

## Chapter 8

# Aeromedical Evacuation

The United States Transportation Command (TRANSCOM) and the United States Air Force (USAF) Air Mobility Command operate a sophisticated worldwide air evacuation system capable of safely transporting critically ill patients of all ages. Crews are composed of flight nurses and technicians, augmented by Critical Care Air Transport Teams (CCATs) when medically indicated. These expert teams are composed of a specially trained physician, nurse, and respiratory therapist. They have the expertise and equipment to provide in-flight intensive medical care.

Currently, no aircraft in the US inventory are dedicated solely to the air evacuation mission. Aircraft of opportunity, primarily USAF C-130 Hercules and C-17 Globemaster fixed-wing platforms, and Army UH-60 Blackhawk and CH-47 Chinook rotary wing aircraft, are configured for patient transport.

Because pediatric patients are more vulnerable than adults to the stressors of flight, evacuating “stabilized” children and neonates by air presents unique challenges. Urgent treatment focused on life-threatening or organ-threatening problems must precede a definitive diagnosis. The impact of flight physiology and the need for specialized transport teams, or at least special consideration, should be factored into mission planning.

### Stressors of Flight

- Hypoxia
  - Routine cruising altitude for strategic air evacuation flights is about 40,000 feet mean sea level (MSL)
  - A cabin altitude of approximately 8,000 feet MSL can be maintained by pressurization of the aircraft
  - In a child without cardiopulmonary disease, this results in a corresponding decrease in the oxygen saturation from near 100% at sea level to 90% at altitude (Dalton’s Law)
  - Administering 2 L/m oxygen by nasal cannula increases the oxygen saturation to approximately 100%

- ▶ In patients with cardiopulmonary disease, anemia, or increased metabolic demands due to burns, sepsis, or recent operative procedures, a higher flow rate may be required to maintain tissue oxygenation
- ▶ A pulse oximeter is a useful guide when administering supplemental oxygen
- Decreased cabin air pressure
  - With climb from sea level to 40,000 feet, the volume of a trapped gas increases as the ambient barometric pressure decreases, causing trapped gases within body cavities (pleura, skull, viscera, etc) to expand (Boyle's Law); at a cabin altitude of 8,000 feet, volume increase approaches 40%
  - Nasogastric tubes, gastrostomy tubes, and ostomy bags must be vented
  - The pressure in ballooned devices (eg, endotracheal tube cuffs, Foley catheters) should be adjusted during the climb and descent phases of flight
  - Strongly consider leaving drains (including chest tubes) in place for flight; patients who have had chest tubes removed generally must wait 48 hours before flight and must be cleared radiographically to confirm pneumothorax resolution
  - When gas in cavities is not readily accessible to decompress (eg, pneumocephalus) and urgent aeromedical evacuation (AE) is required, a cabin altitude restriction (CAR) can be requested (see below)
- Thermal stress/humidity
  - Temperature fluctuations can adversely affect infants because of their high surface-area-to-body-mass ratio and immature thermoregulatory systems
  - Decreased cabin humidity (~ 1%) can contribute to dehydration
    - ▶ An incubator or other flight-approved isolette can provide a neutral thermal and humid environment for infants
    - ▶ At cruise altitude, increased fluid flux occurs into the extravascular space, and increased insensible fluid losses exacerbate dehydration

- Vibration, gravitational forces, subdued lighting (due to combat conditions), and noise (auscultation is almost impossible) are all additional stressors
  - This is a difficult environment in which to manage pediatric patients; the above factors cause patient disorientation and fatigue
  - These factors are significant in tactical evacuation missions using rotary wing aircraft, where space limitation severely impedes the ability of a medical crew to monitor and perform intervention maneuvers in flight; fortunately these flights are usually of shorter duration
  - All lines and tubes must be carefully secured prior to transfer to the aircraft to prevent dislodgment during the requisite multiple patient movements
  - Orthopaedic casts must be bivalved
  - Consider fasciotomy in patients at high risk of developing a compartment syndrome
  - Intubate patients at risk for airway loss or with borderline respiratory status; establishing an emergent airway may be difficult or impossible in a child while in flight
- Prolonged mission duration
  - Strategic AE between major command areas of responsibility can exceed 10 hours and entail unanticipated delays due to operational considerations, equipment failure, weather, and other factors
  - Ensure patients have sufficient medication, blood products (if indicated), and pediatric age-appropriate equipment available; this is especially important with infant and toddler transports because most AE supplies are sized for adults
- CAR
  - Patients with severe pulmonary disease and marginal oxygenation at high ventilator settings may require a CAR to maintain the cabin air pressure near that of the origination altitude
  - A lower cruising altitude will most likely increase the duration of the mission due to increased fuel consumption (possibly necessitating a fuel stop), and often entails flight through more turbulent air

- A CAR may place the aircraft at risk in the combat environment
- Other conditions warranting a CAR include penetrating eye injuries with intraocular air and trapped air that cannot be evacuated before flight (eg, pneumoencephalus)
- Noncertified equipment
  - Approved AE equipment has been extensively tested to ensure that it is safe to operate in flight and that it will not interfere with an aircraft's navigation and electrical systems
  - A waiver may be granted for noncertified or nonstandard medical equipment
- Special considerations
  - Neonatal/pediatric intensive care patients: air evacuations of intubated, pressor-supported, or otherwise unstable pediatric patients demand special care and planning
  - Every effort should be made to create a transport team with the prerequisite pediatric skills
    - ▶ Adding a physician or nurse anesthetist skilled in pediatric intubation, a respiratory therapist, or a pediatric-skilled registered nurse may have a huge impact on patient safety
    - ▶ Physiological deterioration is common during pediatric critical care transport and should be anticipated; unrecognized asphyxia is the primary cause of deterioration
    - ▶ The transport team must be prepared for emergencies such as airway-related events, hypotension, loss of crucial intravenous access, and cardiopulmonary arrest
    - ▶ Although pediatric and neonatal CCATs exist, they are unlikely to be quickly available in hostile environments
      - ▷ Neonatal teams typically transport patients from birth to 3 months of age
      - ▷ Pediatric teams generally transport critically ill patients ages 3 months to 14 years of age
  - Requests are coordinated between the originating physician,

the validating flight surgeon at the patient movement requirements center (PMRC), and the destination/ accepting physician

- ▶ Close coordination between the sending facility and the PMRC is necessary to consider factors as such as weight, transport isolette size, in-flight care requirements, acuity, and team composition

### **Humanitarian Transport Requests**

- The process of arranging pediatric humanitarian evacuations out of theater can take between 6 and 12 months
- Appropriate patient selection is critical; ideally these patients have only a single, fixable, stable problem
- The lack of suitable host-nation care must be confirmed and documented; regional care is preferred over transport to the continental United States (CONUS)
- Individual cases for humanitarian evacuation out of theater are unlikely to be successful without a passionate advocate; personalizing the case with photos and compelling narrative is crucial for success
- These complex requests often require coordination with the local US embassy or State Department, host-nation medical officials, and transit nations' ministries of foreign affairs (or equivalent)
- Identify partners within the country of origin and within international nongovernmental organizations (eg, using resources within the US consulate and Shriners International for a child who needs reconstructive plastic surgery long after a disfiguring burn)
- For Southwest Asia, military approvals are required from local command through Central Command
- All evacuated children must have an attendant; those needing military transport require "Secretary of Defense Designee" status
- Coordination also includes travel to a receiving medical center once in CONUS, obtaining diplomatic transit clearance during wait for ongoing flights, and return transport
- Contact servicing PMRC for guidance

### **Key Steps for AE Request**

- Contact local flight surgeon and/or AE liaison to assist in en route care plan and timing/precedence of evacuation; a patient movement request (PMR) is generated
- Include equipment and support requirements, nonmedical attendants (parent, guardian), precedence, litter, ambulatory (or both), and services required at accepting facility
- The servicing PMRC receives the PMR through the TRANSCOM Regulating and Command and Control Evacuation System (TRAC2ES) via the Internet
  - Facsimile, telephone, and Secure Internet Protocol Router Network (SIPRNet) messages are acceptable if TRAC2ES is unavailable
- PMRC reviews the PMR, validates the request, and establishes an AE requirement
  - The validating flight surgeon, a senior physician assigned to the PMRC, is primarily responsible for this action
- Determine the need for a CCATT (see “special considerations,” page 56)
- Patient clearance
  - Local flight surgeon, working with the referring physician, determines that the patient is medically stable for transport and has appropriate equipment and medication for transport, then clears patient for flight
  - For CCATT patients, the transporting CCATT physician makes the final determination, considering the patient’s ability to tolerate transport and operational issues
- Patient movement precedence
  - **Urgent:** Immediate to save life, limb, or eyesight (transport as soon as possible)
  - **Priority:** Prompt medical care required and not available locally; use when condition can deteriorate and patient cannot wait for routine evacuation (transport within 24 h)
  - **Routine:** Requires evacuation, but condition is not anticipated to deteriorate significantly (transport within 72 h)

## **PMRC Contact Information**

Global Patient Movement Requirements Center (GPMRC)  
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CONUS, US Southern Command  
Commercial (COMM) Telephone: (618) 229-4200 or 4129 (staffed  
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