Chapter 57

Ground and Air Transport of Critical Patients

Learning Objectives

- Describe the role that critical care ground transport plays in care of critical patients
- List the responsibilities of agencies in developing staffing needs
- Develop an understanding of who comprises the critical care ground transport team

Learning Objectives (Cont'd)

- List some equipment needed for critical care ground transport
- Describe the advantages and disadvantages of air medical transport
- Identify criteria for working as a member of an air medical flight crew
Learning Objectives (Cont'd)

- Identify conditions and situations for which air medical transport should be considered
- Describe various considerations for preparing for air medical transport

Staffing

- No national standards
  - Recommendations
    - American College of Emergency Physicians
    - U.S. Department of Health and Human Services
    - All have the same concerns

Staffing (Cont’d)

- Critical care staffing agency responsibilities
  - Written policies for staffing, treatment protocols
  - Infection control procedures
  - Continuing education requirements
  - Scheduling with strict safety standards for rest
Staffing (Cont’d)

● Typical staffing may include:
  ➢ Paramedic
  ➢ RN, nurse practitioner
  ➢ Respiratory therapist
  ➢ MD, PA
  ➢ Some may have a critical care paramedic

Equipment

● Ambulance
  ➢ Licensed with applicable state laws
  ➢ Adequate interior lighting
  ➢ Ability for two-way communication with online medical direction
  ➢ Minimal fuel capacity for 175 miles
  ➢ Lights visible from 500 feet from front
  ➢ Siren heard not less than 500 feet away

Equipment (Cont’d)

● Standard equipment
  ➢ Respirators and ventilators
  ➢ Cardiac monitor
  ➢ Pulse oximeter
  ➢ Minimum of three IV infusion pumps or a triple-chamber infusion pump for administering multiple IV medications
  ➢ Intubation equipment and suction units
  ➢ IV poles for inside the unit and portable pole
  ➢ Medication drug box
Equipment (Cont’d)

- Patient compartment large enough to accommodate large equipment
  - Balloon pumps
  - Incubators

History of the Aeromedical Services

- World War I
- Igor Sikorsky invented the first helicopter for the U.S. military
  - Medical uses—Burma 1944
- Late 1960s civilian transports began
Fixed-Wing versus Rotor-Wing Aircraft

- Fixed-wing aircraft
  - Facility to facility
  - Travel farther
  - Travel higher
  - Travel faster

Fixed-Wing v. Rotor-Wing Aircraft (Cont'd)

- Rotor-wing aircraft
  - Scene to facility
  - Sometimes facility to facility
  - Land in smaller space

Flight Crew Criteria

- Nurses
  - First used in the 1930s
  - Usually certified flight registered nurse
  - Often must also be EMT B or P
  - ACLS and PALS
  - Clinical background in emergency or critical care
Flight Crew Criteria (Cont'd)

- Paramedics
  - First used in the 1970s
  - May be a certified flight paramedic
  - Typically 3–5 years clinical experience
- Other members of flight team
  - Added as necessary
  - Physicians
  - Respiratory therapists

Flight Crew Criteria (Cont'd)

- NFPA criteria
  - Basic cardiac life support
  - Advanced cardiac life support
  - Prehospital trauma life support
  - Advanced trauma life support
  - Pediatric advanced life support
  - Neonatal resuscitation program

Transport Physiology

- Gas laws
  - Govern body's physiological changes
  - Variables that affect gases
    - Temperature expressed in degrees Kelvin
    - Pressure
    - Volume
    - Density
Transport Physiology (Cont'd)

- Boyle's law
  - Pressure increases, volume decreases
  - Pressure decreases, volume increases
  - Gas expansion can cause
- Dalton's law
  - As altitude increases pressure decreases
  - More difficult for oxygen to transfer into blood

Transport Physiology (Cont'd)

- Charles' law
  - As temperature increases, so does volume
- Gay-Lussac's law
  - As temperature decreases, pressure decreases

Transport Physiology (Cont'd)

- Henry's law
  - Gas dissolved in liquid is proportional to pressure
  - Rapid ascension can cause nitrogen bubbles in the blood
- Graham's law
  - Gasses move from high to low pressure
Transport Physiology (Cont'd)

- Stress of transport
  - Decreased partial pressure of O₂
    - Hypoxia
    - Hypoxemia
    - Hypercapnia

Transport Physiology (Cont'd)

- Stress of transport
  - Barometric pressure changes
    - Altitude changes create trapped gasses in:
      - GI tract
      - Lungs
      - Ears
      - Sinuses

Transport Physiology (Cont'd)

- Stress of transport
  - Barometric pressure changes
    - Other medical conditions affected:
      - Sinus block, barosinusitis
      - GI tract issues
      - Recent abdominal surgery
      - Colostomy
Transport Physiology (Cont'd)

- Stress of transport
  - Thermal changes
    - Increase in altitude causes decrease in ambient temperature
    - Vibration can pose a risk to regulation of body temperature
    - Monitor temperature throughout
    - Medications: sedatives and analgesics affect temperature
      - Space blanket
  - Decreased humidity
    - As altitude increases, humidity decreases
    - Risk for fluid loss, dehydration
  - Noise
    - Affects crew-to-crew and crew-to-patient communication
    - Leads to fatigue
    - Earplugs for patients pulled before descent

- Stress of transport
  - Vibration
    - Energy transmitted to patient’s body
    - Generates heat
    - Increases metabolic rate
    - Redistribution of blood from peripheral vasoconstriction
  - Fatigue
    - Stressor for crew
    - Stressor for patient
Criteria for Patient Transport

- **Distance**
  - Fixed wing >100 mile distance
  - Rotary wing shorter distance

Criteria for Patient Transport (Cont'd)

- **Medical patients**
  - Critically ill
    - Dissecting/bleeding aortic aneurysm
    - Intracranial bleeding
    - Acute ischemic stroke
    - Epiglottitis
    - Severe hypothermia/hyperthermia
    - Cardiac intervention
    - Sepsis shock
    - Status asthmaticus
    - Status epilepticus
    - Severe poisoning
    - Cardiogenic shock

- **Trauma patients**
  - Criteria for transport
    - Physiological criteria
      - Airway compromise
      - GCS score <13
      - Signs, symptoms of shock (BP <90)
Criteria for Patient Transport (Cont'd)

- Trauma patients
  - Criteria for transport
    - Anatomic criteria
      - Penetrating torso trauma
      - Amputation proximal to wrist/ankle
      - Limb paralysis
      - Spinal cord injury with deficit
      - Burns with > 15% BSA

Criteria for Patient Transport (Cont'd)

- Trauma patients
  - Criteria for transport
    - Mechanism of injury
    - High speed MVC
    - Prolonged extrication (>20 minutes)
    - Fatality in same vehicle
    - Passenger compartment intrusion >12 inches
    - Mechanism with physiological and/or anatomical findings

Criteria for Patient Transport (Cont'd)

- Trauma patients
  - Other considerations
    - Contraindications
      - Absolute cardiac arrest
      - Terminally ill with DNR order
      - Active untreated communicable disease
      - Stable patients
      - Weather conditions—wind speed and visibility
      - Availability of landing zone
      - Arrival time
      - If extrication and ground transport time is less than arrival time
Patient Preparation

- Different for fixed wing
  - Requires ground transport to aircraft
- Hospital to hospital
  - Airway secured
  - IV in place
  - Cardiac monitor in place
  - Medications be used may require evaluation
  - Paperwork, x-rays, diagnostic test results
  - May need to intubate for flight

Landing Site Preparation

- Size
  - Minimum 100 x 100 ft
- Location
  - 100–200 feet downwind
  - Identify by GPS coordinates/major nearby intersection
  - Day: mark corners of zone with cones
  - Night: mark corners of zone with lights, fifth marker on upwind side

Landing Site Preparation (Cont’d)
Landing Site Preparation (Cont’d)

- Obstruction
  - Identify and mark obstructions in immediate area
  - Avoid power lines, poles, and trees
  - 200 feet from bystanders and livestock
- Surface conditions
  - Inform flight crew of landing surface and slope
  - Not >5 degree slope
  - Order of preference: concrete, asphalt, sod/grass, dirt

Landing Site Preparation (Cont’d)

- Communication
  - One person assigned this task
  - Always use clock positions to relate obstacles

Landing Site Preparation (Cont’d)

- General safety
  - Keep spectators at least 200 feet away
  - Ensure personal equipment secured
  - Do not approach until signaled by crew member
  - Never bend over when approaching
  - Do not hold anything above head
Chapter Summary

- Training and the availability of a critical care paramedic allow agencies to provide critical care to grounds units
- Critical care ground transport may be appropriate for a critical care patient who requires transport to another medical facility

Chapter Summary (Cont’d)

- Critical care ground transports are conducted by a multidisciplinary team of healthcare professionals
- Patient compartment of a critical care ground unit should be equipped with all standard equipment found on a mobile intensive care unit
Chapter Summary (Cont’d)

- Beginning of aeromedical services dates back to the 1940s and continues to the present day, with approximately 350,000 rotor-wing and 100,000 fixed-wing transports annually.
- Fixed-wing and rotor-wing aircraft are used to transport ill or injured people to appropriate medical care.

Chapter Summary (Cont’d)

- Fixed-wing aircraft have been used for almost 90 years for medical transport, typically from facility to facility.
- Rotor-wing aircraft and helicopters are better known for scene-to-facility transport.
- Flight crew criteria apply to nurses, paramedics, and other members of the flight team.

Chapter Summary (Cont’d)

- Transport physiology includes multiple factors that should be considered before and during transport.
- Gas laws govern the body’s physiological response to variables of temperature, pressure, volume, and relative mass of gas.
Chapter Summary (Cont’d)

- Boyle’s law presumes that if temperature is constant, the volume of gas is inversely proportional to its pressure.
- Dalton’s law, the law of partial pressure, states that “total partial pressure of the gas mixture is equal to the sum of partial pressures.”

Chapter Summary (Cont’d)

- Charles’ law expresses that the volume of a fixed mass of gas held at constant pressure varies directly with absolute temperature.
- Gay-Lussac’s law is sometimes combined with Charles’ law because it deals with the relation between pressure and temperature.

Chapter Summary (Cont’d)

- Henry’s law is associated with decompression sickness.
- Graham’s law describes how gases move from an area of higher pressure/concentration to an area of lower pressure/concentration.
- Seven stressors are identified that may be caused by air transport.
Chapter Summary (Cont’d)

- Treatment for hypoxia/hyperventilation includes administering 100% oxygen, initiating positive-pressure ventilation, regulating breathing, watching for hyperventilation, checking equipment, and descending.

- Barometric pressure changes can cause several effects during ascent and descent.

Chapter Summary (Cont’d)

- Patients already ill or injured can have difficulty maintaining body temperature; changes in ambient air temperature during transport can affect the patient.

- Humidity is the concentration of water vapor in air; changes can require the provider to modify patient care.

Chapter Summary (Cont’d)

- Noise affects the ability of the flight crew to communicate, alters patient hearing, and can promote varying levels of fatigue.

- Vibration is defined as the motion of an object in relation to a reference point, usually an object at rest.

- Fatigue is the end product of all exposures that can occur while person is in an aircraft.
Chapter Summary (Cont’d)

- Criteria for patient transport are conditions required for the use of an aircraft for transport
- Critically ill medical patients may require transport by fixed-/rotor-wing aircraft based on defined criteria
- Injured trauma patients may meet established criteria for transport by rotor-/or fixed-wing aircraft

Chapter Summary (Cont’d)

- Other considerations may prevent the use of aircraft for transporting patients
- Patient preparation includes actions to be taken before placing the patient in the aircraft
- Hospital-to-hospital transport is typically done by fixed-wing aircraft but depends on a variety of factors

Chapter Summary (Cont’d)

- Scene-to-hospital transport is typically done by a rotor-wing aircraft; it more commonly involves trauma patients
- Landing site preparation includes size, location, obstructions, surface conditions, night operations, communication, and general safety