The history of air medical transport (AMT) dates to before World War I, when the French evacuated soldiers from Serbia using airplanes as ambulances as early as 1915. The first recorded use of a U.S. military air ambulance was in 1918 when an airplane was converted to accommodate a litter patient in the rear cockpit. During World War II, more than 1.1 million sick and wounded soldiers were airlifted to the United States during the last 3 years of the war. The Korean War introduced the helicopter to AMT, and more than 20,000 battlefield medical evacuations were flown during the conflict. During the Vietnam War, Operation Dustoff transported nearly 1 million of the injured from the front lines to care.

The impact of AMT on the wounded soldier was clear. During World War II, the average time from injury to definitive care was 6 to 12 hours, with a mortality rate of 5.8%. In Korea, the time was 2 to 4 hours, with 2.4% mortality. In Vietnam, the time was 65 minutes, and mortality was less than 1%. Encouraged by the military experience, civilian AMT in the United States was propelled by the 1969 start of the first hospital-sponsored, fixed-wing air medical program. The first civilian helicopter emergency medical services (HEMS) program in the United States was established in 1972.

AVIATION PHYSIOLOGY

A working knowledge of aviation physiology is vital to understanding the effects of AMT on pilots, medical personnel, and patients.

Boyle’s Law

The cornerstone of aviation physiology is Boyle’s law, which states that the volume of a unit of gas (“unit” defined as a specific number of molecules) is inversely proportional to the pressure on it. In concrete terms, Boyle’s law means that as altitude increases and atmospheric pressure decreases, the molecules of gas grow apart, and the volume of the gas expands. With descent (increasing atmospheric pressure), the molecules are condensed, and gas volumes contract.

Physiologic difficulties from expansion and contraction of gases within the closed spaces of the body may occur with altitude change. Squeeze injuries from contraction of air and associated soft tissues within closed cavities occur on descent and are common causes of barotitis, barosinusitis, and toothache. Reverse squeeze injuries occur on ascent, as decreasing barometric pressure leads to an increased volume of the air trapped within the space, exerting pressure on structures. Ascent injuries can include conversion of a simple pneumothorax into a tension pneumothorax or rupture of a hollow viscus by expansion of intestinal gas. The operation of medical equipment containing closed air spaces, such as intravenous tubing and pumps, air splints, ventilators, and endotracheal tube and laryngeal airway cuffs, may also be affected by altitude.

Boyle’s law is predominantly responsible for the presence of hypoxia at altitude as there are fewer molecules of oxygen present per volume of inhaled gas at altitude. Similarly, dispersion of molecules of water vapor within a gas volume is seen at height, and “dry air” results.

Charles’ Law

Charles’ law follows from the volume effects of Boyle’s law. It notes that as the volume of a unit of gas rises, the temperature of that volume falls. The molecular dispersion seen with increases in gas volume at altitude (Boyle’s law) means there is less chance of molecular collision with resulting generation of heat. Charles’ law explains why the ambient temperature decreases with increased altitude.

Dalton’s Law

Dalton’s law states that the total barometric pressure at any given altitude equals the sum of the partial pressures of gases in the mixture \(P_t = P_1 + P_2 + P_3 + \ldots + P_n\). Whereas oxygen still constitutes 21% of the atmospheric pressure at altitude, Boyle’s law notes that each breath brings fewer oxygen molecules per breath to the lungs, and hypoxia results. The clinical effect of Dalton’s law is manifested as a decrease in arterial oxygen tension with increasing altitude.

Henry’s Law

Henry’s law states that the mass of gas absorbed by a liquid is directly proportional to the partial pressure of the gas above the liquid. Henry’s law has its most familiar applications in diving medicine, in which the increased pressure exerted on gases in the body at depth forces the gases into solution in the bloodstream. Rapid ascent from depth causes the gas to come out of solution within the bloodstream, resulting in decompression sickness.
Henry’s law does not carry the same weight in aviation medicine because the degree of change in atmospheric pressure per unit of distance is considerably less than the degree of change in water. However, sudden decompression at altitude may result in dysbarism.

**Additional Stresses of Flight**

Other stresses of flight that can affect the patient or crew include temperature fluctuations, dehydration, noise, and vibration. Temperature changes may produce increases in metabolic rate and oxygen consumption. As noted, at altitude the moisture per volume of air falls. Fluid intake should be monitored carefully during transport, and all patients should receive humidified medical oxygen. Noise and vibration represent the most ubiquitous stresses encountered in AMT, and both may interfere with patient care or the function of medical equipment. Hearing protection should be worn at all times during aircraft operations by patient and crew. Exposures to environmental extremes may result in fatigue, motion sickness, disorientation, ear damage, and deterioration in task performance.

**PRINCIPLES OF AIR MEDICAL TRANSPORT SYSTEMS**

**Administrative Structure**

Air medical services may take several forms. Despite a tremendous growth of operations in the past 20 years, the most common type of HEMS program in the United States remains the hospital-sponsored operation transporting patients from outlying referral centers or accident scenes to tertiary care centers. A single hospital or a consortium of institutions may sponsor these flight programs. In 2011, there were more than 220 dedicated HEMS programs operating more than 750 dedicated aircraft throughout the nation. Approximately 54% of the programs were hospital sponsored, and the balance were operated by privately owned or publicly traded companies. Whereas these for-profit companies represent 46% of the programs, they operate more than 61% of the dedicated helicopters in the United States. Public service agencies may also sponsor air medical services or partner with private companies; vehicles used by these programs are often multifunctional aircraft that serve in medical, search and rescue, fire suppression, and law enforcement roles. The Military Assistance to Safety and Traffic (MAST) program operated by the U.S. Armed Forces provides additional HEMS resources to the community, but in recent years their role for civilian support has been generally limited to Hawaii and Alaska.

Together, the public service and MAST helicopters add more than 120 additional aircraft available for patient transport. There is no accurate accounting of the number of fixed-wing air ambulance companies or airplanes. Although some hospitals do sponsor fixed-wing AMT, it is more common for these programs to be private fee-for-service operations.

**Types of Missions**

Air medical missions may involve primary or secondary response. Primary responses (“scene flights”) are responses in which the aircraft serves as the sole means of patient transport to a receiving facility. Aircraft involved in secondary responses—interfacility transport—move patients from outlying hospitals to facilities offering higher levels of care. AMT missions may also be classified according to the level of care provided. This may be critical care transport, specialty care transport, or advanced or basic life support.

**Air Medical Aircraft**

Although the ground ambulance remains the primary means of out-of-hospital and interfacility patient transport, the use of the air ambulance has grown significantly since the 1970s. No one aircraft is ideal for the needs of all air medical programs or patients.

**Helicopters (Rotor-Wing Aircraft)**

The helicopter offers several advantages over other transport vehicles. Traveling “as the crow flies” at speeds of 120 to 180 mph, helicopter transport time is often 75% less than that for an equivalent distance by ground. The service area of helicopter programs is generally up to 150 to 200 miles from its base of operations. Rotor-wing aircraft have the ability to avoid common traffic delays and ground obstacles and can fly into locations that may be inaccessible to other modes of travel. Helicopter landing zone requirements are a disadvantage compared with ground ambulances but offer an advantage over the airport requirements of airplanes.

Disadvantages to HEMS include noise, vibration, thermal variances, and other stresses on patients and crew exaggerated by rotor-wing flight. Weather considerations may significantly limit the availability of helicopter transport. In smaller aircraft, cramped spaces and weight limitations may limit the number of patients, transport personnel, or equipment that can be carried. This may sometimes compromise optimal patient care (Fig. 191-1).

Many helicopter programs permit flight only under visual flight rules. When the weather conditions (ceiling and visibility) fall below established program minimums, a program may decline to undertake a transport for safety reasons. However, an increasing
number of programs are equipping their helicopters and training their pilots for instrument flight rules (IFR) to allow safe travel in less favorable weather conditions. IFR flight may facilitate use of fixed locations, such as hospital helipads, but it does not facilitate travel to the scene of illness or injury.

Airplanes (Fixed-Wing Aircraft)

Although rotor-wing missions attract more media attention, fixed-wing flights constitute a significant portion of AMT operations. Fixed-wing aircraft provide increased range, greater speed, and often more patient, crew, and equipment capacity than do rotor-wing vehicles. The decreased cabin noise and turbulence creates fewer patient management problems, and pressurization combats the physiologic impact of altitude. Fixed-wing operations are limited to areas that have airports with runways of appropriate length or condition and refueling facilities. During fixed-wing transports, patient transfers require multiple vehicles to go from hospital to airport and back. Various fixed-wing aircraft are available for medical transport. These range from unpressurized light planes with single- or twin-piston engines to pressurized turboprops and jets. The selection of the ideal aircraft depends on the nature of the air medical mission.

Air Medical Flight Crew

Air medical crew members represent the broad spectrum of health care providers. AMT services that provide critical care transport, advanced life support, or specialty care transport must staff the vehicle with a minimum of two medical personnel to provide direct patient care. The majority of AMT programs in the United States provide critical care transport teams composed of one registered nurse and an additional crew member (paramedic, respiratory therapist, physician, or a second nurse); most common is the nurse-paramedic crew. AMT crew configuration may also be mission dependent. A service may at times believe that it is appropriate to use a single medical crew member. For example, it may be appropriate while transporting a stable patient on a routine interfacility transport. Certain flight conditions and situations may also necessitate flying with a single crew member, including heat, humidity, altitude, distance, fuel on board, and weight of the patient.

Flight nurses generally have extensive experience in intensive care units or emergency departments. They may be specialized within the transport team to care for adult, pediatric, or neonatal patients. Paramedics often make their greatest contribution in the transport of critical patients from the scene of illness or injury. Respiratory therapists bring expertise in airway and ventilator management and oxygen delivery systems. Flight physicians may be residents or attending physicians. Much of the early research in AMT crew composition focused on the need for the flight physician. Although this remains controversial, what seems clear is that the crew used by an AMT program must be explicitly tailored to the needs of the community and the patients it serves.

The AMT environment imposes unique considerations on the air medical flight crew that can influence their ability to provide patient care. Human factors work has shown that most medical care procedures are more difficult to perform in an AMT vehicle than in other ground-based settings. Auscultation of the heart and lungs, palpation of pulses, performance of cardiopulmonary resuscitation, endotracheal intubation, radio communications while using a respirator or face mask, and recognition of visual alarms may all be impaired while aloft. In addition, fatigue, motion sickness, exposure to engine exhausts, an erratic pattern of work activity, and the high risk involved in AMT operations may affect task performance significantly. Seizures from photic stimuli associated with rotor motion (“flicker illness”) has also been reported. High-fidelity simulation of air medical missions can acquaint flight crew to the novel environment, but fiscal and personnel costs may be prohibitive.

Medical Direction

All air medical services require the active involvement of a physician as medical director responsible for supervising, evaluating, and ensuring the quality of medical care provided by the AMT team. Emergency physicians play a significant role, with nearly 50% of all air medical directors having a background in emergency medicine. The medical director must have the final authority over all clinical aspects of the air medical service and should ensure that the flight crew have adequate training and qualifications to optimize patient care. Medical care policies and procedures should be established, including specific provisions for on-line and off-line medical control. The Air Medical Physician Association and the National Association of EMS Physicians have established guidelines for the medical director of an air medical service.

Safety

Safety is the predominant concern of air medical operations, and ensuring safe flight is a fundamental part of every flight program. Safety must also be an overriding consideration in weighing the risks and benefits of AMT. The role of aircraft pilots and mechanics is essential to the airworthiness of the vehicle, and medical personnel must also be proficient in both routine and emergency operations in and around the aircraft. Checklists may aid in safety practices but alone may not detect significant operational concerns. Crew fatigue and other self-imposed stresses that could affect safety, such as the use of prescription or over-the-counter medications, tobacco, and alcohol, must be scrupulously avoided. Weather requirements (“minimums”) must be strictly enforced. On receipt of a flight request, the pilot must verify the weather conditions and the condition of the aircraft. To ensure impartiality, the pilot should not be told of the patient’s condition or acuity. The pilot maintains the unquestioned right to decline a mission because of aircraft or weather considerations.

The practice of “helicopter shopping” has been a major factor in a number of fatal HEMS events. Helicopter shopping refers to
the practice of a requesting EMS agency or hospital calling numerous HEMS operators until one agrees to accept a flight without disclosure to the accepting HEMS operator that other programs have declined the flight because of bad weather or other safety concerns.31,32 The practice has been so common that in 2006, the Federal Aviation Administration issued a letter to all state EMS directors describing helicopter shopping and requesting that they take action to prohibit this practice.29

Landing Zones

Helicopter landing zones are inherently dangerous places. The most obvious risk of injury is impact with rotor blades. This danger is heightened during ground operations because the blades dip lowest to the ground at the slower rotor speeds associated with engine start-up and shutdown. Injuries also may occur as a result of debris being propelled through the air by “rotor wash,” increased engine start-up and shutdown. Injuries also may occur as a result of debris being propelled through the air by “rotor wash,” increased noise levels and an inability to hear warnings, and slippery surfaces found on exposed landing sites.

Many hospitals have designated landing areas that are appropriately lit and secured (Fig. 191-2), with fixed coordinates and predesignated liftoff and approach patterns. However, most primary (scene) responses occur at unmarked sites. Ground personnel must be trained to designate and secure a safe landing zone for helicopter operations. AMT programs have an obligation to help train ground staff on proper landing zone setup and conduct (Boxes 191-1 and 191-2).

Helicopter flights direct to the scene of an accident pose unique risks to AMT from hazards near the landing zone. This risk is heightened at night. In response to this concern, out-of-hospital care providers and flight programs have found it beneficial and safer to use a hospital helipad for rendezvous. This practice raised concerns about Emergency Medical Treatment and Active Labor Act (EMTALA) responsibilities to provide a medical screening examination for these patients. In May 2004, the Centers for Medicare and Medicaid Services resolved this issue, noting that the use of a helipad on hospital property does not trigger EMTALA provisions as long as the helipad is being used only as a stopping place for EMS personnel to rendezvous with AMT, facilitating transport of a patient to the closest appropriate facility.34

Other adjuncts to landing zone safety and night operations in general are night vision goggles and terrain avoidance warning systems. A growing number of AMT programs are equipping their aircraft with these sophisticated technologies in an effort to enhance safety.

Integration of Air Medical Transport within Emergency Medical Service Systems

AMT should be an integral resource within a comprehensive EMS system. Integration begins with the establishment of geographic service areas. Service areas may be determined on the basis of program mission description, aircraft range and speed, placement of specialty centers and receiving facilities, and population densities. As a general rule, helicopters are generally less useful in urban settings because of the proximity of health care facilities and a lack of open and safe landing zones. Paramedics, emergency medical technicians, and other public safety personnel should be provided with guidelines specifying when AMT should be considered. These protocols are best developed by EMS medical directors in close collaboration with their air medical colleagues.

CLINICAL CONCEPTS AND PATIENT CARE

Although virtually all types of patients have been transported by air medical services, available data do not allow prospective, definitive identification of which patients will benefit from flight. Many questions about the triage of patients to air or ground transport, the efficacy of air medical care, and the precise effects of AMT on morbidity and mortality in medical and surgical conditions remain unanswered. There are volumes of studies indicating what patients can be cared for in the air medical environment and what skills and equipment can be used, and there are also many studies
As demonstrated by a large 2011 study assessing nearly 75,000 secondary HEMS transports, interfacility air transport of the more seriously injured patient (but not those with lesser severity) is also associated with improved outcomes. Two studies also found improved outcomes with seriously injured patients transported by HEMS while also concluding that stable patients may be transported from outlying hospital to definitive care by ground with equal effect. Noting that HEMS represents the only modality by which nearly 28% of U.S. residents have timely (within 1 hour) access to level I or level II trauma centers emphasizes the vital role of AMT in care of the injured patient. Studies have also presented data that suggest lack of HEMS benefit for the trauma victim, but these studies represent a minority of works and are limited by confounding factors such as inclusion of transports to nontrauma centers. Whereas caution should be exercised in definitive statements about the criteria for and the value of AMT, and such statements can be interpreted only in light of the overall local environment in which the transport system exists, the clear message from the literature is that HEMS functions best as a part of a comprehensive trauma system and not as an isolated entity.

In terms of specific populations of patients, some studies suggest that most trauma victims transported by air have non-life-threatening injuries. Fortunately, the best large-scale population analysis, of more than 40,000 HEMS transports from the 2007 American College of Surgeons National Trauma Data Bank, clearly demonstrates that HEMS-transported patients are indeed of much higher acuity than ground-transported patients. For example, the median Injury Severity Score of HEMS patients exceeded the commonly used “severe injury” cutoff of 15; HEMS patients also had a 43% rate of intensive care unit admission. If we look more specifically within the trauma population, we find that data from Pennsylvania and California of head injury patients undergoing out-of-hospital intubation demonstrate HEMS-associated improvements in both morbidity and mortality. A 2009 study from Italy confirmed the association between HEMS transport and improved head injury outcome as assessed by either mortality or functional endpoints.

AMT is unlikely to improve outcome in those whose injuries are either trivial or grave. However, if the Injury Severity Score is collapsed into five ordinal categories, a significant association between helicopter transport and improved mortality is found in the middle three categories (survival odds ratios range from 2.1 to 2.6). Other work has also found that AMT shows benefit over ground transport only for those more seriously injured patients in both rural and urban environments. In all these cases, it remains uncertain if improvements in outcome are related to the provision of improved on-scene care or the integration of HEMS into a comprehensive trauma system as opposed to the air transport itself. Fortunately, even the acknowledged imprecision of triage to HEMS does not preclude “real-world” identification of AMT-associated trauma outcomes benefit. In a 2010 population-based study in Canada, patients were entered into the study if HEMS services were requested, and outcomes were compared between those who actually underwent AMT and those who went...
Box 191-3 Criteria for Air Medical Transport (AMT)

Distance to the closest appropriate facility is too great for safe and timely transport by ground ambulance. Patient’s clinical condition requires that the time spent in transport be as short as possible. Patient’s condition is time critical, requiring specific or timely treatment not available at the referring hospital. Potential for transport delay associated with ground transport is likely to worsen the patient’s clinical condition. Patient requires critical care life support during transport that was not available from the local ground ambulance service. Patient is located in an area inaccessible to regular ground traffic, impeding ambulance egress or access. Local ground units are not available for long-distance transport. Use of local ground transport services would leave the local area without adequate EMS coverage.

For interfacility medical transport, the requesting physician based on his/her best medical judgment and information available at that time of transport determined the need for AMT.

For scene medical transport, the requesting authorized out-of-hospital provider based on applicable policy, his/her best medical judgment and information available at that time of transport determined the need for AMT.

by ground because of the unavailability of HEMS. The study identified a benefit of HEMS, compared with ground transport, of 5.61 more lives saved per 100 transports.62

Cardiac Disorders

The ability to study HEMS-related outcomes benefit in acute coronary syndrome is limited by the lack of validated scores that can be used to stratify risk and to predict outcome. Works have noted that helicopter transport extends the geographic referral base of primary angioplasty centers and that outcomes of patients flown from a distance for definitive care equal outcomes of patients presenting primarily to the referral center.63 AMT systems have been shown to be able to safely transport complicated cardiovascular patients with conditions such as acute coronary syndrome, ST segment elevation myocardial infarction, and aortic aneurysm.64-67

Although HEMS could conceivably shorten door to percutaneous coronary intervention (PCI) time by transporting patients with ST segment elevation myocardial infarction rapidly from hospitals without PCI capability to a referral center, in many circumstances the patient will not have angioplasty of the infarct-related vessel performed within the recommended window and would be best served by receiving thrombolytic therapy at the initial hospital and then being transported in a less emergent fashion. AMT might therefore be better used for transport of critical cardiology patients who require emergent care, such as bypass surgery or balloon pump support, that is beyond the capability of the sending hospital.

Stroke

With the advent of time-critical therapy for ischemic stroke, HEMS has played an increasing role in the regionalization of acute neurologic care. Early studies demonstrating safety of transport of post-thrombolysis stroke patients have been complemented by case series illustrating the increasing use of helicopter interfacility transport for stroke.68,69 Case reports and series have demonstrated the utility of air medical dispatch for primary (scene) transport of patients with strong suspicion of stroke.70-72 In one region, ground EMS providers were able to identify stroke with accuracy, and helicopter-transported patients composed nearly 25% of the stroke center’s thrombolytic volume. The use of strict triage definitions kept inappropriate calls for AMT to acceptably low levels while allowing a significant extension of the geography served by an individual stroke center.71 Performance measurement programs can monitor the efficacy of the AMT service.72

Pregnancy

With appropriate triage, the speed of air transport of the high-risk pregnancy can counterbalance the risk of delivering an infant in an aircraft’s confined space.73,74 Case series demonstrate that high-risk obstetric patients transported by air from distant hospitals have outcomes as good as those of patients presenting primarily to an obstetric referral center.75-77 Common reasons for obstetric transport include preterm labor and premature rupture of membranes.76

Neonates and Children

The use of AMT to extend the geographic reach of neonatal care centers is reported from many settings.77-78 The most rigorous analysis suggests that long-distance AMT allows infants with medical complications born in remote areas to achieve outcomes equal to those of infants born in urban centers. Although neonates are vulnerable to physiologic deterioration, specialty team air transport is associated with no more derangement in oxygenation and ventilation than is transport by ground vehicle.77 As in the case of trauma, the question remains if the advantage of AMT is related to the use of air transport or specialty services brought to the patient’s side.

Many areas depend on AMT to deliver critically ill or injured children to regional pediatric centers. Although speed of transport may be an important consideration, as with neonates it seems the emphasis is often more on the transport team than on the mode of transport. Experienced pediatric transfer teams often bring a level of expertise unavailable to the pediatric patient in the outlying hospital and are noted to have fewer adverse events during transport than nonspecialty teams.79-81 Appropriate training, experience, and competency are essential for those responsible for transport.82 AMT has been shown to be safe for moving of even the most critical children requiring extracorporeal membrane oxygen support.83

Efficacy and Cost-Effectiveness

Cost-benefit is an area of increasing focus for AMT. The crux of the problem lies in the inability to precisely identify in a prospective manner which patients will truly benefit from fixed-wing or rotor-wing flight. As a result, in many cases there is little if any guidance regarding when air medical dispatch is indicated.84 With use of endorsed guidelines (such as those endorsed by the AMPA) for air medical dispatch, EMS regional authorities should collaborate to generate criteria best for their own systems, with constant refinement guided by rigorous use review.85 Despite this ideal, however, in practice the lack of firm indications and guidelines means that AMT often acts more as a “taxi service” responding to the needs of referring physicians, hospitals, and EMS services
PART VI ◆ Emergency Medical Services

Compared with the cost-benefit ratios of other medical interventions, AMT is well within the accepted range per quality-adjusted life-year saved.96-98 One Scandinavian study concluded that the benefits of ambulance missions flown by helicopters exceed the costs by a factor of almost six.89 Another group from the region estimated that HEMS contributes to the cost-effectiveness of primary PCI, and other investigators have demonstrated the favorable cost-effectiveness of helicopter stroke transports.30,91 However, these results cannot be taken as definitive statements on a global basis, as any cost-benefit calculation is applicable only within the health care environment of the system under study.92

Cost-effectiveness determinations are not straightforward. It is difficult to calculate true cost-effectiveness for transports that are not likely to occur (as with high-risk obstetrics cases at risk of precipitous delivery)73 or that would deliver patients outside critical time windows (as for stroke or cardiac transports) in the absence of AMT.93,94 Cost-efficiency is also difficult to demonstrate when there are no comparison options (such as transport from coastal islands or locations without road access) or when integrated ground and air transport systems have already become established in ways that effectively prohibit head-to-head comparisons of risks and outcomes (as is true in most of the United States). If we accept that HEMS represents the only mechanism by which more than 80 million U.S. citizens have timely access to mortality-improving high-level trauma center care, it is obvious that some form of air transport is a “must-have” for some EMS regions, and calculations of cost-efficiency fall away in favor of service provision.

Although transport by air is nearly always more expensive than that by ground, the costs of air medical flight should be viewed in contrast with the “real-life” alternative mode of transport. In many cases, and especially where time and distance are significant factors, the total fiscal and opportunity costs of AMT are arguably less expensive than the alternative.94 Unfortunately, the work of assessing the cost-effectiveness of AMT is complicated by the extremely limited amount of information on the cost-effectiveness of ground-based modes of transport.95 Experts assessing existing literature have concluded that although the available data do not enable rigorous meta-analysis, most investigations do demonstrate that appropriately used HEMS is cost-effective.

FUTURE OF AIR MEDICAL TRANSPORT

AMT works best and provides the most benefit to the patient when it is integral to and enhances an overall system of out-of-hospital care and interfacility transport and when systems are in place to educate requesting agencies and professionals about the appropriate use of available air and ground resources.

This work has noted that the major challenge within the AMT community is to determine not whether but rather in whom there is benefit to air medical flight. Currently, the major dilemma facing helicopter transport outcomes researchers is the identification of triage variables that can prospectively (i.e., at the time of transport vehicle selection) guide use of the air medical resource.84,85,96 It also seems that over time, advances in ground-based EMS and the availability of critical care ground ambulances for interfacility transports are beginning to offset many of the assumed benefits of AMT. Nonetheless, the regionalization of specialty services, development of new therapies that are highly time sensitive, and inflexible geography mean that there will always be a role for AMT in emergency care.

The references for this chapter can be found online by accessing the accompanying Expert Consult website.
References

8. Blumen IJ: HEMS Accident Analysis—The State of the Union. Presented at the Air Medical Transport Conference; St. Louis, Missouri; October 2011.


64. Youngquist ST, McIntosh SE, Swanson ER, Barton ED: Air ambulance transport times and advanced cardiac life support interventions during the interfacility transfer of patients with acute ST-segment elevation myocardial infarction. Prehosp Emerg Care 2010; 14:292.


