programs accepting the responsibility of caring for the critically ill or injured pediatric patient as part of their program mission and scope of practice must provide this critical level of care on all transports regardless of mode or distance traveled.

The pediatric transport team shall consist of a group of highly specialized health care providers trained to assess, stabilize and transport the critical pediatric patient to the most appropriate medical facility. All transported patients shall receive continuity of care meeting or exceeding that provided at the referral center.

The initial training and continuing education of these specialized team members shall exceed the knowledge and competencies described in Module 31, Pediatric Care, and focus on the management of unstable or potentially unstable disease entities.

Critical care pediatric patients come in all sizes, shapes and ages; however, the vast majority are under the age of 5, and the bulk of those less than 1 year of age. Therefore, particular attention should be paid to the physiologic and anatomic nuances of this age group. In addition, traumatic injuries and experimental behavior are the hallmark of adolescence, and these often necessitate ALS transport.

OBJECTIVES

Upon completion of this module, the student will be able to:

- Perform in a secondary team or team leader role with documented proficiency
- Serve as a content expert and resource for other air medical crew members on the topics of pediatric assessment, age-specific diseases and injury patterns, pediatric resuscitation and stabilization, as well as children with special health care needs

TEAM QUALIFICATIONS

The configuration of the pediatric team may vary based on local and state guidelines, as well as program medical direction. There must be a core crew consisting of two team members meeting the minimum qualifications, with the team leader meeting both minimal and optimal team qualifications.

Minimal Pediatric Transport Team Qualifications (team leader and secondary team member requirements)

- Registered nurse, paramedic, respiratory therapist and/or EMT certified or licensed in the state of the base of operation
- BLS provider
- PALS provider
- Successful completion of a flight training program that meets or exceeds the recommendations of the *Guidelines for Accreditation of Medical Transport Services* (CAMTS) and any relevant state or regional agency.
- Successful completion of a ground transport orientation that complies with state guidelines and program policies
- Additional team members such as a pediatric intensivist, pediatric emergency physician, critical care fellow, pediatrician, pediatric resident, pediatric nurse practitioner or critical care transport nurse may be added to the core transport team on a case specific basis.

Optimal Pediatric Transport Team Qualifications (team leader requirements)

- Registered nurse licensed in the state of the base of operation
- Completion of a Critical Care Pediatric Course and skills lab
- Proficient completion of a pediatric-specific competency checklist
- ACLS provider
- NRP provider

Basis for Team Configuration

- Established local and state guidelines
- Legal scope of practice of team members
- Program policies and protocols
- Medical director approval

CRITICAL COMPETENCIES

Team Leader

Must be proficient in all aspects of critical care pediatric transport. Proficiency shall be based on individual performance of the following:

- Technical and clinical competencies
- Critical thinking and leadership skills
- Competency in community relations and interpersonal communication

Secondary Team Member

Must be capable of assisting the team leader with assessment, stabilization, invasive procedures, obtaining consents and interacting or communicating with families and referring staff.

Pediatric Transport Team

All teams responding to the request for a Pediatric Critical Care Transport must demonstrate competency in the following skills, and any others deemed necessary by the Program Medical Director.

- Pre-transport stabilization and patient packaging
- Initial and detailed pediatric assessment
- Provision of age- and developmentally-appropriate care
- Advanced airway management, including oral and/or nasal intubation
- Umbilical artery and/or umbilical vein catheterization
- PICC line placement as deemed appropriate by Program Medical Director
- Needle thoracostomy
- Chest tube insertion
- Chest x-ray interpretation
- Mechanical ventilation, including ECMO, jet, oscillation, and nitric oxide as appropriate for program mission and scope of practice
- Fluid support and medication administration as appropriate
- Special considerations in the care of the VLBW (<1000 Gm.) infant
- Neonatal resuscitation and delivery room stabilization skills

CONTINUING EDUCATION

The transport coordinator and/or medical director of the transport team shall evaluate the skills and clinical competencies of all team members. Yearly reassessment of team member skills and knowledge must be accomplished and documented. Methods of evaluation and documentation may include any or all of the following:

- Written examination
- Skills labs
- Case presentations with oral exam

ASSESSMENT AND EVALUATION

The initial and detailed assessment and care should follow the guidelines presented in Module 31, Pediatric Care. The assessment and transport of critically-ill or injured pediatric patients is best accomplished by trained pediatric team members possessing expanded knowledge and skills.

CONDITIONS WARRANTING TRANSPORT

Pediatric transports often originate at a facility with fewer pediatric resources than the receiving critical care center. The pediatric team leader must demonstrate competency and leadership in the overall management of critically ill and injured children as well as the transport environment. Module 31 lists conditions that usually require an urgent or emergent transfer by ground or air with a specialized pediatric transport team.

The following nonoperative injuries and traumatic conditions do not require immediate surgical intervention but warrant monitoring in a pediatric critical care setting:

- Bruise assessment
- Burn assessment
- Bite mark assessment
- Specific clinical presentations (traction alopecia, shaken baby syndrome, wounds in various stages of healing, spiral fractures, and fractures of bones not commonly injured)
- Signs and symptoms of sexual abuse

Children with Special Health Care Needs (CSHCN)

Any child requiring assistive devices, therapies or medications to maintain and function at their optimal level or highest potential should be considered a CSHCN. Because of their reliance on such therapies, the possibility of complications, setbacks and concurrent illnesses or injuries increases, necessitating more frequent ALS transports than another child of the same age.

SUMMARY

Care of the pediatric patient must be both age- and developmentally-appropriate. The pediatric team leader and the secondary team member must be prepared to deal with the critical injury or illness of the patient while supporting the patient and family emotionally whenever possible. This highly specialized team must possess the knowledge and expertise to care for a wide range of neonatal, pediatric and adult illnesses and injuries including invasive procedures and monitoring. The team scope of practice is dictated by licensure and program medical direction, with the didactic training, skills competency and continuing education commensurate with the program mission and scope of practice. Accompanying this module is Exhibit 34-1: Guidelines For Critical Care Pediatric Team Competency.

EXHIBIT 34-1: GUIDELINES FOR CRITICAL CARE PEDIATRIC TEAM COMPETENCY

The following competencies are required for any team accepting the responsibility of critical care pediatric transport as part of their program mission and scope of practice. Team leaders must demonstrate competency in all of the areas listed on the competency checklist. Secondary team members must be working toward completion of competencies appropriate for their position on the team.

Triage

- Accept verbal report from sending facility
- Categorize transport according to severity and mode of transport
- Estimate E.T.A. for referral facility
- Activate appropriate transport personnel and vehicle
- Notify medical director and PICU of new admission
- Prepare appropriate equipment for departure

Respiratory Support

Provide supplemental oxygen and assisted ventilation including:

- Anesthesia bag
- BVM "E-C" clamp technique
- Oxyhood
- Nasal cannula
- Nasal CPAP
- Oral and/or nasal intubation
- Laryngeal mask airway insertion
- Performance of needle cricothyroidotomy
- Tracheostomy replacement and care
- Mechanical ventilation
- Titration of oxygen based on pulse-oximetry trends blood gas analysis and central perfusion
- Obtaining and analyzing arterial blood gases
- OG/NG placement
- Suctioning-oral, nasal, endotracheal
- Performance of needle thoracostomy
- Chest tube insertion

Vital Signs/Monitoring

Place child on noninvasive and invasive monitoring as appropriate including:

- Arterial pressure monitoring
- Pulse-oximetry
- End-tidal CO2 etc.
- Familiarity with color-coded, age appropriate procedure tapes as resuscitation reference
- Urinary catheter placement, accurate I & 0
- Radiologic review and assessment of chest, abdomen, extremities

Fluid and Glucose Management

- Initiate intravenous therapy via peripheral, arterial or venous central lines and Intraosseous; Specifically, partially implanted and totally implanted central venous catheters, complications, dislodgement, obstruction, infection
- Peripherally Inserted Central Catheters (PICC lines; as determined by Program Medical Director)
- Titration of fluid IV maintenance, fluid boluses and glucose maintenance

- Administration of blood and blood products
- Feeding Tubes, insertion and/or management of nasogastric/orogastric, nasojejunal/orojejunal, gastrostomy, button, and PEG (percutaneous endoscopic gastrostomy)

Pediatric-specific Medication Doses and Administration

Competency validation of medication knowledge including weight-based dose calculation, medication desired effect, route, adverse effects, interactions, and considerations; medication discontinuance and reversal if necessary.

- Administration of ACLS medications
- Rapid sequence Intubation medications per program policy
- Antimicrobials
- Diuretics
- Cardiovascular (digitalis glycosides; sympathomimetics; antiherpertensives; vasodilators; antiarrythmics)
- Analgesics
- Anesthetics
- Sedatives
- Paralytics
- Bronchodilator therapy
- Prostaglandin (PGE1)

Lab results

Competency validation in recognition of normal and critical-threshold lab values including:

- Electrolytes
- Hematology/clotting panel
- Blood gases
- Urinalysis

Equipment

Competency validation of safe usage of equipment in multiple transport settings. Must include all equipment used by the pediatric transport team, including, but not limited to:

- Transport incubator
- Transport monitor
- Transport ventilator
- Pulse oximetry
- Cardio-respiratory and blood pressure monitors
- Pediatric-sized restraint devices
- Size appropriate methods of cervical spine control

Transport Vehicles

Competency validation to include but not limited to:

- Safety orientation of ground vehicle or air ambulance to include location of emergency exits, fire extinguishers, securing of self and equipment, life vests and floats, emergency oxygen, survival kits, radio usage and ELT activation for air ambulance.
- Function as air crew member with rotor-wing transport using safety instruction such as rotor safety, obstacle watch, participation in take off and landing safety checklist, etc.
- Knowledge of and adherence to safety rules for each type of transport vehicle.
- Location of vehicle oxygen, suction, and emergency

A. **Didactic Hours**: 16

B. **Patient Care Hours**: 72–144; pediatric intensive care

C. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

MODULE 35: DEVICE-DEPENDENT CARDIOVASCULAR PATIENTS

Authors: Ms. Elaine Philipson, RN, EMT-P,
University of Michigan Medical Center, Ann Arbor, MI
Mr. David Roberts, RN, EMT-P, University of Michigan Medical Center,
Ann Arbor, MI
Ms. Connie Schneider Eastlee, RN, MS, CMTE, Fitch & Associates,
Platte City, MO

Reviewer: Mr. Mickey P. Evans, RN, EMT-P,
Crawford Long Hospital Emergency Department, Atlanta, GA

OBJECTIVES

Upon completion of this chapter, the student should be able to:

- Define the hemodynamic status of the severely compromised cardiac patient
- Describe the role of cardiac assist devices in the air medical transport arena
- Review the indications, contraindications and complications of patients on cardiac assist devices
- Discuss the appropriate medications, indications and dosages in the cardiac assisted patient
- Define the documentation necessary by the provider pre, during and post transport for patients on cardiac assist devices

INTRODUCTION

With advances in medical care and technology, cardiac transplant and cardiac assist devices have evolved into an accepted treatment modality for patients with end-stage heart failure and profound cardiac dysfunction. As result, transport teams are challenged to meet the demands of hemodynamically unstable patients and high-tech medical equipment during transport.

Hemodynamically unstable cardiac patients who fail to respond to maximal conventional medical therapy can be bridged to transplantation or native heart recovery using new generation mechanical circulatory support devices.

This chapter focuses on the types of cardiac assist devices currently used, indications for using the device, potential complications the transport team must be cognizant of, pertinent information to record for documentation, and transport equipment issues.

TEAM QUALIFICATIONS

The configuration and qualifications of a team accepting the responsibility for device-dependent cardio-thoracic (CT) patients as part of their program mission and scope of practice will vary based on local and state guidelines as well as team medical direction.

Minimal CT Team Qualifications: (Team leader and secondary team member requirements)

- Registered nurse, paramedic, respiratory therapist and/or EMT-certified or licensed in the state of the base of operation
- BLS. (Basic Life Support) provider
- ACLS (Advance Cardiac Life Support) Provider
- Successful completion of a Flight Training Program, that meets or exceeds the recommendations of the *Guidelines for Accreditation of Medical Transport Services* (CAMTS) and any relevant state or regional agency.
- Successful completion of a ground transport orientation that complies with state guidelines and program policies.
- Additional team members, such as cardiologist, CT fellow, physicians assistant, respiratory therapist, perfusionist or critical care transport nurse, may be added to the core transport team on a case specific basis.

Optimal CT Team Qualifications (Team leader requirements)

- Registered nurse licensed in the state of the base of operation
- Completion of a cardiothoracic device course and skills lab
- Completion of advanced EKG interpretation course
- Proficient completion of a cardio-thoracic specific competency checklist

Basis for Team Configuration

- Established local and state guidelines
- Legal scope of practice of team members
- Program policies and protocols
- Medical director approval

CRITICAL COMPETENCIES

Team Leader

Must be proficient in all aspects of cardio-thoracic patient transport, including management of device patients. Proficiency shall be based on individual performance of the following:

- Technical and clinical competencies
- Critical thinking and leadership skills
- Competent in community relations and interpersonal communication

Secondary Team Member

Must be capable of assisting the team leader with assessment, stabilization, invasive procedures, obtaining consents and interaction with families and referring staff, as well as capable of assuming care and management of the Device.

Cardio Thoracic (CT)Transport Team

All teams responding to the request for a critical cardiothoracic patient transport must demonstrate competency in the following skills, and any others deemed necessary by the program medical director:

- Pre-transport stabilization and patient packaging
- Obtaining consents
- Performance of detailed assessment including but not limited to: heart sounds, EKG tracing interpretation; circulatory/perfusion assessment, respiratory assessment for CHF, pneumothorax etc.; neuro assessment
- Advanced airway management
- Initiation of mechanical ventilation
- Placement of peripheral and central lines per scope of practice
- Fluid support and administration of cardio-tonic and vaso-active medications
- Detailed documentation, including:
    - Patient assessment prior to, during and post transport
    - Vital signs every 5 –15 minutes
    - IABP or device pressures prior, during and post transport: Patient aortic end-diastolic pressure; peak systolic pressure; augmented systolic and diastolic pressure; Balloon aortic end-diastolic pressure
    - Ventilator settings prior to, during, and post transport

- Line and device insertion site, dressings, bleeding, swelling or redness
- Pedal pulses (dorsalis pedis and tibial)
- Capillary refill, sensation and immobilization of limbs
- Balloon or device placement verification by x-ray or catheterization
- Device specifics: Type and size of catheters, waveforms, trigger mode, timing; counterpulsation ratio
- Alarms status on during transport
- Medications infusing and rate during transport
- Urine output
- Transport times

Continuing Education

The transport coordinator and/or medical director of the transport team shall evaluate the skills and clinical competencies of all team members. Yearly reassessment of team member skills and knowledge must be accomplished and documented. Methods of evaluation and documentation may include any or all of the following:

- Written examination
- Skills labs
- Case presentations with oral exam

ASSESSMENT AND EVALUATION

The initial and detailed assessment of cardiothoracic patients should follow the guidelines presented in Module 16, Cardiovascular Considerations in Air medical Transport. The evaluation and treatment of these device-dependent patients is best accomplished by trained CT team members, who possess expanded knowledge and skill in the interpretation of EKGs, cardiac-specific labs, and echocardiogram results.

CONDITIONS WARRANTING TRANSPORT

Most patients with cardiac diseases or symptoms will be transported by EMS providers via ground vehicle. There is, however, a select group of critically ill cardiothoracic patients who either need device placement or have a device and need transfer to a higher level of specialized cardiothoracic or transplant care. These transports can be accomplished via ground or air as the patient’s condition dictates. The teams accepting these critically ill and/or device-dependent patients as part of their Program Mission and Scope of Practice must demonstrate competency and leadership in the overall management of the cardiac patient. A skilled

CT Team should be chosen to transport the following conditions to a regional center for continuing high-risk care and/or transplant.

CARDIAC ASSIST DEVICES

Pacemakers

A cardiac pacemaker is a battery-powered device that delivers electrical stimuli directly to the heart to initiate and/or maintain a specified heart rate when its own intrinsic pacemaker is incapable of doing so. The primary components are a pulse generator and a pacing catheter. The pulse generator may either be outside the body (external) or permanently implanted inside the body (internal). The electrical impulse delivered by the pacemaker is recognized on the ECG as a sharp narrow "spike" or "pacing artifact". It appears as a vertical line of a very short duration.

- **Temporary Cardiac Pacing**
  Temporary pacing requires an external pulse generator. It is employed for short-term therapy when an arrhythmia is transient or in emergency situations when cardiac pacing is essential. Temporary pacing may also be used as a bridge to permanent pacing.

  Routes and Methods of Temporary Cardiac Pacing
  Temporary pacing can be accomplished transvenously, via the esophagus, transcutaneously, epicardially or via a coronary artery.

  Transvenous pacing, the most common approach involves a percutaneous puncture into the internal jugular, subclavian, or femoral vein. The balloon-tipped or semi-floating pacing catheter is introduced into the endocardium of the right heart, either in the atria or the ventricle.

  An electrode in the esophagus achieves atrial pacing. It is relatively noninvasive, safe, and simple.

  Transcutaneous ventricular pacing is noninvasive. It is used during emergency treatment of asystole or severe bradycardia. It involves a large surface area, high impedance electrodes placed on the anterior and posterior chest wall, stimulation of long duration, and high current. Transcutaneous pacing produces a hemodynamic response similar to that of transvenous ventricular pacing.

  Epicardial pacing electrodes are implanted during surgery in postoperative cardiac surgical patients.

Pacing via a coronary artery can be accomplished during percutaneous transluminal coronary angioplasty.

Indications
Temporary pacing systems may be indicated in patients who are at risk for developing high-degree AV block, severe sinus node dysfunction, before and after cardiac surgery, and during cardiac catheterization. Pacing is also indicated when temporary bradycardia causes symptomatic hemodynamic instability, or asystole in acute myocardial infarction.

Rapid temporary pacing can be used to terminate tachydysrhythmias such as atrial flutter, AV nodal and AV reentry, and sustained ventricular tachycardia.

- ***Permanent pacemakers***
  Permanent pacemakers are used when an arrhythmia is likely to be recurrent or permanent. The pulse generator is implanted just beneath the skin in the subcutaneous space. The pacing leads may be introduced via a transvenous route or during a thoracotomy.

Indications
The Joint Committee of the American College of Cardiology and the American Heart Association established indications for permanent pacing. The two major indications are failure of impulse formation and failure of cardiac conduction. These usually result from degenerative, fibrotic, or atherosclerotic processes that damage pacemaker cells and surrounding tissue. Specific indications are as follows:

<u>Complete Heart Block</u>: Fixed chronic complete heart block with a slow ventricular response irrespective of symptoms.

<u>Second Degree AV Block</u>: Type I or Wenckebach most frequently results from a conductive disturbance in the AV node. Type II usually results from a conduction disturbance distal to the AV node. Type II is progressive, unpredictable and may result in Stokes-Adams attacks.

<u>Bundle Branch Blocks</u>: There are various types of bundle branch block, symptomatic patients with bifascicular or intermittent complete heart block also require pacing. Patients who show alternating right and left bundle branch blocks have significant bilateral bundle branch disease, and permanent pacing is usually indicated.

Sick Sinus Syndrome: The sick sinus syndrome entails episodic or persistent sinus bradycardia with periods of sinus arrest or sinoatrial block. Tachyarrhythmias may alternate with the bradycardia and often reveals a failed or slow recovering sinus node. Pacemaker therapy is highly successful in patients with sick sinus syndrome and syncopal episodes.

Slow Junctional Rhythm: A manifestation of the sick sinus syndrome but can occur in normal patients with a failure of sinus node activity or an insignificant rise in pulse rate.

Slow Atrial Fibrillation or Flutter: Patients may demonstrate symptomatic prolonged asystolic pauses even when the atrial rate is otherwise rapid.

Atrial Inexcitability: A condition in which the atria cannot be stimulated by pacing as a result of diffuse abnormal atrial muscle. Rate responsive ventricular pacing is indicated in symptomatic patients.

Recurrent Ventricular Standstill: Reflects extensive pacemaker and conduction tissue degeneration and belongs to the pan-conduction group.

Ablation of His Bundle: Performed for a variety of intractable atrial arrhythmias.

Carotid Sinus Hypersensitivity and Vasovagal Syncope: Common in elderly with artherosclerosis and hypertensive heart disease. Syncope is usually due to bradycardia and vasodilatation.

Tachyarrhythmias: Cardiac pacing is a treatment option for both supraventricular and ventricular tachycardias. With modern surgery or ablative techniques pacing is rarely required.

- **Implantable Pacemaker Components**

Pacemaker Pulse Generator

Within the pulse generator lies the power source and electrodes, hermetically sealed in a titanium or stainless steel casing to protect the content. Modern pulse generators are sophisticated power packs that are small, compact, reliable and multiprogrammable. The main batteries used for implantable pulse generators are lithium-iodine cell.

Pacemaker Lead
Delivers the electrical signal from the pulse generator to the myocardium and conducts intracardiac potential back to the sensing circuit. There are two major types of lead systems. A unipolar lead has only one electrode on the lead itself. A bipolar lead has two poles on the lead a short distance from each other at the distal end, and both electrodes lie within the heart. The stimulating tip electrode is responsible for delivery of charge to the myocardium. The main complications of a unipolar lead is oversensing and frequent skeletal muscle contractions. Modern lead conductors have immense strength and flexibility with high fracture and corrosion resistance. They are composed of strands of wire tightly coiled around a hollow core to allow removable stylets to pass to the distal electrode. These leads are insulated with polyurethane. The lead connector joins the lead to the pulse generator.

Lead Fixation
Passive fixation engages the myocardium by indirect means usually with a wedge, tines, balloon or helifix design. Active fixation penetrates the myocardium commonly with a screw-in design.

Transvenous Atrial Leads
The right atrial appendage is trabeculated and suitable for atrial pacing and sensing. A number of endocardial atrial J leads have been developed for use in this area. Most designs are a bipolar atrial electrode lying within the cavity of the atrium and used for atrial sensing only.

Epimyocardial Leads
The pacemaker lead is sutured directly to the epicardial surface. This method is now reserved for situations where the transvenous approach is technically impossible or has failed.

- **Modes of Cardiac Pacing**

A three-letter identification code is frequently used to describe the mode of pacing. The first letter refers to the chamber paced: V (ventricle), A (atrium), or D (dual chamber). The second letter refers to the chamber sensed and uses the same three letters. The third letter denotes the mode of response to sensing I (inhibited), T (triggered), O (asynchronous), and D (multiple response). When there is no sensing capacity, O is used to denote asynchronous.

Ventricular Pacing Systems
Ventricular asynchronous (VOO) has ventricular pacing but no sensing. Ventricular inhibited (VVI) is the most common system in use today. Spontaneous QRS potentials are sensed and pacing stimulus inhibited. Inventricular triggered (VVT), instead of inhibition, the full output of the pulse is delivered into the spontaneous QRS during the refractory period.

Atrial Pacing Systems
Atrial asynchronous (AOO) and triggered (ATT), like their ventricular counterparts, are virtually obsolete. Atrial inhibited (AAI) is the most common form of atrial pacing with or without the addition of rate-responsive pacing. The advantage of AAI pacing is maintenance of the atrial contribution of ventricular filling.

Dual-Chamber Pacing Systems
Although many pacing modes can be used with dual chamber pacing systems, all of these can be incorporated into a single multiprogrammable pulse generator with or without an added rate-responsive function.

- **Complications**

Implant related complications:
Pneumothorax/Hemothorax
Thrombosis in vessel around lead
Hematoma at site of insertion
Lead damage
Component failure
Lead fracture, dislodgement
Infection/Allergy
Erosion
Localized infection
Systemic infections
Electrical malfunction
Oversensing/undersensing
Failure to capture.
Failure to sense.

- **Documentation**
ECG strips
Programmed settings on pulse generator
Patient's hemodynamic tolerance
Presence and consistency of pacing and sensing

- **Transport Issues**
  Electrical isolation form surrounding electrical sources
  Insulation of pacing wires not in use
  Emergency procedures/default and emergency settings built into pacemaker
  Deactivation of permanent pacemaker with external magnet
  Oversized magnetic fields may interfere with proper function

Implantable Cardioverter-Defibrillators

Implantable cardioverter-defibrillators (ICDs) have become an important therapeutic modality for patients with life-threatening ventricular dysrhythmias. The internal defibrillator terminates the lethal dysrhythm by delivering electrical countershocks directly to the heart. Typical recipients are elderly, suffer from chronic cardiovascular disease and experience concomitant medical problems. If the dysrhythmia is nonterminating, the ICD is programmed to deliver a sequence of subsequent shocks.

- **System Components and Function**
  The ICD system is comprised of two basic components: a pulse generator and lead electrodes. The latest series of devices have anti-tachycardia pacing capabilities in addition to cardioverting/defibrillating functions.

- **Implantation**
  ICDs are now almost exclusively implanted using a transvenous approach when implantation is the sole procedure. Subclavian vein puncture or cephalic vein cut down is used for access. The generator is implanted in a subcutaneous or submuscular pocket located in the pectoral area or upper abdomen. Patients undergoing combined revascularization and ICD insertion usually receive extrapericardial ventricular patch electrodes. The devices are capable of recording a cumulative number of shocks delivered via event counters. Manufacturers are currently developing a nonthoracotomy lead system.

- **Complications**
  Transvenous defibrillator leads have a high rate of structure failure that require operative lead replacement. Hardware problems may include inadvertent device inactivation by electromagnetic fields, as in magnetic resonance imaging (MRI), premature battery depletion, or random component failure.

- **Emergency Procedures/Precautions**
  - Patients with ICDs should carry identification cards with information regarding manufacturer, model, lead system and a 24-hour emergency contact telephone number.
  - During emergencies placing a magnet on top of the device can temporarily disable ICDs. The magnetic field closes a reed switch in the generator circuit.
  - The presence of an ICD should not deter standard resuscitation techniques. An anteroposterior configuration of the external defibrillation paddles is efficacious in those patients.
  - Multiple defibrillator discharges in a short period of time requires prompt attention and event interrogation. Multiple shocks can be a manifestation of ICD system failure, resulting in significant battery depletion.
  - Sensing lead malfunction may result from lead fracture and may cause inappropriate discharges triggered by sensing artifact.
  - Magnetic resonance imaging is contraindicated in ICD patients.
  - Consider sedation and IV antiarrhythmics for appropriate discharges.

- **Documentation**
  Detailed event-logging, vital signs, level of consciousness, and recording of ECG monitoring

- **Transport Issues**
  Studies demonstrate that in-flight discharges of the ICD poses no danger to the medical crew or aircraft.

Intra-Aortic Balloon Pump

Intra-Aortic Balloon Pump (IABP) therapy, also referred to as counterpulsation, is utilized in cardiac illnesses where conventional medical therapy i.e., oxygen, inotropes, vasodilators, diuretics, IV fluids and other drugs, are inadequate to support the left ventricle. The intra-aortic balloon is typically inserted percutaneously via the femoral artery into the aorta 2–3 cm distal to the left subclavian artery. Balloon inflation results in increased myocardial oxygen supply by increasing coronary artery and collateral vessel blood flow during diastole. Perfusion to the renal and cerebral arteries may also be enhanced. Balloon deflation is designed to provide assistance to the left ventricle by decreasing the workload of the left ventricle, thus reducing myocardial oxygen demand.

- **Indications**
  Today, IABP therapy is utilized for a wide range of indications in which left ventricular failure occurs, regardless of the etiology.

  Refractory Ventricular Failure
  Treatment is aimed at relieving left ventricular workload and restoring the balance between myocardial oxygen supply and demand, allowing the myocardium time to heal and recover maximal function. Intra aortic balloon counterpulsation assists in this effort by decreasing left ventricular workload and increasing coronary artery perfusion.

  Cardiogenic Shock
  Left ventricular (LV) failure following an acute myocardial infarction may progress to cardiogenic shock.

  Unstable Refractory Angina
  Myocardial ischemia and chest pain associated with unstable angina may be effectively treated with IABP therapy. The IAB can be beneficial in maintaining adequate coronary artery perfusion, relieving myocardial ischemia, and decreasing myocardial oxygen demand.

  Impending Infarction
  Patients experiencing severe chest pain accompanied by electrocardiogram changes and/or dysrhythmias who do not obtain relief from drug therapy, are at risk of developing irreversible myocardial tissue damage. By improving coronary blood flow and reducing left ventricular work, chest pain and ECG changes associated with the myocardial ischemia can be minimized.

  Mechanical Complications due to Acute Myocardial Infarction
  Depending on the area of an acute myocardial infarction, mechanical complications can occur. The resulting hemodynamic compromise can have lethal consequences especially if not treated immediately. Ventricular septal defects, papillary muscle dysfunction or papillary muscle rupture usually requires surgical intervention, often emergently. If the patient undergoes cardiac catheterization or surgical intervention in a hemodynamically compromised state, mortality and morbidity can be significantly increased. The IABP is utilized for temporary support to achieve hemodynamic stability until definitive measures are taken.

  Ischemia Related Intractable Ventricular Arrhythmias
  Ventricular irritability can be a frequent complication of acute MI, and may lead to severe dysrhythmias and further hemodynamic

compromise. Conventional drug therapy and supportive measures are often sufficient to reverse the irritability and dysrhythmias. However, patients refractory to conventional medical therapy are at high risk for further myocardial damage and death. IABP therapy has proven effective in stabilizing the hemodynamic condition of these patients by increasing coronary artery perfusion, reducing ischemia and maintaining adequate peripheral perfusion.

Cardiac Support for High Risk General Surgical Patients and Coronary Angiography/Angioplasty Patients

Patients with existing impaired cardiac function are considered to be high-risk candidates for general surgery. Use of IABP provides hemodynamic stability by assisting in balancing myocardial oxygen supply and demand, preoperatively, intraoperatively, and during the critical post operative period when the demands on the heart are particularly high.

Septic Shock

For patients unresponsive to maximal supportive therapy secondary to septic shock, intra-aortic balloon counterpulsation can increase coronary blood flow, reduce left ventricular workload, and improve tissue perfusion by maintaining adequate mean arterial pressure.

Weaning from Cardiopulmonary Bypass

The use of the IABP decreases left ventricular resistance, increases cardiac output, and increases coronary artery and systemic perfusion pressures, facilitating the patient's removal from cardiopulmonary bypass.

Support for Failed Angioplasty and Valvuloplasty

Unsuccessful valvuloplasty may result in cardiac dysfunction. The IABP may be used to support cardiac function in these patients until valve repair or replacement can be performed.

- **Contraindications**

Absolute contraindications to IABP therapy are listed below. The decision to initiate IABP therapy is often relative and based upon patient risk versus benefits.

Severe Aortic Insufficiency

Aortic regurgitation could possibly overload the ventricle with additional blood volume and increase cardiac work.

Abdominal or Aortic Aneurysm
There is a high risk of rupture from increased pressure generated by counterpulsation.

Severe Calcific Aorta-Iliac Disease or Peripheral Vascular Disease
Peripheral vascular disease may limit the physician's ability to advance the catheter through the atherosclerotic vessel.

- **Potential Complications**
The most common complications associated with IAB therapy are vascular in origin.

Limb Ischemia
- Check distal pulses, color, temperature, and capillary refilling prior, during (every 15 minutes) and post transport
- Monitor differential toe temperatures
- Keep head of bed less than 30 degrees

Excessive Bleeding from the Insertion Site
- Observe anteriorly and posteriorly for bleeding or hematoma formation prior, during and post transport
- Monitor anticoagulation therapy
- Prevent catheter movement at insertion site
- Apply direct pressure at insertion site, assuring distal blood flow

Thrombocytopenia
- Assess platelet count daily
- Avoid excessive heparin administration
- Replace platelets as needed

Balloon Leak
- Observe the tubing for blood
- Low augmentation, gas loss
- If blood is observed in the catheter extension tubing stop pumping immediately and assess the patient

Aortic Dissection
- Assess patient for pain between shoulder blades, equal pulses, and mental status
- Monitor hematocrit.
- Discontinue inflation of IAB if dissection expected

Compartment Syndrome

- Observe limb for swelling and/or hardness prior to transport
- Could potentially become worse during fixed-wing transport
- Measure and record calf girth
- Monitor interstitial pressure
- Maintain adequate colloid osmotic pressure

Infection

- Observe insertion site for signs of infection
- Culture blood for symptoms of infection
- Change dressings using sterile technique per infection control policy
- Administer antibiotics per schedule during transport

- **Complications During Transport**

The best way to handle complications during transport is by planning ahead and being prepared. The following are responses that should occur without delay:

Cardiac Arrest: CPR may be performed. The ECG or arterial trigger may synchronize to your chest compressions. Refer to your console's operating manual for recommended timing selection during CPR.

Ruptured IABC: If blood is found in the balloon tubing and there is a sudden loss of augmentation on the arterial waveform, immediately shut off the IABP.

Kinking: Assess the catheter tubing and electrical cords from the console to the patient for kinks.

Disabled Pump: Disconnect the IAB tubing from the console. Place a three-way stopcock at the end of the tubing and deflate the IAB with a 60-cc syringe. Then manually inflate and deflate the IAB with one half the volume. Be prepared to provide pharmacologic support with any hemodynamic changes.

Power failure: Check the battery power indicator on the console. Check the electrical connection to the ambulance or aircraft. Most inverters on the ambulance or aircraft only operate when the engine is on. If the power is not operational then manually inflate the IABC.

Embolus: Discontinue balloon inflation and treat symptoms.

Septicemia: Treat with antibiotics, consider vasopressors for vascular tone.

- **Transport Issues**

Timing
The intra-aortic balloon must be timed to inflate and deflate correctly to provide full benefit to the patient. The arterial pressure waveform will be used to synchronize inflation and deflation of the intra-aortic balloon with the cardiac cycle. On the arterial pressure waveform, the dicrotic notch is created by the abrupt closure of the aortic valve. This signifies the onset of diastole. Coronary filling occurs at this time. The intra-aortic balloon will therefore be timed to inflate at the dicrotic notch. The primary goal of inflation at the onset of diastole is to displace the blood volume within the aorta towards the coronary arteries. The balloon will remain inflated throughout diastole, augmenting the diastolic pressure, improving coronary artery perfusion and increasing myocardial oxygen supply. The augmented diastolic pressure is usually greater then the systolic pressure. The balloon will be timed to deflate at the end of diastole, immediately prior to systolic ejection, resulting in a decrease in both the end-diastolic pressure and the next systolic pressure. The deflation of the balloon results in a decrease in left ventricular afterload and a decrease in myocardial oxygen demand.

Modern IABP consoles utilize automated timing software to eliminate user error and simplify the transport process. These new generation pumps automatically manage dysrhythmia and EKG interference.

Arrhythmias
Once the timing is set, the control system automatically compensates for a wide range of rate and rhythm variations. In arrhythmias such as atrial fibrillation, the R wave trigger is used to provide the most effective augmentation.

Effects of Altitude
Barometric pressure affects the helium gas within the balloon. Balloon-gas volume, in an unrestricted state, can expand from 40 cc at sea level to as much as 51.7 cc at 7000 feet. The balloon will expand proportionately to the increase in altitude, mediated by the resistive properties of the balloon.

The intra-aortic balloon pump can be “purged” which references the transducer to current atmospheric pressure. This transducer, positioned between the helium source and balloon catheter, senses changes in barometric pressure and adjusts the helium gas charge delivered in the balloon during inflation, which prevents possible balloon expansion. Barometric pressure changes about 40 mm Hg for every 2000 feet. This corresponds to approximately 2.5 cc balloon expansion. Because balloon counterpulsation is only briefly interrupted with each purge (approximately 3 seconds), it is appropriate to purge every 2000 feet of altitude ascent. Once cruising altitude is reached, routine purging is no longer required. Balloon gas contraction is approximately 1.5 cc per 1000 feet. It is therefore recommended that the balloon be purged at every 1000 feet change in altitude during descent.

IABPs should be operated in the auto fill mode during air medical transports, where the system will "automatically" purge and fill the IAB when local atmospheric pressure decreases or increases by 25 or 50 mmHg respectively. These pressure changes occur approximately every 1,000 feet of rise or 2,000 feet of drop in altitude.

- **Documentation**

  The IABP transport record should include the following information.

  - Patient assessment prior, during and post transport
  - Vital signs every 5 –15 minutes
  - IABP Pressures prior, during and post transport
    - Patient aortic end-diastolic pressure
    - Peak systolic pressure
    - Augmented systolic pressure
    - Augmented diastolic pressure
    - Balloon aortic end-diastolic pressure
  - IAB insertion site
    - Bleeding
    - Dressing occlusiveness
    - Hematoma
  - Pedal pulses (Dorsalis pedis and tibial)
  - Capillary refill of limbs
  - Sensation of affected limb
  - Immobilization of affected limb
  - Balloon placement verification by x-ray or catheterization
    - Type and size of IAB catheter
    - Waveforms
    - Trigger mode
    - Timing
    - Counterpulsation ratio (1:1, 1:2, 1:3)
    - Alarms status on during transport

External Ventricular Assist Devices

A ventricular assist device (VAD) provides systemic circulatory support through flow to all vital organs. The ventricular assist device artificially performs the pumping action of the heart with the use of an external blood pump, either pulsatile or nonpulatile. Used for short-term treatment, the device type can be left ventricle (LVAD), right ventricle (RVAD), or both ventricles (BiVAD). The primary goal for these devices is myocardial recovery by allowing the native heart to rest and recover while maintaining vital organ perfusion. The secondary goal is bridge to transplant if the myocardium is not recoverable.

- **Indications for a Ventricular Assist Device**
  Post cardiotomy low output syndrome
  Cardiogenic shock
  Failure to wean off bypass
  Myocarditis
  Cardiomyopathy

- **Types Of Devices**

  External Centrifugal Bypass Assist Devices—Nonpulsatile or steady state flow, i.e. roller pumps, often used in open-heart surgery. These devices are useful for short-term support (5 days). Long-term support leads to frequent complications and multiorgan failure.

  External Pulsatile VAD—Pneumatically driven pumping chambers consisting of diaphragms compressed by pulses of air delivered from the pneumatic, computer-controlled drive console.

- **System Components**

  Cannula—Large tubes are inserted into the atrium and corresponding artery. These cannuli drain the blood from the patient into the external blood pump.

  Blood Pumps—A dual chamber design with atrial and ventricular bladders. These blood pumps fill by passive, gravity drainage, and are hung at the patients bedside. Once the ventricular bladder fills, the pneumatic driveline pushes air into the blood pump, thus collapsing the ventricular bladder and sending the blood back to the patient. Raising or lowering the blood pumps can alter proper filling of these bladders.

Console—Highly automated control console consisting of ON, OFF, and weaning. Minimal operator intervention is required. The only connection between the blood pump and the VAD console is the pneumatic driveline. The console is responsible for detecting when the ventricular bladder is full and delivering the air through the drivelines to collapse the bladder. The console also provides a pump rate and flow rate.

- **Complications**

  Bleeding—most common complications of VAD supported patients. Most incidences occur within the first 24 hours post-op. Sources include insertion sites, tamponade, or operative site oozing.

  Volume Deficit—hypovolemia occurs early in the post-op phase. Large amounts of fluid volume are typically required in the first 48 hours.

  Failure of Unassisted Ventricle—right-sided failure develops during the post-op course demonstrated by elevated right ventricular pressures.

  Infection—prophylactic antibiotic coverage is usually maintained for a minimum of 3 days.

  Acute Renal Failure—often develops due to pre-existing conditions and is often treated with dialysis or hemofiltration.

  Decreased Perfusion/Hypoxia—results from any of the above complications or respiratory failure.

- **Transport Issues**

  The VAD patient transport is highly invasive and complex with potential for many complications. Post-op patients often have open chest cavities and multiple chest tubes. Patients may also have a combination of cardiac assist devices, i.e. BiVAD and balloon pump.

  - Battery Power
  - Emergency back-up system.
    A fixed-rate control system will take over should the computer-based control system fail.
  - Foot Pump
    The foot pump is used in the event of a complete system failure. This pump also replaces the need for CPR.

- Alarms
  Audible alarms and messages will remain until the condition is corrected. Refer to individual operating manuals for functions and solutions.
- Anticoagulation
  Heparin is used in virtually 100 percent of current cases. Anticoagulation protocol should be followed and ACTs monitored frequently.
- Chest Tubes
  Maintain all chest tube to suction to prevent tamponade and monitor outputs for signs of hemorrhage.
- Hemodynamic Monitoring/Volume Management
  Hemodynamic monitoring is essential to proper volume management. Many devices are preload sensitive; therefore, intravascular volume and filling pressure must be maintained.
- Pharmacologic Therapy
  Inotropes may be required to support the unassisted ventricle in uni-ventricular support. In BiVADs renal dose dopamine is often the only support required. Vasopressors/vasodilators are commonly used to manage peripheral resistance (SVR, PVR).
- Arrhythmias
  VADs are asynchronous devices that have no trigger from the electrical activity of the heart. Dysrhythmias will not compromise the hemodynamics of the BiVAD patient. The uni-ventricular support patient may develop inadequate preload and decrease flows. Defibrillation, cardio version, pacemakers and antiarrhythmic drugs may be used to convert persistent dysrhythmias.

  Do Not Perform CPR; this will dislodge the catheters.

- Ventilation/Oxygenation
  Ongoing assessment of the patient's pulmonary status is needed to ensure adequate oxygenation. A decrease in SVO2 and outflow may indicate the need for blood.
- IABP
  When an IABP is left in a VAD patient either the EKG or arterial pressure trigger modes may be used. The IABP can be surgically removed.
- Blood Pump Considerations
  Blood pump filling is accomplished by gravity; the top of the blood pump should be level with or below the patients atrium. Cannula should be sutured to the skin and all connections zip tied to prevent disconnection. Extra driveline

tubing can be inserted up to 12 feet to facilitate loading of patient and equipment. A bed mount for the blood pumps reduces the risk of accidental damage/disconnection.

- Temperature Loss
  Treat hypothermia using conventional methods. Protect the pumping chamber from environmental factors that may increase heat loss through convection.
- Console Considerations
  Plan space and weight to accommodate console; new transport console are available that allow the blood pumps to be laid horizontal for transport. Ensure access to the foot pump in case of failure. Test power supply to ensure satisfactory operation in the transport vehicle.

The quickest and safest mode of transport depends on the patient's condition and logistical factors. Depending on the amount of equipment and personnel, weight may be an issue when deciding the mode of transportation. The transport team has to manage and assess the patient's volume status and hemodynamics, manage dysrhythmias, continue anticoagulation, pharmacological and blood therapies. Some transports may require a perfusionist to assist in the patient care and management of the circuit.

.

- **Documentation**
  Documentation for the VAD should include the following information:

  - Patient assessment
  - Placement/condition of cannula sites/chest tubes
  - Hemodynamic status
  - Blood pump chamber filling/empting
  - Blood pump height
  - ACT levels/anticoagulation status
  - Clot formation in system
  - Output flows and rate
  - Temperature

<u>Implanted Vented Electric/Pneumatic Left Ventricular Assist Systems</u>

Implanted Left Ventricular Assist Devices (LVAD) comprise an implanted LVAD and external power source with control electronics. The system assists a left ventricle that is no longer capable of sustaining the patient's cardiac output and blood pressure. The device does not provide any support to the right side of the heart but may alleviate right ventricular congestion. Implanted LVADs utilize a textured blood-contacting surface to minimize thromboembolic events. The texturing has been engineered to trap and firmly anchor blood components and to encourage the formation of a stable biologic lining. These devices are designed to enhance quality of life on mechanical circulatory support. Upon completion of the postoperative recovery phase, the patient is completely mobile, requiring only a belt-mounted controller and a pair of rechargeable batteries. The implanted LVAD can be used as a bridge to transplant or as permanent placement in nontransplant candidates.

- **System Overview**

  The LVAD is implanted subdiaphragmatically in a properitoneal or intraperitoneal position. The inflow conduit is inserted into the left ventricular apex of the heart. The outlet conduit is attached to the ascending aorta. The failed ventricle empties directly into the LVAD, since it can accept blood at a very low pressure. The LVAD can then transfer blood into the aorta at the required arterial pressure while the natural ventricle refills.

  The blood pump is driven by a self-contained electric motor. It is powered by two batteries or DC power via a small systems controller. A coaxial electric/vent line passes through the skin from the LVAD to the controller. This double lumen line externalizes both power and control leads plus an air passage. The air passage is used to vent the space behind the piston of the LVAD, which allows the pump to be operated pneumatically in the event of malfunction.

  The support hardware includes a bedside power base unit providing isolated DC power and a display module that provides system status and performance data. The LVAD can produce flows up to 10L/min at a mean arterial pressure of 120mmHg and a pump rate of 120 BPM.

- **Pump Rates and Modes**

  The LVAD may be operated in either of two modes:

  Auto Rate Mode—the pump ejects when approximately 90 percent capacity is reached. The pump is responsive to physiologic demand and speeds up or slows down based on pre-load to the LVAD.

  Fixed Rate Mode—the pump ejects at a pre-set rate per minute, independent of pump volume status.

  Default Modes—
  Basal Mode—occurs if there is a broken signal wire or a malfunctioning microprocessor. Fixed rate 40 bpm

Power Saver Mode—Fixed rate 50 bpm occurs when battery power is low.

- **Potential Post-Implant Complications**
  Postoperative complications related to hypovolemia, tamponade, bleeding, arrhythmia and infection. Long-term complications include pulmonary hypertension, right heart failure, infection and equipment failure (power loss, broken wire, blocked tube, motor failure, or fluid in vent system).

- **Handling Emergencies**
  An emergency exists whenever the system cannot pump an adequate amount of blood. The system controller will sound an alarm if the system is malfunctioning. In the event of an emergency, assess pump function.

  Pump Failure
  Hazardous events are those that cause the pump to slow or stop. If restoration of pump function is not easily achieved, pneumatic operation should be initiated, using the device-specific procedure.

  Dysrhythmias
  In the event of the need for defibrillation or cardioversion, disconnect the power source and initiate hand pumping prior to the discharge of electricity. A system controller malfunction may necessitate the change of the system controller following the standard procedure.

- **Transport Issues**
  Thorough knowledge of the equipment and system is essential for transport of patients with implanted LVADs. A working knowledge of alarms and emergency procedure should be obtained prior to transport.

  Do Not Perform CPR on LVAD patients; use of the hand pump will replace the need for compressions.

Extra Corporeal Life Support/Extra Corporeal Membrane Oxygenation

ECLS is achieved by draining venous blood, removing carbon dioxide, adding oxygen through an artificial lung and returning the blood to the circulation via a vein (venovenous) or artery (venoarterial).

- **Venoarterial Bypass (VA)**
  Artificial organs replace the function of both heart and lung either partially or totally.

- **Venovenous Bypass (VV)**
  The blood is returned to the venous circulation and mixes with venous blood from the systemic organs before entering the right atrium. There is no net effect on central venous pressure or hemodynamics. The systemic blood flow is the native cardiac output, and is unrelated to the extracorporeal flow.

- **Arterio-venous (AV) Support**
  AV extracorporeal circulation is commonly used for hemodialysis or hemofiltration but not for cardiac or pulmonary support.

- **Indications**
  A patient with severe, potentially lethal respiratory failure, who is unresponsive to conventional management with a primary condition that is reversible may be a candidate for ECLS.

  Different ECLS centers have different capabilities and eligibility criteria.

  Eligibility criteria
  - PEEP>8cm for 12 hours
  - FiO2 >.8 for 12 hours
  - pH < 7.28
  - PIP > 40cm H2O

  Exclusion criteria
  - <3KG
  - Major hemorrhage
  - Immunosuppression
  - Neurological impairment
  - Cerebral-vascular accident
  - Duration of ventilation > 10 days
  - Major burns
  - Irreversible lung disease

- **System Overview**
  The ECMO circuit consists of several components.

  Artificial Lungs
  Membrane lungs are used for ECLS to avoid problems of direct gas exposure. Most centers use solid silicone rubber membrane lungs.

  Heat Exchangers
  Because heat is lost in evaporation of water in the membrane lungs, a disposable heat exchanger is used to maintain normal body temperature.

Roller Pump/Centrifugal Pump
Most circuits use a roller pump to push blood volume through the system. Centrifugal pumps are used for infants.

Bladder Holder/Pump Controller
A pliable silicone bladder is placed in a holder, which senses the bladder collapsing. This safety device prevents excessive negative pressure, cavitations and air embolization.

Pressure Display Box
A compact, sensitive, pressure display system that measure instantaneous pressures.

Water Bath
Warm water is circulated to the heat exchangers from a recirculating water bath

Venous Saturation Monitor
In line circuit SVO2 is measured by reflection oximetry.

ACT Tester

Battery Pack

Mobile Cart

- **Cannulation**
  The surgical procedure is often performed at the patient's bedside, as the patient is often too unstable for transport to the operating room or to the receiving facility. This involves transporting the ECMO team to the referring institution for cannulation and then transporting the patient once stabilized on the ECMO circuit to the receiving facility.

  Cannulation at a referring facility requires extensive education, communication and equipment. ECMO centers have developed procedures and guidelines to prepare referring institutions for this complex procedure.

  For venous access, the right jugular vein is the location of choice. For venoarterial circulation, the right common carotid artery is the vessel of choice. If femoral vessels are used for cannulation, it may be necesaary to establish distal perfusion.

- **Initiation of Bypass/Role of Flight Nurse**
  - Administer PRBC’s and FFP as indicated
  - Platelet transfusion as tolerated within the first 30 minutes
  - Decrease ventilator settings after desired flow is reached
  - Obtain ABG, HCT and glucose within first 30 minutes
  - ACT every 15 minutes
  - Begin heparin infusion when ACT fall below 300 seconds

- **Complications**
  - Circuit rupture/disconnection.
  - Decannulation.
  - Surgical incident.
  - Equipment failure

- **Transport issues**
  - Two portable oxygen sources needed, one for oxygenator sweep gas, the other for patient ventilation.
  - Fully charged battery pack
  - Access to hand crank system in case of equipment failure.

Total Artificial Heart (TAH)

The total artificial heart's benefit over heart transplantation and other devices is its availability in the face of a constant shortage of donor hearts. The artificial heart's goal is to fully sustain the body’s circulatory system and closely mimic the function of the human heart. The artificial heart is designed to extend the lives of the patients who would otherwise die of heart failure, and to offer a satisfactory quality of life. Newer artificial hearts do not require any invasive connections through the skin, reducing the chance of infection. Power supply is transmitted across the intact skin to an internal coil.

- **Complications**
  - Bleeding/infection are the most serious immediately post-op.
  - Internal pump failure is rare and has a high mortality.
  - Complications may result from external component failure, i.e. power supply.

- **Transport issues**
  - Fully charged batteries for a good power supply will be needed. The internal pump usually has an emergency back up power supply that is only good for a short period of time.
  - Emergency procedures would include supportive therapy and pharmacological support.

- Medication for preload and afterload may be beneficial. Vasopressors/Vasodilators are commonly used to manage peripheral resistance (SVR, PVR). Artificial hearts will not respond to inotropic medications.
- Medical control should be consulted. Internal pump failure is rare and untreatable in the transport setting.

Heart Transplant

Patients suffering from heart failure that are unresponsive to medical or surgical management may be candidates for a heart transplant. Candidates are those that are likely to survive with a good quality of life. Heart transplant candidates who develop irreversible end-organ failure in other organ systems are generally not transplant candidates. Indications and criteria vary from transplant program to transplant program, but generally include:

- **Indications for transplant**
  - Cardiogenic shock requiring mechanical assistance
  - Refractory heart failure
  - Severe or restrictive cardiomyopathy
  - Refractory angina pectoris
  - Congenital cardiac anomalies.

- **Medical criteria for acceptance as a cardiac transplant recipient**
  - Patients with class IV cardiac disease
  - Not amenable to other surgical or medical therapy
  - Clinically estimated survival below 6 to 12 months
  - Age below 55 years
  - Absence of irreversible pulmonary hypertension
  - Absence of other systemic disease limiting survival
  - Absence of unresolved pulmonary infarcts

  Based on these criteria a patient is selected that is believed to have the best chance of benefiting from the operation and the attendant substantial commitment of medical resources.

- **Medical management of candidates**
  - Pharmacological support with:
    Intravenous diuretics
    Intravenous inotropic agents
  - Mechanical support with:
    Intra-aortic balloon pump
    Ventricular assist devices

- **Transport issues**
  Transplant candidates who require blood transfusions need leukocyte-removing filters to minimize anti-HLA antibody formation. Pharmacological support of the patient may include multiple ongoing inotropic medications, pulmonary support by mechanical ventilation and the use of mechanical cardiac assist devices, i.e. IABP. Heart transplant candidates may not tolerate movement or activity during transport, due to their low cardiac reserve. Maintaining hemodynamic stability is the ultimate goal during transport of the cardiac compromised patient.

MEDICATION REGIMES

Pharmacologic therapy for the mechanically assisted cardiac patient includes

- Inotropes such as epinephrine, dobutamine, dopamine, isoproterenol and/or amrinone
- Vasopressors, such as neosynephrine, levophed, and epinephrine, are used to increase systemic vascular resistance (SVR)
- Vasodilators, such as nipride, nitroglycerin, prostaglandin E1 commonly used as indicated to maintain normal resistance SVR & PVR
- Anti-arrhythmics such as lidocaine, quinidine, amiodarone, diltiazem, and digoxin, are used to preserve electrical conduction pathways if myocardial recovery is the treatment goal of the mechanically assisted cardiac patient. Although the patient may not be hemodynamically compromised, treatment of prolonged dysrhythmias by defibrillation, cardioversion, insertion of pacemakers may be used in conjunction with pharmacologic therapy.
- Antibiotic coverage is prophylactic for a minimum of 3 days after implantation of a cardiac assist device. Extended coverage is at the discretion of the clinician and is usually organism specific.
- Patients who exhibit signs or symptoms of fluid overload, including pulmonary vascular engorgement, peripheral edema, or an increased central venous pressure, usually require diuretic therapy.
- Relief of pain and anxiety remains an essential element in the care of the cardiac compromised patient. Narcotics remain the drugs of choice in the treatment of pain. If the patient’s anxiety is not controlled by the administration of narcotics, mild sedation with a benzodiazepine agent is appropriate. By keeping the patient free of pain and anxiety, myocardial oxygen demand will be decreased.

SUMMARY

New advances in technology have made alternative treatments possible for hemodynamically unstable cardiac patients who have failed to respond to maximal conventional medical therapy. With these new treatment modalities, a patient can be bridged to transplantation or native heart recovery using new generation mechanical circulatory support devices. These patients however, present a challenge to even the most experienced critical care, air medical providers. A thorough knowledge of cardiovascular anatomy and physiology as well as an understanding of the device mechanics, medication regimes and the potential complications of the therapy itself is mandatory for those air medical teams accepting the responsibility for these critical patients as part of their mission and scope of practice.

Accompanying this module are:

Exhibit 35-1: Suggested Equipment and Supplies for Device Patients
Exhibit 35-2: General Transport Guidelines for Cardio-Thoracic Device Patients

EXHIBIT 35-1: SUGGESTED EQUIPMENT AND SUPPLIES FOR DEVICE PATIENTS

This list is not complete and is intended to be an adjunct to equipment already used by the transport team. The program mission, scope of practice and medical direction will determine the specific equipment and medications required.

Respiratory
- Oxygen and medical air
- Endotracheal supplies
- Masks, cannulas, etc.

Medical equipment
- ECG monitor and defibrillator
- Pacemaker (Transvenous and External)
- Hemodynamic monitor
- Intravenous supplies
- IV infusion pumps
- Pulse oximetry monitoring
- End-tidal CO2 monitoring
- Ventilator

Balloon pump/device supplies:
- Compatible cables for ECG
- Compatible cables and transducer for arterial pressure monitoring
- IAB/device connectors
- PVC extension tubing
- Slave cables
- Additional helium tank or other gas source
- Arterial flush solution

Medications:

ACLS drugs	Valium
Nitroglycerin	Sedatives
Epinephrine	Paralytics
Levophed	Dobutamine
Isuprel	Lasix
Nipride	Pronestyl
Heparin	Morphine
Dopamine	

EXHIBIT 35-2: GENERAL TRANSPORT GUIDELINES FOR CARDIO-THORACIC DEVICE PATIENTS

To be followed on all device-dependent patient transports. Devices, methods of loading and securing equipment will be program-specific. Assure that all steps are per the manufacturers' recommendations and program policy.

Prior to departure and en route to referring hospital:

- Review pre-transport checklist
- Check the device for proper functioning prior to loading.
- Load IABP/device into the EMS vehicle
- Remove secondary stretcher from ground ambulance, helicopter, or fixed-wing.
- Load and lock the device into the ambulance or aircraft.
- Plug into the electrical outlet to keep the Device charged.
- Secure all equipment or bags in the ambulance or aircraft.
- Assemble the EKG cable.
- Assemble the pressure cable and arterial line.
- Assemble the device tubing.
- Set the device parameters and alarm limits; use audible alarms

Initial assessment:

- Introduce team to patient, family, nursing staff and physician.
- Obtain updated report on patient status upon arrival to referral facility.
- Obtain copied chart and patient consent for transfer.
- Establish and maintain airway.
- Provide and assist breathing.
- Check pulses.
- Check neurological status: including level of consciousness, reflexes etc.

Detailed assessment:

- Perform head to toe assessment including vital signs
- Check vital signs initially and every 5–10 minutes.
- Check hemodynamic pressures.
- Check device pressures.
- Listen for breath sounds and determine ventilation status. Check pulse oximetry and end-tidal CO2 readings.
- Check the insertion site for bleeding, dislodgement, kinks in tubing etc. If bleeding occurred through the dressing, circle the area.
- Splint the affected limb to restrict mobility, as needed
- Check pulses, sensation, capillary refill and blanching in both extremities. Mark pedal pulses on affected extremity.
- Monitor EKG and run strip for documentation.
- Monitor and document urine output.
- Review chart for documentation of device placement, line placement and confirmation of locations
- Hang medications as ordered

Prior to departure from referring center and en route to receiving facility:

- Prepare patient and family for transport; answer questions; provide receiving facility information
- Confirm device settings and alarm limits
- Attach patient to transport device, adjust timing as needed
- Complete patient packaging and transfer to transport stretcher
- Continually reassess patient and adjust treatment plan accordingly.
- Continue to monitor vital signs, neuro status, device settings and fluid status every 5–15 minutes, as time allows

Upon arrival:

- Verify tube and line placements, ventilator and device settings
- Provide verbal and written patient report

A. **Bibliography**:

Abiomed® *BVS 5000® Bi-ventricular Support System.* Guide to Patient Management, Abiomed, Inc., Massachusetts, 1994.

Beaver, K.: "Correlation of Balloon Pressure Waveforms To Troubleshooting Gas Leakage and Restriction Alarms," *Critical Care Nursing Clinics of North America*, 8 (4), 383–388, 1996.

Blumen, I.J., Abernethy, M.K., Dunne, M.J.: "Flight Physiology: Clinical Considerations," *Critical Care Clinics*, 8 (3), 597–618, 1992.

Chapman, R.A., and Bartlett, R. H. *Extracorporeal Life Support Manual for Adult and Pediatric Patients,* Dept. of Surgery, University of Michigan 1991.

Grif Alspach, J. *Core Curriculum for Critical Care Nursing*, 4th ed. W.B. Saunders, Philadelphia, 1991.

American College of Emergency Physicians: Principles of Appropriate Patient Transfer, *Annuals of Emergency Medicine*, 19,337–338, 1990.

Bellinger, R.L., Califf, R.M., Mark, D.B. et al: "Helicopter Transport of Patients During Acute Myocardial Infarction," 61, 718–722, 1988.

Campbell, P.: "Air Transport of the IABP-Dependent Patient*," Air Medical Journal*, Nov/Dec, pp. 20–21, 1986.

Flewelling, S.: "Developing an IABP Education Program," *Dimensions of Critical Care Nursing*, 5(5), pp. 310–319, 1986.

Frew, S.A.: *Patient Transfers: How to Comply with the Law*. Dallas, American College of Emergency Physicians, 1990.

Gottlieb, S.O., Chew, P.H., Chandra, N. et al: "Portable Intra-Aortic Balloon Counterpulsation: Clinical Experience and Guidelines for Use," *Catheterization and Cardiovascular Diagnosis*, 12:18–22, 1986.

Gould, K.A.: "Perspectives on Intra-Aortic Balloon Pump Timing," *Critical Care Nursing Clinics of North America*, 1(3), 443–458, 1989.

"Guidelines for the Transfer of Critically Ill Patients," *Critical Care Medicine*, 21(6), 931–937, 1993.

Grimes, M.: "Intra-Aortic Balloon Pump Failure at Altitude," *The Journal of Air Medical Transport*, Dec, pp. 5–8, 1989.

Hanlon-Pena, P.M., Ziegler, J.C., Stewart, R.: “Management of the Intra-Aortic Balloon Pump Patient: Pharmacologic Considerations,” *Critical Care Nursing Clinics of North America*, 8 (4), 389–408, 1996.

HeartMate® *Implantable Vented Electric Left Ventricular Assist System,* Operating Manual, Thermo Cardiosystems, Inc., Massachusetts, 1995.

Joseph, D.L. and Spadoni, S.M.: “Timing Waveform Analysis,” Critical Care Nursing Clinics of North America, 8 (4), 349–356, 1996.

Kramer, R.P. and Snow, N.J.: “Technical Considerations for Transporting Patients by Air Ambulance with Intra-aortic Balloon Pumps,” Journal of Extra-Corporeal Technology, 18:145, 1986.

Lee, G: *Flight Nursing: Principles and Practice*, Mosby Year Book, St. Louis, MO, 1991.

LoCicero, J., Hartz, R.S., Sanders, J.H. et al: “Interhospital Transport of Patients with Ongoing Intraaortic Balloon Pumping,” *American Journal of Cardiology*, 56, pp. 59–61, 1985.

Mertlick, G., Quaal, S.J.: “Air transport of the Patient Requiring Intra-Aortic Balloon Pumping,” *Critical Care Nursing Clinics of North America*, 1(3), pp. 443–458, September 1989.

Mertlick, G., Quaal, S.J., Borgmeier, P. R. et al: “Effect of Increased Intra-Aortic Balloon Pressure on Catheter Volume: Relationship to Changing Altitudes,” *Critical Care Medicine*, 20 (2), 297–303, 1992.

Quaal, S.J.: *Comprehensive Intra-Aortic Balloon Pumping*, ed 2. St. Louis, CV Mosby, 1993.

Quaal, S.J.: “Maintaining Competence and Competency in the Care of the Intra-Aortic Balloon Pump Patient,” *Critical Care Nursing Clinics of North America*, 8 (4), 441–450, 1996.

Sitzer, V.A. and Atkings, P.J.: “Developing and Implementing a Standard of Care for Intra-Aortic Balloon Counterpuslation,” *Critical Care Nursing Clinics of North America*, 8 (4), 451–458, 1996.

Stavarski, D.H.: “Complications of Intra-Aortic Balloon Pumping: Preventable or Not Preventable,” *Critical Care Nursing Clinics of North America*, 8 (4), 409–422, 1996.

Topol, E.J., et al. *Comprehensive Cardiovascular Medicine,* Lippincott-Raven, Philadelphia, 1998.

Schneider, C.N., Gomez, M., Lee, R.: "Evaluation of Ground Ambulance, Rotor-Wing, and Fixed-Wing Aircraft Services," *Critical Care Clinics*, 8 (3), 533–564, 1992.

Singh, J.B., Connelly, P., Kocot, S. et al: "Interhospital Transport of Patients with Ongoing Intra-Aortic Balloon Pumping," *American Journal of Cardiology*, 56:59,1985.

Sitzer, V.A. and Atkings, P.J.: "Developing and Implementing a Standard of Care for Intra-Aortic Balloon Counterpuslation," *Critical Care Nursing Clinics of North America*, 8 (4), 451–458, 1996.

Valensuela, T., Criss, E., Copass. M., et al: "Critical Care Air Transportation of the Severely Injured: Does Long Distance Transport Adversely Affect Survival?" *Annuals of Emergency Medicine*, 19, 169–172, 1990.

Wedige-Stecher, T.: "Fixed-Wing Transport of a Patient Requiring Intra-Aortic Balloon Pump and Left Ventricular Assist Device," *The Journal of Air Medical Transport*, Feb, pp. 6–8, 1990.

B. **Test Questions**:

1. With a patient on a biventricular assist device, pump filling is affected by the following :

   a. Hypovolemia
   b. Pump height relative to patient
   c. Cardiac tamponade
   d. **All of the above**

2. When a patient is managed with extracorporeal membrane oxygenation (ECMO), oxygenation and ventilation are both accomplished by gas sweep through the membrane lung oxygenation.

   a. **True**
   b. False

3. Pacemaker does not start timing sequences in response to intrinsic cardiac depolarization. This is a problem related to:

   a. Oversensing
   b. Failure to capture
   c. **Undersensing**
   d. No output

4. Identify the correct position of the tip of the balloon as reflected on a chest x-ray:

    a. The 4th/5th intercostal space
    b. At the renal bifurcation
    c. The left clavicular junction
    d. **The 2nd/3rd intercostal space**

5. If an Implanted pnuematic left ventricular assist device fails (stops pumping), what would be the appropriate action?

    a. Troubleshoot the console
    b. Call the manufacturer
    c. **Initiate hand pumping the device within 30 seconds**
    d. Start CPR

C. **Didactic Hours**: 16

D. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient care hours.

Examples

1. Load and secure all cardiac assist devices in transport vehicles used by program.

2. Practice the use of cardiac assist devices, emergency techniques and procedures in simulated clinical setting.

3. Demonstrate hemodynamic assessment.

4. Demonstrate competency in the set-up and operation of all devices used by program
5. Recognize and treat complications arising from use of the device.
6. Manage multiple intravenous infusions

E. **Patient Care Hours**: 72–144

MODULE 36: THE MECHANICALLY VENTILATED PATIENT

Author: Dr. Cathy Carrubba, Tampa General Hospital, Tampa, FL

Reviewer: Mr. Steven Sittig, RN, Mayo Eugenio Litta Children's, Rochester, MN

OBJECTIVES

Upon completion of this module, the student should be able to:

- Contrast the indications for noninvasive and invasive positive-pressure ventilation
- Define respiratory failure
- Discuss the differences between pressure-cycled and volume-cycled ventilation
- State the appropriate ventilator settings for patients with chronic obstructive pulmonary disease, cardiogenic pulmonary edema, hypovolemic shock and traumatic brain injury
- List and describe emerging modalities of mechanical ventilation for the neonatal patient.

INTRODUCTION

Patients requiring assisted mechanical ventilation during transport require specific modes of assistance dependent on the underlying illness or injury. This module will review the basic types of ventilators, discuss both invasive and noninvasive modes of operation, and make suggestions for ventilatory monitoring and management during transport.

Indications for Noninvasive Positive Pressure Ventilation

Assisted positive pressure ventilation can be delivered noninvasively using a face or nose mask, or invasively through an endotracheal tube or tracheostomy tube. Noninvasive assistance by mask can provide continuous positive airway pressure (CPAP), or bilevel positive airway pressure (BiPAP). CPAP is used most often for obstructive sleep apnea but can also be used to treat poor oxygenation despite high delivered oxygen concentrations as seen with pulmonary edema. BiPAP is designed to provide a level of support, in which inspiratory and expiratory pressures are adjustable. BiPAP can be considered a noninvasive bridge between CPAP and invasive ventilatory support. These types of noninvasive assisted ventilation are seen increasingly in the ICU, ER and home settings. Portable, battery operated BiPAP and CPAP ventilators are now available, but not frequently utilized in the transport environment. Patients in need of airway protection must be differentiated from those who need intensive assisted ventilatory support. Noninvasive ventilatory support will not protect the airway. However, a patient with an intact, although insufficient respiratory drive who is capable of protecting their patent airway may be a candidate for this therapy. Patients with rapidly reversible etiologies of their respiratory distress, such as a COPD exacerbation or pulmonary edema may also be appropriate candidates. Patients in whom advance directives include limitations on resuscitative and life support procedures such as intubation may also be candidates for this therapy in instances of reversible ventilatory insufficiency. And, as always, the transport crew must be prepared to secure the airway invasively should noninvasive therapy fail. Potential adverse effects seen with noninvasive positive pressure ventilation are the same as with invasive positive pressure ventilation as described below.

The future of this mode of therapy in appropriately selected individuals may improve transport outcomes and dramatically change the length of stay and cost of care for these patients.

Indications for Invasive Airway Management

Invasive ventilation allows manipulation of tidal volume, inspiratory and expiratory times, ventilation modes and ventilation rate. The airway is protected, and there is immediate access to the pulmonary tree. Knowledge of ventilatory options and parameters is essential for air medical team members.

There are three general indications for invasive airway management: (1) airway protection; (2) pulmonary hygiene; (3) respiratory support for inadequate spontaneous ventilation. The first subset would include a toxic overdose or a patient with upper airway obstruction from trauma or rapidly progressing head or neck infection. The second group would be patients requiring suctioning for copious secretions, such as a purulent airway infection or an organophosphate poisoning. The third group includes patients with pulmonary injury or disease which has limited their ability to sustain adequate ventilation, such as those patients with asthma, COPD, pulmonary edema or the head injured patient with signs of brain herniation who would benefit from hyperventilation. What all of these patients have in common is impending ventilatory failure. The objective of assisting ventilation in these patients is to improve gas exchange, correct adverse pressure/volume relationships that may exist, as found in asthma, COPD, pulmonary fibrosis and atelectasis, and allow the lung to heal while avoiding complications.

Criteria for Respiratory Failure

Respiratory failure is said to be present if two of the following four criteria are met:

- acute dyspnea;
- PaO_2 <50 mm Hg on roomair
- respiratory acidemia
- $PaCO_2$ >50 mm Hg.

Three of these four criteria are dependent on blood gas determinations, which may not be available to the flight team. As always, one should treat the patient and not the blood gas values. Therapy recommended for the underlying illness should guide clinical decisions. Frequently repeating the patient assessment will provide the health care practitioner with sufficient indications for intubation. A patient in respiratory distress with decreasing mental status, increased work of breathing, and deteriorating vital signs is exhibiting sufficient status changes to require aggressive airway management and intubation. Deteriorating pulse oximetry or end tidal CO_2 readings, if available, can aid in this decision making. Given the increased challenge of monitoring in a transport environment, it may be prudent to secure the airway with an appropriate adjunct prior to transport of a patient in distress. Factors such as space limitations and noise in the medical cabin can make intubation and confirmation of proper placement difficult, if not impossible. Flight crews should discuss these decisions with their medical director. Program philosophy and patient care guidelines should be reviewed during initial training and as part of the continuing education program, and should be supported by written protocols.

PRESSURE CYCLED VS. VOLUME CYCLED VENTILATORS

There are two commonly used types of ventilators, pressure cycled and volume cycled. Each has advantages and disadvantages in their use and applicability based on the patients' illness or injury.

Volume Cycled Ventilators

Volume cycled ventilators deliver a set tidal volume, by a logic circuit's manipulation of the inspiratory time and flow rate. These logic controls are either pneumatically powered or microprocessor controlled. The newer microprocessors typically only require 2 liters per minute to operate the logic while some pneumatic models require 12 liters per minute or more depending on ventilator settings. It is important to know the ventilator's logic consumption and add it in when calculating gas supply duration. During volume ventilation, if there is a significant increase in the patient's pulmonary resistance or decrease in compliance, the delivered peak pressure may increase to dangerous levels while trying to deliver the set tidal volume. Therefore, volume cycled ventilators should have a safety valve setting for maximum allowable peak inspiratory pressures, to minimize adverse effects of forcing a fixed volume under high pressure into the airway. With volume cycled ventilation, exhalation occurs passively. In the critically ill or injured patient with rapidly changing pulmonary mechanics, volume cycled ventilators may be more appropriate, providing added protection from hypoventilation as airway resistance increases and compliance decreases. Volume ventilators are used by many transport services during cardiac arrest when additional manpower is not immediately available, freeing up the health care provider for CPR and medication administration as needed.

Pressure Cycled Ventilators

Time cycled, pressure limited ventilators are the second most common transport ventilator. These ventilators are used primarily for newborns and small pediatric patients. Delivered tidal volume on these ventilators is a product of inspiratory time and set peak pressure. Once a breath is triggered, the inspiratory valve is opened; pressure is allowed to build until the set pressure is reached at which time inspiration stops regardless of tidal volume. The ventilator then cycles into expiration, pressure drops back to baseline, and exhalation occurs passively. The actual tidal volume delivered to the patient also depends on the patient's pulmonary compliance. Changes in the patient's pulmonary status can dramatically affect delivered tidal volume. Since peak pressure is limited and time cycled, it is very easy to lose substantial tidal volume despite the ventilator appearing to function correctly. Many times these ventilators have a constant flow of gas through the ventilator circuit to allow spontaneous respiration without triggering the ventilator.

There is little consensus in the literature concerning which type of ventilator is best in the hospital setting. In air transport, utilization of mechanical ventilators in transport is preferred over hand ventilation by resuscitation bag as it allows more consistent minute ventilation and application of PEEP. Care must be taken when using either volume cycled or time cycled pressure limited ventilators in an air medical environment. Since altitude changes can affect delivered tidal volume and or rate, the medical flight crew should carefully check the set parameters, even though some ventilators will automatically reset the volume as the altitude changes.

ADVERSE EFFECTS OF POSITIVE PRESSURE VENTILATION

Potential adverse effects of positive pressure ventilation include:

- Increased intrathoracic pressure with resultant decreased blood return to the heart and decreased cardiac output
- Fluid retention from decreased renal blood flow and decreased renal filtration which is seen with long term ventilation
- Air trapping and increased intrinsic PEEP (iPEEP)

- Barotrauma
- Respiratory tract infections from increased pressure, and presence of a foreign body such as an ET tube
- Respiratory alkalosis with subsequent metabolic disturbances;
- Increased agitation
- Increased work of breathing and increased respiratory distress

All of these potential adverse outcomes must be anticipated, and the transport team must be ready and able to correct these as they arise.

INITIAL VENTILATOR SETTINGS

The initial ventilator settings should be determined by the goals of therapy and the type of ventilator chosen. Understanding the physiology of the injury or illness and in turn what type of support the patient may require, will assist the air medical team member to select the most appropriate ventilator settings.

Settings for Volume Cycled Ventilators

In volume cycled ventilators, tidal volume, respiratory rate, inspiratory/expiratory (I:E) ratio and oxygen concentration (FiO_2) must be set. Tidal volume is generally set at 6–10 ml/kg of body weight. Respiratory rate is generally 10–12 breaths per minute for an adult. FiO_2 is set acutely at 100 percent and titrated down quickly based on physical assessment and blood gases. If alveolar collapse is a problem, PEEP should be added (2.5 to 10 cm H_2O) which in turn will reduce the concentration of oxygen needed to maintain the desired oxygenation.

Settings for Pressure Cycled Ventilators

When using a pressure cycled ventilator, inspiratory pressure should be set such that a comparable tidal volume results (usually 20 to 40 cm H_2O). The normal health I:E ratio is 1:2. In addition, CPAP can only be delivered by a pressure cycled ventilator.

Settings for Obstructive or Restrictive Pulmonary Disease

Undiagnosed Chronic Obstructive Pulmonary Disease may exist in up to 25 percent of the adult and elderly population. The goal in patients with obstructive lung disease is a slow correction of hyperinflation and acidosis. In patients with obstructive or restrictive pulmonary disease, care must be taken to set PEEP below the level of iPEEP or it should not be used at all. Initial I:E settings of 1:3 or 1:4 should be used, and for patients with restrictive lung disease, smaller tidal volumes (5–8 ml/kg) should be used, with more rapid respiratory rate settings (18–24 breaths per minute). This will minimize the hemodynamic consequences and risk of barotrauma.

Settings for Adult Patients with an Overdose

Typical settings for an adult overdose, who is “otherwise healthy”, would be an initial FiO_2 of 100 percent; a tidal volume of 8–10 ml/kg; 10–12 breaths per minute; I:E ratio of 1:2; and PEEP 0–5 cm H_2O. Care must be taken in assuming “otherwise healthy”, and therefore intrinsic airway pressures should be identified and monitored.

Settings for Patients with Status Asthmaticus

Typical initial settings for a patient in status asthmaticus would be an initial FiO_2 of 100 percent; tidal volume of 5–10 ml/kg; 10–12 breaths per minute; I:E ratio of 1:4; PEEP of 2.5–10 cm H_2O and not exceeding the iPEEP. PEEP is generally not recommended for mechanically ventilated patients with asthma. But some studies have shown some benefit as PEEP increases intraluminal pressures more than intrapleural pressures. This would help prevent the small airways from collapsing during increased expiratory effort.

Many institutions stabilize intubated asthmatics using a technique referred to as permissive hypercapnia. In this instance, a lower tidal volume (5–8) and respiratory rate (6–10) would be used. This prevents excessive alveolar distension. The goal of therapy is to provide adequate oxygenation while limiting inspiratory time and peak airway pressures to avoid increasing hyperinflation and barotrauma. Bronchodilators and corticosteroids are used concurrently to reduce bronchospasm and inflammation.

Settings for Patients with Chronic Obstructive Pulmonary Disease Exacerbations

In patients with COPD exacerbation, initial settings are similar to those for asthma. Permissive hypercapnia has also been used in these patients. I:E ratios of 1:3 or 1:4 are effective. The goal of therapy is to correct respiratory acidosis gradually, over a period of hours, to avoid metabolic alkalosis and subsequent electrolyte abnormalities. The target values for pH, $PaCO_2$, and PaO_2 should reflect the patients’ normal baseline. In addition, lung volume may be increased because of airtrapping. Normalization of lung volume depends on adequate expiratory time. In a patient who is intubated and on mechanical ventilation, it is necessary to allow adequate expiratory time. If this is not accomplished initially, increasing hyperinflation may occur. It may be necessary to remove the patient from the ventilator momentarily to allow complete exhalation.

Readjustment of the I:E ratio to allow longer expiration must be accomplished. The tidal volume may also need to be minimized. Bronchodilators and corticosteroids may also reduce intrinsic PEEP. As iPEEP is reduced, the work of breathing decreases. The addition of PEEP, at levels lower than iPEEP, may also reduce the work of breathing.

Settings for Patients with Cardiogenic Pulmonary Edema

In cardiogenic pulmonary edema, initial settings should be FiO_2 100 percent; tidal volume 8–10 ml/kg; respiratory rate of 10–12 per minute; I:E of 1:2; and PEEP of 2.5–15 cm H20. Care should be taken to monitor the patient for deleterious effect on hemodynamics as the PEEP is increased. PEEP is a primary therapeutic intervention for pulmonary edema, but it has an adverse effect on cardiac output. A compromise between PEEP and titration of oxygen must be made. Patients should ideally have Swan-Ganz catheters placed to aid in making this adjustment.

Settings for Patients with Adult Respiratory Distress Syndrome

In patients with ARDS, initial settings should be FiO_2 of 100 percent (with downward titration as rapidly as possible to avoid oxygen toxicity); tidal volume of 6–8 ml/kg (to avoid barotrauma to severely damaged alveoli); respiratory rate of 20–25; I:E of l:2, and PEEP of 2.5–10 mm Hg, with careful monitoring to assure optimal oxygenation while limiting risk of iatrogenic lung injury.

Settings for Patients with Hypovolemic Shock

In a patient in hypovolemic shock, initial settings should minimize PEEP, to avoid further hemodynamic compromise. They can otherwise be set as in a healthy overdose patient, as above. Therapy is directed towards the underlying cause of shock, avoiding PEEP until circulating volume is restored

Settings for Traumatically Brain Injured Patients

In the head injury or TBI patient, increasing tidal volume above 10 ml/kg is no longer recommended. Normal ventilation should be maintained, to maximize oxygenation and brain perfusion. This can be accomplished by maintaining the oxygen saturation at or above 90 percent, the systolic blood pressure (SBP) at or above 90 mm Hg and the Glasgow Coma Score (GCS) at or above 9. Increasing the respiratory rate should only be considered in the event of suspected brain herniation. An increased rate will further reduce the $PaCO_2$, brain perfusion and the intra-cranial pressure, but will not maximize oxygenation.

MODES OF INVASIVE POSITIVE PRESSURE VENTILATION

There are many different modes of positive pressure ventilation available. Selection will depend on the patients' underlying illness or injury, and will be adjusted based on the patients' response to the initial mode selected. The most common modes will be discussed here.

Controlled Mechanical Ventilation (CMV)

CMV delivers breaths at a preset rate, regardless of the patients' intrinsic ventilatory effort, and can be delivered by a volume cycled or pressure cycled ventilator. This mode is preferred for electively paralyzed or apneic patients.

Assist Controlled Ventilation (ACV)

ACV responds to the patients' intrinsic ventilatory effort, but will cycle at a preset minimum background rate if the patient fails to take a breath within that preset time. ACV can be delivered by a volume cycled or pressure cycled ventilator. During ACV, the machine will cycle to inspire every 5 seconds, or 12 breaths per minute, in the absence of a spontaneous breath from the patient. If the patient takes a breath, an assisted breath is given simultaneously and the ventilator monitor resets to watch for a breath in the next 5 seconds. If no breath is taken within 5 seconds, the machine delivers one, and the clock starts again. All breaths are delivered at the machine settings. Potential problems with assist control ventilation can occur if the patients' intrinsic rate is much higher than the preset rate. It can also worsen air-trapping in patients with COPD or asthma. It is also poorly tolerated in awake patients.

Intermittent Mandatory Ventilation (IMV)

IMV can be thought of as a combination of continuous mechanical ventilation and spontaneous ventilation. IMV can be delivered by a volume cycled or pressure cycled ventilator. During IMV, a respiratory rate is set and delivered, regardless of any effort by the patient. When the patient takes a breath, gas from the ventilator is supplied, but there is no preset volume or pressure. It is used in many awake patients because it requires less sedation, no paralysis, and allows the patient to preserve muscle tone in the muscles of ventilation which makes it easier to eventually get them weaned from the ventilator. It also allows the patient to adjust the $PaCO_2$ using intrinsic triggers. A drawback of intermittent mechanical ventilation is that it can allow "stacking" of breaths, which is a mechanical breath being delivered at the same time as a spontaneous breath. Stacking can cause barotrauma from hyperinflation.

Synchronized Intermittent Mandatory Ventilation (SIMV)

SIMV can be thought of as a combination of assist control ventilation and spontaneous ventilation. SIMV can be delivered by a volume cycled or pressure cycled ventilator. The mechanical breath is synchronized to support the patients' spontaneous breaths at a set rate, preventing stacking. If the patient breaths at a rate faster than the set rate, gas from the ventilator circuit is delivered with out assistance from the ventilator. If the patients' spontaneous respirations slow or cease, the ventilator will default to the preset rate.

Pressure Support Ventilation (PSV)

PSV allows breathing to be controlled by the patient, with peak pressures being controlled by the ventilator. The machine senses the patients' spontaneous breathing and provides prompt attainment of a preset peak inspiratory pressure each time the patient takes a breath. The machine also senses the end of inspiration, and allows exhalation to proceed spontaneously. With this support the work of breathing is decreased for the patient. Careful monitoring is necessary because tidal volume is uncontrolled. This mode is most frequently used as a step in weaning the patient from the ventilator, and may have limited usefulness in transport.

Positive End Expiratory Pressure (PEEP)

PEEP can be added to any of the ventilation modes discussed above. The effect of PEEP is to maintain alveolar patency at the end of exhalation, which increases functional residual capacity. Indications for PEEP and CPAP include the need to increase PaO_2 in the severely hypoxemic patient, or in a patient in whom oxygen toxicity is a concern, since both will increase PaO_2 without an increase in FiO_2, This occurs by decreasing the intrapulmonary shunting and ventilation perfusion mismatch seen in many pulmonary disorders. PEEP and CPAP also minimizes alveolar collapse associated with insufficient surfactant as found in premature infants. Victims of near-drowning also benefit from the administration of PEEP or CPAP. The increased pressure helps to displace fluid from the alveoli, thus improving functional residual capacity and perfusion.

A word of caution: Intrinsic PEEP can also result from improper assisted ventilation, when exhalation time is inadequate between breaths. The alveolar end expiratory pressure becomes more positive than the positive pressure in the more proximal airways. Inspiratory efforts will become less and less effective, and barotrauma may occur. Further compromise in hemodynamics can also occur. iPEEP also exists in the majority of patients with respiratory failure from obstruction because of air-trapping. This adds to the work of breathing, because the iPEEP must be overcome before an adequate tidal volume can be generated. When assisting patients with iPEEP, the extrinsically set PEEP should be set approximately 2/3 below the iPEEP. Rate, tidal volume, and expiratory time should then be set to optimize exhalation, and thus prevent increases in hyperinflation and barotrauma.

MONITORING PATIENTS ON MECHANICAL VENTILATION

Vital Signs, Capnography and Pulse Oximetry

Mechanical ventilation requires constant monitoring and adjustment of therapeutics. Cardiac and blood pressure monitoring, pulse oximetry, capnometry and ABGs are all useful. Vital signs should be constantly monitored. A rise in blood pressure or heart rate can indicate a need for adjustment of settings, or for additional sedation. Hypoxemia may first manifest as tachycardia and tachyapnea. Later signs are bradycardia or ventricular irritability. Capnography and pulse oximetry provide helpful information, but are best used to trend changes in the patients condition and to verify your assessment findings. An ABG measured within 20–30 minutes of the initiation of positive pressure ventilation and after changes in ventilation is helpful to guide titration of FiO_2. During transport, trending the PaO_2 and $PaCO_2$ along with frequent patient assessments will assist in this titration as well, especially if the initial blood gas results correlated well with the oxygen saturation and capnometry readings.

Peak Inspiratory Pressure

The monitoring of peak inspiratory pressure (PIP) is necessary when caring for mechanically ventilated patients during transport, and in fact may be considered an additional vital sign parameter. PIP is a measure of airway resistance and lung compliance. Changes in peak inspiratory pressure may reflect problems related to ventilation. Decreases in PIP may indicate a decreased delivery in tidal volume to the patient. This can be caused by ventilator malfunction (insufficient gas supply, inadvertent setting change; leaks, or disconnect). A decrease may also be seen as a result of effective therapy in asthma or COPD, indicating less pathologic obstruction. An increase in PIP will be seen in airway occlusion as caused by a kinked tube, increased secretions, airway spasm, pneumonthorax, or worsening pulmonary edema or ARDS.

Tidal Volume (TV)

Most transport ventilators cannot accurately monitor a patient’s tidal volume, although it may be helpful for air medical teams to understand the usefulness of this information when patients have been ventilated in a facility prior to the transport. The measurement of volume of expired air is especially useful in monitoring children who may have air leaks around an uncuffed endotracheal tube. It can also be indicative of a loss of integrity in the breathing circuit. In addition, it may be useful in assessing the effectiveness of spontaneous respirations.

EVOLVING MODALITIES IN VENTILATOR THERAPY

There are newer modalities and treatments being developed each year. Although some of these newer ventilatory modes are proving to be helpful for special patient populations in the hospital setting, they may not all be appropriate or convenient to use in the air medical environment.

Some of the newer modalities being utilized in the hospital setting and to a lesser degree in the air medical environment, include:

Inverse Ratio Ventilation (IRV)

IRV allows the inspiratory time to extend longer than the expiratory time.

Airway Pressure Release Ventilation (APRV)

A respiratory support mode that provides a moderately high level of continuous airway pressure that is interspersed with brief deflation (release) periods. Spontaneous breaths can occur throughout the ventilation cycle.

High Frequency Ventilation (HFV)

A mode of ventilation that incorporates tidal volumes less than or equal to dead-space that are delivered a super-physiologic rates. Accepted definition of a high frequency ventilator is any ventilator that can deliver greater that 150 breaths per minute.

Proportional Assist Ventilation (PAV)

An interactive ventilation support mode that provides patient-triggered breaths during which flow and volume delivery are controlled by the clinician-set goals placed on sensed patient effort. With PAV, increases in patient effort result in increased flow and airway pressure.

Extra-Corporeal Membrane Oxygenation (ECMO)

An adjunctive support system in which venous blood is directed to a machine that then removes carbon dioxide and also re-oxygenates the blood. This processed oxygenated blood is then returned to the patient's great veins or arterial system.

Nitric Oxide

Recent studies support the need for further research and clinical trials to evaluate the efficacy of inhaled nitric oxide (INO) as a treatment for very low birthweight (VLBW), premature infants with developing chronic lung disease (CLD). Early studies are very promising, and show improved oxygenation in most infants with early CLD, without inducing changes in markers of inflammatory or oxidative

SUMMARY

There are many ways to appropriately ventilate a patient during an air medical transport. The choice of modes, adjuncts, settings, and desired clinical results will determine the method of ventilatory support. The air medical crew must be familiar with all on-board ventilatory and supportive equipment in order to properly care for the wide range of patients that may be encountered. Adequate training, experience and the understanding of respiratory physiology and applied mechanical ventilation are critical for transport team members. To supplement this knowledge and skill, air medical transport personnel must also be well versed and competent in the administration of appropriate analgesia, sedation and paralytics as discussed in the module on respiratory patients.

A. **Bibliography**:

Mosby's Emergency Medicine, Vol 1, Adult; CDROM, Vol. I, Section II, Resuscitation, 1994.

Hunt, RC, et al: Inability to assess breath sounds during air medical transport by helicopter, *JAMA* 265(15):1982, 1991.

Emergency Medicine, Concepts and Clinical Practice, ed. Rosen, Peter, Barkin et al, Fourth Edition, 1998. Section 4:25, Aeromedical Transport and Inflight Emergencies, p.334–350.

Flight Nursing Core Curriculum, National Flight Nurses Association, 1997.

Flight Nursing, Principles and Practice, 2nd edition, R.S. Holleran, editor, Mosby, 1996.

Emergency Procedures and Techniques, 3rd ed. Simon, Brenner, et al., Williams and Wilkins, 1994.

Clinical Procedures in Emergency Medicine, 2nd edition, edited by Roberts and Hedges, W. B. Saunders Company, 1991.

Advanced Cardiac Life Support, American Heart Association, 1997–99.

Pediatric Advanced Life Support, American Hearth Association, 1995.

Advanced Trauma Life Support Program, Committee on Trauma, American College of Surgeons, 1999.

Tobin, MJ: Current concepts in mechanical ventilation, *N Engl J Med* 330:1056, 1994.

Tobin, MJ (ed): *Principles and practice of mechanical ventilation*, New York, 1994, McGraw-Hill.

Banner, MJ, et al: Mechanical ventilators: fundamentals. In Perel A. Stock, MC (eds): *Handbook of mechanical ventilatory support*, Baltimore, 1991, Williams and Wilkins.

Sullivan, MP, et al: Continuous positive airway pressure in the prehospital treatment of acute pulmonary edema, *Ann Emerg Med* 25:129, 1995.

Pollack, CV, et al: Treatment of acute bronchospasm with beta-adrenergic aerosols delivered via a BiPAP circuit, *Ann Emerg Med* 26:547, 1995.

B. **Test Questions**:

1. Indications for intubation include:

   a. **The need for aggressive pulmonary hygiene**
   b. Chronic ventilatory insufficiency
   c. Productive cough
   d. Acute pulmonary edema, first episode

2. All mechanical ventilators fall into one of two categories, volume cycled or time cycled.

   a. True
   b. **False**

3. Careful monitoring of patients during mechanical ventilation includes:

   a. Blood gases
   b. Vital signs
   c. Peak inspiratory pressure
   d. Expiratory volume
   e. **All of the above**

4. All patients on mechanical ventilation must be paralyzed and sedated.

   a. True
   b. **False**

5. Therapeutic goals in COPD patients on mechanical ventilation include:

   a. Rapid correction of repiratory acidosis
   b. Normalization of pH, $PaCO_2$, and PaO_2
   c. **Increase in lung volume to compensate for air-trapping**
   d. Normalization of lung volumes

6. In cardiogenic pulmonary edema, PEEP is a primary therpeutic intervention.

   a. **True**
   b. False

7. Therapeutic interventions with mechanical ventilation in the patient with ARDS include all of the following except:

   a. Rapid downward titration of FiO_2 to avoid oxygen toxicity;
   b. Minimalization of PEEP to avoid alveolar injury,
   c. **Low tidal volume and rapid respiratory rate, to avoid barotrauma**
   d. Increased peak inspiratory pressures to maximally expand alveoli.

8. All modes of ventilation described in this chapter can be delivered by pressure cycled or volume cycled ventilators except pressure support ventilation and continuous positive airway pressure.

   a. True
   b. **False**

C. **Didactic Hours**: 4

D. **Skills Hours**: Your program should have a competency list for this area based on program-specific protocols, medical direction, program mission, and scope of practice. Skills lab hours should be scheduled as needed to develop required competencies. Skills lab hours should be scheduled prior to any assigned patient hours.

E. **Patient Care Hours**: Mechanical ventilation skills can be integrated into other patient care experiences.

APPENDIX A

MEDICATIONS USEFUL IN AIR MEDICAL TRANSPORT

The following are medications that may be useful aboard a transport vehicle. These must be used as per local protocol or program medical direction.

Module 8: Hazardous Materials

- Those approved for each provider level in the treatment or management of hazardous materials exposures
- AHLS antidotes list

Module 16: Cardiovascular Patients

- Refer to ACLS guidelines and local medical direction

Module 17: Respiratory Patients

- Refer to ACLS guidelines and local medical direction. Also see Exhibit 17-2, which lists medications used during intubation.

Module 18: Neurological Patients

- Narcotic analgesics
- Barbiturates
- Phenytoin
- Benzodiazepines
- Neuromuscular blocking agents (for use in RSI)
- Vasopressors
- Thrombolytics

Module 19: Exposures and Envenomations

- Crotalidae antivenin
- Latrodectus antivenin
- Folate
- Cyproheptadine
- Methylene blue
- BAL
- EDTA
- Sodium nitrite
- Sodium thiosulfate
- N-acetyl cystine
- Digoxin specific FAB

- Thiamine
- Protopam
- Atropine
- Ethanol
- Glucagon
- Calcium
- Flumazenil
- Bicarbonate
- Naloxone

Module 20: Metabolic, Endocrine, Immune Suppressed

- .9 percent NS
- .45 percent saline
- Hypertonic saline
- D50
- D5W
- Glucose
- Insulin
- Glucagon
- Sodium bicarbonate
- Potassium chloride
- Kayexalate
- SSKI (potassium iodide)
- Calcium chloride
- Calcium gluconate
- Calcitonin
- Phosphorus
- Albuterol
- Furosemide
- Hydrocortisone
- PTU (propylthiouracil)
- Propanolol
- Dexamethasone
- Acetaminophen
- Levothyroxine

Module 22: Restraint and Care within a Confined Space

- Chlorpromazine
- Haloperidol
- Droperidol
- Diazepam
- Midazolam

- Lorazepam
- Morphine sulfate
- Fentanyl
- Succinylcholine
- Rocuronium bromide
- Vecuronium bromide

Fluids and analgesia as per administrative medical direction

Lidocaine
Atropine
Analgesics
Versed
Etomidate
Valium
Succhinycholine
Vecuronium
Rocuronium
Ketamine
Ativan
Versed
Morphine
Valium
Methylprednisolone (Solu-Medrol)

APPENDIX B

PRACTICAL TIPS FOR PROVIDERS

Module 3: Public Relations

1. Create a clinical "Center of Excellence"

    - Share your knowledge and experience with others while in the patient care areas, at referring facilities and during outreach education offerings
    - Combine your best interpersonal skills and overall transport expertise to guide and mentor others
    - Pre-scheduled safety briefings, outreach education offerings and participation in local EMS Week activities may provide an excellent opportunity to inform and educate while giving the flight crew "noncrisis" time to interact with EMS colleagues

2. Be an "Ambassador" for your air medical program and institution by investing time and energy in public relations

    - Work toward becoming a respected member and participant within your community
    - Practice public speaking and share information about your program
    - Live a safe and healthy life, with understanding of chosen risks
    - Provide role model examples of safe choices for the community
    - Commit to teach the community, particularly children, about injury prevention, safety awareness, and particular safety interventions needed in your community
    - Your program will benefit from involvement in community events such as fire and burn safety awareness, anti-DUI programs prior to high school proms and graduation, as well as static displays at air-shows

3. Take a "Leadership Role" in problem solving by identifying and working with any external groups critical of or unfamiliar with your program

    - Educate area EMS agencies, hospitals, and other referral sources so that there is a mutual understanding about your program's policies and procedures.

- Reduce that mutual understanding to writing in the form of a transfer agreement if there are complex issues, if both parties want a written agreement, or if there is local regulatory need for a written agreement.
- Draft transfer agreements carefully, with knowledge of the risk and benefits of written agreements.

4. Participate in EMS system and emergency management "Planning and Decision Making"

   - Assist in the development of a local system that activates your service early, in cooperation with the local EMS system, and provides a safe and secure landing zone
   - Educate the general public, first responders, and EMS professionals about your program's activation and landing zone protocols
   - Work with local health care facilities to establish safe activation and landing protocols
   - Work to insure logical inclusion of your program in local disaster plans

Module 4: Diversity and Cultural Issues

- Develop an understanding of your own culture
- Get to know the cultural make up of the community and the people that are likely to use your services
- Recognize that people from the same culture may have different beliefs and values
- Recognize that cultural competency is an ongoing process

Module 5: Personnel and Aircraft Standards

- Practice emergency procedures in the most realistic setting possible.
- Evaluate safety performance as a part of any practical training such as a megacode.
- Maintain a safety and prevention attitude for all aspects of the program

Module 6: Aircraft Safety Training

- Complete all skills training on-board or adjacent to the aircraft(s) utilized by your own program or vendor
- Practice scenario-based "what-if" exercises between regularly scheduled training updates

- Utilize safety briefings to discuss options available when faced with an untoward event

Module 7: Air medical Resource Management

- Know your own strengths and weaknesses
- Make efforts to understand the personalities and perspectives of colleagues
- Participate in regularly scheduled emergency drills
- Participate in formal group discussions on safety, mission preparedness and situational awareness

Module 9: Environmental Factors and Survival

- To help air crew members prepare to survive a crash, survival training should be specific to the air medical response area
- The survival training instructors should be familiar with the air medical environment, geography, climate and equipment mandated by the responsible regulatory agency
- Useful equipment/supplies in survival training include the following, which every participant should practice using:
  - Compass
  - Plastic Bag
  - 20 feet of “550 grade” parachute cord
  - Knife
  - Water-proof matches

Module 10: Casualties/Search and Rescue

- EMS is never Incident Command (IC)
- At the scene, think "Safety First!"
- Don’t forget potential hazmat issues
- Use pre-assigned disaster frequencies used by the IC, rather than normal communication frequencies

Module 11: Communications

- Use a pre-printed form for taking requests. This form will vary from program to program and may evolve as the program changes. Using a standardized form will simplify the call-taking procedure and will allow the medical crew to be aware of what information is and is not being asked of the requesting party. Exhibit 11.1 shows a sample form.
- Even if a computerized database is used for communications, the communications specialists should practice working without it. Also,

important database information (e.g., LZ descriptions, hazards, required notifications, phone numbers) should be available even if the computerized system is unavailable. The back-up information can be in printed format, or can be an export of the relevant information from the main database.

Module 15: Patient Assessment and Preparation

- **General Packaging**

  - Cover stretcher with sheet, blanket or waterproof protective padding. This helps to maintain the patient's temperature, provides additional comfort and contains blood and/or body fluids. This will also help to protect the aircraft and the caregivers from potentially harmful exposures. Wrap the patient so that the blanket opening follows the anterior midline of the patient. This allows better patient access for treatments and observation.
  - Ensure that the appropriate-sized hard cervical collar is in place. If the proper sized commercial cervical immobilization device (CID) is not available, use towel rolls and padding to ensure in-line position. This is particularly important with pediatric patients because their head is larger in proportion to their body and this difference must be compensated for. Once the patient has been secured to the board across the chest, hips and above the knees, the head and cervical spine can then be secured. This will prevent the cervical spine from becoming the pivot point if the body shifts during packaging.
  - Consider how taking the patient up in altitude may affect his overall condition, the air trapping and expansion in lines, cuffs, balloons and any other closed system.
  - Check security of electrodes, leads, and/or external pacer wires prior to departure.
  - Place blood pressure cuff on the arm/extremity closest to the crew members for easy monitoring access.
  - Place pulse oximeter probe on patient’s finger/site so that the cable plug-in is easily accessible.
  - Empty Foley catheter bag and coil tubing on lower extremities to minimize retrograde flow up the tubing.
  - Restraints should be placed on extremities early for easy securing during flight if needed.
  - Impermeable shoe covers can be used to protect the headset earpieces and microphone from body fluids.

  - Protect the patient from the elements. Some form of eye protection such as a visor, disposable sunglasses, or even X-ray film or a blanket can accomplish this. The patient also needs to be protected from precipitation and extreme temperature changes. A large umbrella, plastic sheet or other waterproof covering should be available. During extremely cold weather, additional blankets, heat packs, space blankets, etc. should be available. In the case of extreme heat, fluids and hydration need to be the priority. Minimizing the patient's contact with hot surfaces and minimizing the time spent in the sun should be accomplished as soon as possible.

- **Airway Support**

  - A portable oxygen supply should be readily available. The oxygen bottle may be placed between the patient's legs or at foot of stretcher during loading and unloading. It must be removed to a secure location prior to flight.
  - The oxygen supply should be ready for quick change over from portable sources to onboard sources. Be sure the pilot has turned on the on-board oxygen source prior to connecting the patient.
  - The head of the patient should be placed where in-flight intubation or airway management can be accomplished.
  - The resuscitation bag and appropriate-sized mask should be readily available.

- **Tubing, Cables, Lines and Catheters**

  - Ensure that all EKG cables, invasive tubing, intravenous lines, urinary catheter tubing, chest tube or other drainage device tubing are not caught on something, crimped or placed under the patient.
  - Guide all lines, etc. to the nearest opening in the patient blanket for improved visualization and safety.
  - Chest tube drainage devices should be positioned to prevent reflux. One-way Heimlich valves attached to urinary catheter bags may be preferable to other methods of chest drainage.

- **Fluid Administration**

  - Glass bottles should never be used. Administer medications commonly packaged in glass, such as nitroglycerine, via syringe pump whenever possible.

- Label all IV tubing at the nearest port for quick identification during transport.
- Label IV pumps with solution names and type of line (i.e., arterial, PICC, PIV, etc.).
- To manage multiple bags, connect all solution bags with a carabiner through the top hole in the bags.

- **Nasogastric Tube**

  - The gastric tube must be patent in order to decompress the stomach for flight. Confirm placement prior to leaving and ensure that the tube is secured. All patients being managed with BVM or are intubated should have a gastric tube in place to decompress the stomach, thus minimizing the chance of vomiting and aspiration. Stomach decompression without suction can be accomplished by leaving the NG, OG or GT unclamped and open to air or attached to a catheter-tipped syringe. During take off, landing or with frequent altitude changes, the plunger should be pulled gently back to aspirate stomach contents and accumulated air.

Module 21: Hypothermic and Hyperthermic Patients

- **Hypothermia**

  - Remove wet clothing and protect the patient from further heat loss. Remember to cover the patient’s head.
  - Profoundly hypothermic patients who exhibit cardiac ectopy may be candidates for bretylium. Lidocaine is ineffective for the treatment of hypothermia-induced dysrythmias.
  - Lactated Ringers solution is not recommended in the hypothermic patient because the hypothermic liver cannot metabolize the lactate
  - Optimal rewarming techniques depend upon the patient’s condition
  - A respiratory rate of 4–6 breaths per minute is sufficient in the hypothermic patient. If respirations are present, assume a perfusing cardiac rhythm is also present.
  - Begin CPR in the presence of conformed ventricular fibrillation or asystole
  - Defibrillation is unlikely to be effective with core temperatures below 30 degrees C
  - Pharmacological interventions typically used in a code situation have little effect with core temperatures below 30 degrees C

    - Infusion of 250–500 cc of warm (>40 degrees C) D5NS is indicated in most patients with a core temperature below 32 degrees C. Some evidence indicates patients may do better if this is infused prior to moving them.

- **Hyperthermia**

    - Remove the patient from the hot environment
    - Support airway, breathing, and circulation
    - Initiate cooling measures as appropriate to the patient's core temperature and the transport environment
    - Free water deficits must be corrected slowly, to prevent cerebral edema
    - Allow vital signs, urine output, laboratory values, and cardiovascular status to guide fluid replacement
    - Heat stroke is a life-threatening illness that must be corrected rapidly

Module 22: Restraint and Care within a Confined Space

- Safety in the air medical transport environment must be the priority
- There is no substitute for proper prior planning, coupled with a sound knowledge base and thorough medical protocols
- It is the ACM's responsibility to carefully evaluate each patient for combativeness or potential combativeness prior to flight
- All patients who are combative or potentially combative should have four-point (full extremity) restraints applied prior to loading the patient in the aircraft
- Combative or potentially combative patients must be completely subdued and restrained (with pharmacological and/or physical restraints) prior to transport
- Some patients cannot be safely transported by air, and alternate means of transportation should be sought
- Each program should have protocols in place that address transport of the combative or potentially combative patient, as well as transport of prisoners

Module 24: Orthopedic Trauma: Amputations and Deformities

Patient comfort:

- Pad voids when patient is secured to any immobilization device, especially the lumbar area, shoulders and head; minimize pressure spots
- Ensure that straps used to secure patient to immobilization device are snug, but not tight enough to restrict chest expansion or place undue pressure across chest or groin

- Follow proper sequence of securing patient to long-spine board, immobilizing torso first then head and extremities
- Secure injured extremity independently, then to board or patient torso; this will keep the extremity supported during patient transfer to and from the patient stretcher and hospital gurney
- Explain immobilization process to all patients, even to those with a decreased level of consciousness

Module 25: Burns: Thermal/Chemical/Electrical

- Consult with closest receiving Burn Care facility to draft policies and procedures for treating and transporting burn victims
- Participate with local fire, safety and utility personnel to educate the community about the risks and prevention of burn injuries

Module 26: Head, Neck, and Facial Trauma

- End tidal CO2 monitoring (if available) can guide levels of hyperventilation and can give visual graphics of endotracheal tube functions. Monitoring ETCO2 can help detect patient asynchrony with ventilator, cuff leakage, and adequate inspiratory cycles.
- When accomplishing rapid sequence induction intubation, have all intubation supplies and back-up airway adjuncts available prior to medication administration.
- During intubation with rapid sequence medications assign tasks to other health care providers to assist with monitoring of patient.
- Cervical spine immobilization, along with a reliable commercial tube restraint or taping technique, can be used to maintain endotracheal tube integrity during patient transport and movement
- Application of hearing protection in brain injury can help reduce noxious stimuli and reduce ICP.

Module 28: Abdominal Trauma

- ALWAYS confirm NG/OG tube placement prior to installing any fluid through the tube. Document the method used to confirm appropriate placement.
- Make sure the NG/OG tube is clamped and secured during ground transport. Upon entry into the aircraft, connect the tube to low wall suction and reconfirm placement.
- Any abdominal injured patient being transported in a pressurized aircraft should have an NG/OG tube in place
- When checking bladder pressures, do not forget to add the saline/water injected into the bladder to your Input and Output sheets
- Always check the posterior surfaces of your patient for occult injuries and hemorrhage

<u>Module 29: Obstetrics and Childbirth</u> and
<u>Module 30: Neonatal Care</u>

- **Triage**
    - The air medical crew and their communications center must be well-versed in the levels of care and services required for both uncomplicated mothers and newborns as well as high-risk maternal and neonatal patients
    - Perinatal Center definitions differ from Trauma Center definitions;
        - The highest level of Perinatal/Neonatal Care is defined as Level III
        - The highest level of Trauma Care is defined as Level I
    - Selecting the most appropriate level of receiving care is dependant upon the presenting diagnosis, nature of illness, mechanism of injury and expected course of illness
    - Regional or state triage guidelines should be in place to assist the EMS and air medical providers in selecting the most appropriate facility
    - appropriate facility

<u>Module 31: Pediatric Care</u>

- Approach child on his/her level
- Consider chronological and developmental age of child
- Be truthful
- Assess before you touch
- Speak to the child, not over the child
- Provide emotional support
- Use humor and knowledge of childhood interests
- Enlist the help of parents and caregivers
- Be aware of the teens need for privacy
- Honor patient-provider privilege when asked to share nonessential information with parent or law enforcement
- Be a role model

APPENDIX C

ADDITIONAL RESOURCES

Association of Air Medical Services (AAMS)
526 King Street, Suite 415
Alexandria, VA 22314–4143
Ph: (703) 836-8732 Fax: (703) 836-8920
www.aams.org information@aams.org

Additional AAMS Publications include:

- AAMS Minimum Standards
- AAMS Safety Position Statements
- AAMS HazMat Guidelines
- AAMS Appropriate Use Position Paper
- AAMS/ASTNA Resource Document for Air Medical Quality Assurance Programs
- Pediatric, Neonatal, and Maternal Patient Care Addendum to the AAMS/ASTNA Resource Document for Air Medical Quality Assurance Programs
- AAMS Media Relations Guide
- AAMS Post Accident Resource Document

AAMS also offers the Medical Transport Leadership Institute (MTLI), a two-year program aimed to enhance leadership and management of medical transportation through formal education programs stressing management theory and its direct practical application. Graduates of the MTLI program receive the *Certified Medical Transport Executive* (CMTE) designation.

Air Medical Physician Association (AMPA)
383 F Street
Salt Lake City, UT 84103
Ph: (801) 534-0829 Fax: (801) 534-0434
www.ampa.org

AMPA Publications include:

- Medical Direction and Medical Control of Air Medical Services
- Appropriateness of Air Medical Transport in Acute Coronary Syndromes
- Medical Condition List and Appropriate Use of Air Medical Transport

Air & Surface Transport Nurses Association (ASTNA)
9101 E. Kenyon Avenue, Suite 3000
Denver, CO 80237
Ph: (800) 897-NFNA (6362) Fax: 303/770-1812
www.astna.org astna@gwami.com

ASTNA Publications include:

- Flight Nurse Safety in the Air Medical Environment
- Improving Flight Nurse Safety in the Air Medical Helicopter Environment
- Role of the Registered Nurse in the Prehospital Environment
- Intravenous Conscious Sedation in Air Medical Transport
- Staffing of Critical Care Air Medical Transport Services

National Flight Paramedics Association (NFPA)
383 F Street
Salt Lake City, UT 84103
Ph: (801) 530-7152 Fax: (801) 530-7152
www.flightparamedic.org

National Association of Air Medical Communication Specialists (NAACS)
P. O. Box 28
Otis Orchards, WA 99027-0028
Ph: (877) 396-2227
www.naacs.org

National E.M.S. Pilots Association (NEMSPA)
526 King Street, Suite 415
Alexandria, VA 22314–4143
Ph: (703) 836-8930 Fax: (703) 836-8920
www.nemspa.org

NEMSPA Publications include:

- AMS Pilot Additional Duties
- Pilot Prevue Assessment

The *Air Medical Journal* is the air medical community's combined trade and research journal. Each issue contains research articles, abstracts and book reviews designed to keep you up-to-date on the latest discoveries. Each issue also includes stories on hot industry topics, legislative updates, operational data, member profiles, editorials and classifieds.

How to Subscribe:
Call 1-800-654-2452 and reference the Air Medical Journal, or visit www.mosby.com/airmedj.