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INDICATIONS FOR AIR MEDICAL TRANSPORT: PRACTICAL APPLICATIONS

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INTRODUCTION

Modern air medical evacuation dates to World War II, when the United States successfully transported more than 1.3 million patients by fixed-wing aircraft over three years with an in-flight mortality rate of less than one in 30,000. Helicopters first found use in the Korean conflict and by the Vietnam War had become the mainstay of rapid transport to definitive surgical care.

The successful use of helicopter transport in military trauma was eventually extrapolated to the civilian world. The first civilian helicopter program was established by St. Anthony Hospital in Denver, Colorado, in 1972. Since then, helicopter and fixed-wing transport systems have proliferated. In recent years the air medical industry has experienced a period of significant helicopter expansion. At a presentation during the 2005 Air Medical Transport Conference, it was reported that there were over 600 dedicated medical helicopters in the United States. In addition, there were more than 100 dual-purpose helicopters performing patient transports. According to the Atlas and Database of Air Medical Services (ADAMS), there were 272 helicopter services, operating 753 helicopters from 614 bases. It was estimated that more than 300,000 patients are currently transported by helicopter annually in the U.S.[1] This suggests a total annual charge for helicopter air medical transport in excess of $1.5 billion. In addition, there are hundreds of dedicated and non-dedicated airplanes that conduct patient transport. Flightweb's Air Medical Transport Registry alone identifies nearly 200 fixed-wing programs.

As physicians, we approach the transport of a critically ill or injured patient from a variety of perspectives. First of all, we have an obligation to assure that the patient is taken to the most appropriate facility using the right mode of transport. We are also responsible for the safety of the patient and crew and therefore must determine if the risk of transport outweighs the benefits of transferring the patient using any transport mode. Finally, we are also fiscal stewards of the health care system and must not utilize costly resources where other less expensive alternatives are as effective.

The purpose of the current chapter is to review the appropriate indications for the use of air medical transport and to discuss retrospective utilization review criteria for scene and interfacility air medical transport of the critically ill or injured patient.

GENERAL CONSIDERATIONS

In the most general sense, air medical transport is indicated when the benefits provided by the personnel and equipment available during helicopter and fixed-wing transport are greater than the risks of the transport. Several factors must be considered in the transport decision, including the pathophysiology of the patient's illness; the training and experience level of the transport team; the urgency of definitive care; and the location of the aircraft, the transport team, and the referring and receiving facilities (Table 3-1). Time is obviously an important consideration, with the distance to be covered, the geography involved and local traffic conditions being important factors. Air transport is most beneficial over rough terrain, under heavy traffic conditions and over moderate to long distances. In addition, local and regional health care resources also play a significant role in the decision to use air transport.

Helicopter transport is most effective in travel distances between 15 to 100 miles of definitive care, whereas fixed-wing transport should be considered for transports greater than 100 miles. Under these circumstances, fixed-wing transports are typically faster and more economical than helicopter transport. It must be remembered that helicopter transport often provides direct site to site transport whereas fixed-wing transports require two additional transfers from the referring hospital to the airstrip and from the airstrip to the receiving hospital, in most cases.

In weighing the benefits of air medical transport, four factors must be considered (referred to as the "4 S's of air transport"): speed, smoothness, special skills (of crew) and access. The most important of these factors is speed. Thus, any patient with an illness or injury that is considered time-dependent is a candidate for air medical transport. On the other hand, patients who require critical care services during transport who do not have a time-dependent condition may be more appropriately transported by ground critical care services if these are

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General Considerations for the Method of Transport
1. Optimal scene time or interhospital transport time
2. Patient medical illness or injury
3. Distance (and time) of transport, including local geography and traffic conditions
4. Special skills possessed by the medical crew
5. Weather conditions
6 Cost

Table 3-1: General Considerations for the Method of Transport

available. We will discuss some of these time-critical considerations later in this chapter, but clearly patients with traumatic injury or acute coronary events are considered obvious candidates for air medical transport.

The smoothness of flight may also be a consideration, particularly for the patient who is transported great distances over rough terrain. Patients with spinal injury or severely hypothermic patients may benefit from air transport since rough ground transport conditions may worsen the patient's existing medical illness.

The special skills of the medical crew may also be an important consideration in selecting air medical transport. Critical care personnel may be necessary based on the underlying medical condition of the patient. Medical crew proficiency in airway management, critical care medications, and special skills such as ultrasonography[2,3] may directly benefit the patient. The availability of specialized transport teams including pediatric and neonatal providers, perinatal nurses, circulation technologists, physician specialists and respiratory therapists delivers tertiary services to the patient before arrival at the receiving facility. Air medical transport may be logistically appropriate when local providers are capable of delivering Basic Life Support only, or when the transport of a critical patient might leave a community without any emergency care resources.

Finally, there are rare occasions where air transport is the only method to access a patient for transport. In the urban environment, this may occur when traffic conditions preclude either response or egress from the location of a critically ill or injured patient. Similarly, certain rugged terrain or isolated island environments may not be conducive to ground access, making air transport the only practical option. Other patients in remote rural environments may be best transported using fixed-wing resources.

There are also conditions in which air medical transport is not indicated. Air transport should not be used in the patient who has a stable illness or injury and who is not felt to be at high risk for life-threatening problems during transfer. Such patients should be transported by ground ambulance, which offers a more cost-effective method of transfer and preserves limited air medical resources.

Weather is the other limiting consideration in determining the ability to transfer a patient using air transport. Each helicopter or fixed-wing program is bound by specific weather minimums that must be met before an aircraft can safely fly. It is the duty of the pilot to assess the prevailing weather conditions prior to flight. This decision must be completely objective and made in the absence of any clinical information, thus removing any emotional factors from the decision-making process.

One final concern should be the safety of the flight crew and patient during transport. Each air medical transport carries an inherent safety risk that must be considered before launching a mission. This issue will be addressed in greater detail later in this handbook. Specific concerns regarding any patient safety issues such as combativeness resulting from a medical or traumatic condition must be addressed prior to transport.

The actual decision to utilize air medical transport can be made based on a few simple questions that can be applied to any patient transport (Figure 3-1). The first consideration is whether the distance and time from definitive care are likely to result in net time-savings for the patient in transport. This requires the specific decision-maker to understand the location of the responding aircraft, the distance to definitive care and the road conditions for travel (traffic congestion, speed limits, construction, etc.). If there is a potential for saving time, air transport may be considered. Diaz et al. analyzed almost 9,000 ground and air 911-dispatched transports.[4] The authors found that air medical transport had a faster arrival to the receiving hospital when simultaneously dispatched with ground for transports more than 10 miles and earlier arrival when dispatched after ground transport when the distance from the scene was more than 45 miles.

The next question to consider is whether the patient does indeed have a time-critical illness. Any patient who has the potential for an emergent intervention or procedure should be a candidate for air transport. Examples of such urgent interventions include surgery, cardiac catheterization, electrophysiologic intervention, hemodialysis, cardiopulmonary bypass, balloon pump insertion, hyperbaric oxygen treatment and newborn delivery, to name a few.

A related consideration is whether, in the judgement of the referring physician, minimizing the patient's out of hospital time might have an impact on the patient's clinical outcome. Unstable patients requiring care in an intensive care setting are appropriate for air transport even if an immediate intervention is not planned. Trauma victims with fluctuating intracranial pressures

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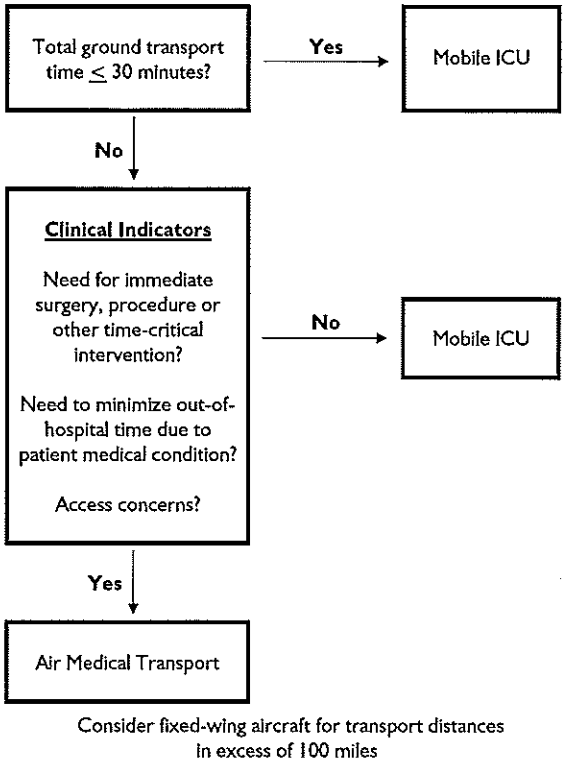

Figure 3-1: Medical Decision-Making in Air Medical Transport

or septic medical patients are examples of this consideration.

Finally, other factors such as special skills of the medical crew and logistical issues such as access and local resources must be addressed in the transport decision.

A similar decision process used to select air transport may be applied in a retrospective manner to each transport to determine appropriate utilization. In this way, the service medical director can identify trends in over-utilization of air transport, address specific problem areas and thus fulfill our obligation to be the stewards of valuable health care resources.

SPECIFIC MEDICAL CONDITIONS

TRAUMA

Air medical transport has its roots in the care of injured patients during wartime and no clinical condition has been as well studied as the impact of air transport on trauma mortality. Many methods have been used to approach this issue, but the most rigorous studies employ TRISS methodology.[5] In this method, trauma patients are stratified according to their Trauma Score, Injury Severity Score, mechanism of injury and age. The study population is measured against a large trauma cohort called the Major Trauma Outcome Study (MTOS). Using this methodology, one determines if the study population has characteristics that resemble to MTOS cohort (M statistic). A reasonable closeness of fit is suggested by an $M \geq 0.88$. The comparison of the study group mortality against the MTOS cohort is defined by the Z statistic. Finally, the W statistic expresses the number of unexpected lives saved per 100 patients.

Baxt and Moody,[6] using the TRISS methodology, were the first to demonstrate an improvement in trauma mortality in patients transported by specially trained crews in a helicopter from the trauma scene, when compared to ground transport. The same study was repeated evaluating seven independent air medical transport services operating in several regions of the country and staffed with differing crew configurations.[7] In each case, a survival benefit was shown by air transport from the scene, although the magnitude of the benefit varied among the programs. An overall improvement in mortality of 21% was demonstrated by air transport. Since that time, several other studies have used similar methodology to demonstrate that air medical transport improves survival when compared to ground transport.[8-12] It should be noted that these studies have demonstrated a benefit to air medical transport in suburban and rural settings; the use of direct air response in urban settings has yielded mixed results,[13-15] particularly with penetrating trauma.[16] Finally, the demonstrated benefit of air transport not only applies to direct scene transports but also interfacility transports of trauma patients.[17,18] The American College of Surgeons has developed algorithms delineating the need for transport to a Trauma Center for both scene (Figure 3-2) and interhospital (Figure 3-3) requests. Where speed is critical or special crew skills are required, air transport is indicated.

The reason for the improvement in survival seems to be related to both the advanced skills provided by the transporting crew and the speed of transport provided by helicopter. Few studies have been able to clearly address which of these factors appears to be more significant.[12,19] Cameron et al.,[19] for example, showed that there was no significant difference in expected outcomes in trauma patients transported by helicopter where special skills such as intubation were not routinely employed in the treatment of patients with major head trauma. This study identified speed as the most important factor in improving survival. On the other hand, Celli and Cervoni[20] demonstrated a profound decrease in mortality when comparing air to ground transport (20% versus 54%) in patients with severe head injury, primarily due to the higher intubation rate among air-transported

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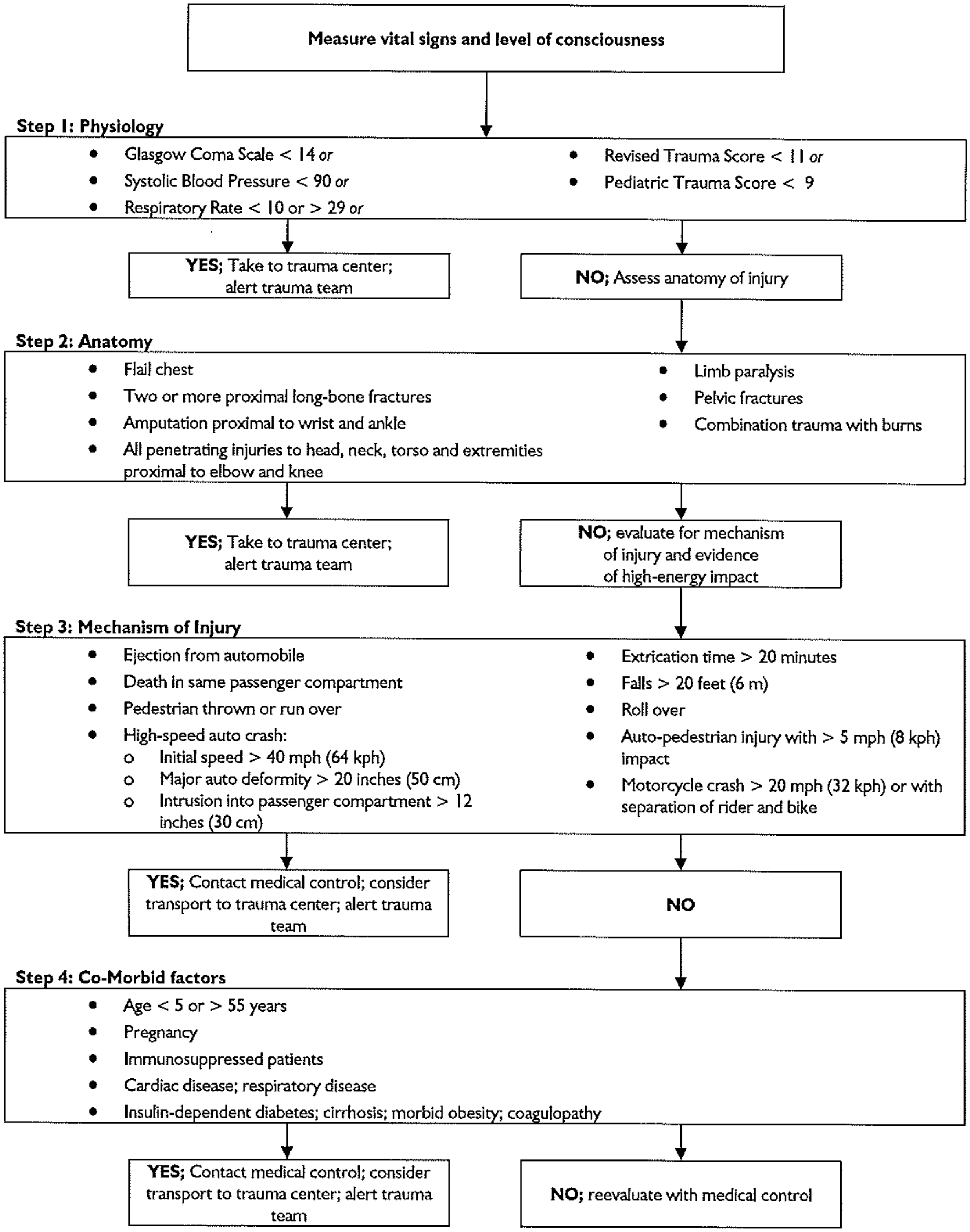

Figure 3-2: Scene Triage Criteria

Central Nervous System
• Head injury
  o Penetrating injury or depressed skull fracture
  o Open injury with or without cerebrospinal fluid leak
  o Glasgow Coma Score (GCS) < 14 or GCS deterioration
  o Lateralizing signs
• Spinal cord injury

Chest • Wide mediastinum or signs suggesting great vessel injury • Major chest wall injury or pulmonary contusion • Cardiac injury • Patients who may require prolonged ventilation
Pelvis/Abdomen • Unstable pelvic ring disruption • Pelvic ring disruption with shock and evidence of continuing hemorrhage • Open pelvic injury
Extremity • Severe open fractures • Traumatic amputation with potential for replantation • Complex articular fractures • Major crush injury • Ischemia
Multi-system Injury • Head injury with face, chest, abdominal or pelvic injury • Injury to more than two body regions • Major burns or burns with associated injuries • Multiple, proximal long bone fractures
Co-Morbid Factors • Age > 55 years • Children • Cardiac or respiratory disease • Insulin-dependent diabetics, morbid obesity • Pregnancy • Immunosuppression
Secondary Deterioration (Late Sequelae) • Mechanical ventilation required • Sepsis • Single or multiple organ system failure (deterioration in central nervous, cardiac, pulmonary, hepatic, renal, or coagulation systems) • Major tissue necrosis

Figure 3-3: Interhospital Triage Criteria (Adopted with permission, ACS Committee on Trauma: Resources for Optimal Care of the Injured Patient, 1997.)

patients (80% versus 10%). Biewener et al.[21] have recently challenged this concept by demonstrating similar outcomes in patients transported by air or ground to a Trauma Center. These authors concluded that it was the timeliness and level of service that was the major factor in patient outcome.

Brathwaite et al.[22] examined a statewide trauma registry and found a documented advantage for air transport in three subsets of patients: ISS 16 to 30, ISS 31 to 45 and ISS 46 to 60. This makes intuitive sense since air transport is unlikely to provide benefit to patients with only minor injuries (ISS < 16) and equally unlikely to provide benefit to the most severely injured patients who are unlikely to survive their critical injuries. This latter group may be more difficult to define at the time of presentation.

Thomas et al.[23] used regression analysis to review the outcomes of 16,699 patients transported to Level I adult and pediatric trauma centers. Although the crude mortality for air transport was 3.4 times that of ground transport, there was a significant reduction in mortality among those transported by air (odds ratio 0.76; 95%, CI, 0.59-0.98, $p = 0031$).

Specifically focusing on moderate to severe traumatic brain injury, Davis et al.[24] found the patients transported by air medical transport had an improvement in adjusted mortality (odds ration 1.90; 95% confidence interval 1.60 to 2.55; $p < 0.0001$) and good outcome (odds ratio 1.36; 95% confidence interval 1.18 to 1.58; $p < 0.0001$). Successful out-of-hospital intubation by air medical crews was thought to be a major factor in improved outcomes.

The use of regional or statewide trauma criteria based on the suggested triage guidelines outlined by the ACS (Figure 3-2) should help reduce over-triage of trauma patients. These findings have been confirmed by Cunningham,[25] Jacobs,[12] and Thomas.[23]

It has been shown that patients in trauma arrest have a poor prognosis[26] and specifically that air transport provides no clinical benefit to these patients.[27,28] Thus, air transport should rarely be considered for trauma patients already in cardiac arrest. These patients should be transported urgently to a local facility or pronounced on scene based on input from on-line medical direction as well as local protocol. One possible exception is the use of air transport for patients with gunshot wounds to the head when potential organ donation is a consideration.[29]

Similarly, data on the use of air transport in the urban environment[30] suggests that helicopters should be used only where a distinct time savings can be identified. Schiller et al.[31] found a mortality of 18% in patients transported by air compared to 13% mortality in a similar group transported by ground in their urban study. In their recent review in an urban setting, Shatney et al.[32] found that the helicopter saved time in only 14.8% of 947 transports and was beneficial in at most 22.8% of cases. Cocanour et al.[33] found that air medical crews provided additional skills in only 4.9% of 122 victims of penetrating trauma and that air transport actually prolonged arrival at hospital time in their metropolitan setting. Further cost versus benefit analysis studies should identify those subsets of urban trauma victims who might potentially benefit from air transport.

On the other hand, Slater et al.[34] compared the use of air transport for transport of burn victims. While those patients transported by air medical transport were more severely burned, the authors noted that many patients flown did not have evidence of inhalation injury or high-severity burns. These represent two patient populations that would potentially benefit from air transport. Saffle et al.[35] specifically studied over-triage in air transport of burn patients. They found that only 60% of patients met published criteria for air medical evacuation. They proposed a role for telemedicine in determining appropriate use of air medical services in this population.

One final point about the use of air medical transport in trauma patients is that helicopters are not only life-saving but they may be cost-effective (Table 3-2). Gearhart et al.[36] demonstrated that per year of life saved, air transport is far more economical than many interventions that represent common standards of practice in this country. Additionally, to supply a comparably equipped and staffed ground ambulance over long distances may be less cost-effective than air medical transport.[37]

Emergency Intervention	Discounted Cost per Year of Life ($)
Prehospital Defibrillation	820
Air Medical Transport for trauma	2,454
Prehospital Paramedic System	8,886
Neonatal ICU for infants 500-999 gms	18,000
Median for 310 medical interventions	19,000
Three-vessel CABG for severe angina	23,000
t-PA therapy for acute MI	32,678
Prophylactic AZT after needlestick injury	41,000

Table 3-2: Cost-effectiveness comparison of emergency medical interventions. (Adopted from Gearhart PA, Wuerz R, Localio AR: Cost-effectiveness analysis of helicopter EMS for trauma patients. Ann Emerg Med 30:500-506, 1997).

CARDIAC DISEASE

In recent years, the treatment of acute coronary syndromes has undergone significant revision. The emphasis of care has turned from post-event interventions to addressing emergent revascularization of the patient with acute coronary syndromes. When early revascularization is achieved, the result is improvement in residual left ventricular function and reduction in mortality. Recent studies have begun to demonstrate the superiority of mechanical revascularization over thrombolytic agents.[38] Percutaneous intervention (PCI) is most beneficial when undertaken by experienced providers in an active catheterization lab with cardiothoracic surgical support. However, the intervention must be accomplished within 60 minutes from the potential administration of fibrinolytic agents.[39] Several European studies have demonstrated that long distance transfer of patients for PCI shows benefit over locally administered fibrinolytic agents.[40,41] This appears not only to be true for patients with acute ST-elevation myocardial infarction, but is also emerging as the therapy of choice in patients with unstable angina.[42]

Air medical services are an obvious consideration where there is a need for rapid transport of a critically ill patient to specialized centers capable of providing emergency cardiac interventional services. Several studies[43-46] in the late 1980's were the first to demonstrate that patients with acute myocardial infarction (AMI) could be safely transported via helicopter to tertiary care centers. These authors were able to demonstrate that complication rates were low in this population. Straumann et al.[47] specifically addressed the issue of safe transport of patients with AMI being transported for primary PTCA. They showed that air transport of such patients could be done safely even in unstable patients, thus extending their "coverage area" for primary angioplasty. Finally, two additional studies demonstrated that patients who required cardiac pacing could be safely transported in the air medical environment.[48,49]

Others have disputed whether air transport poses an increased risk in patients with acute coronary syndromes. Tyson et al.[50] suggested that air medical transport may pose a potential risk to patients with AMI and unstable angina as the result of substantially elevated catecholamines during air transport. These findings tended to be supported by Schneider et al.,[51] who found a significant increase in serious untoward events (new arrhythmia, worsening chest pain, hypotension, bradycardia, cardiac arrest, respiratory arrest or seizure) in cardiac patients transported by air when compared to ground transport. A higher complication rate was not confirmed by Jaynes et al.,[52] who demonstrated no significant difference in adverse events when directly comparing ground and air transport. Fromm et al.[53] specifically focused on bleeding complications in patients receiving thrombolytic agents and found no increase in these complications.

Only a few studies have attempted to directly compare the outcomes for air and ground transport of acute cardiac patients. Some of these studies have been limited by small sample size, poorly matched controls and lack of a large database, such as MTOS, in which risk stratification can be easily linked to outcomes. Stone et al.[54] found an increased total mortality for cardiac patients transported by air and no significant improvement in ICU length of stay, total length of stay and 72 hour mortality. Berns et al.[55] showed an improvement in time of delivery, chest pain upon delivery and total hospital stay for air transported patients but no demonstrable improvement in mortality. More recently, however, Grines et al.[56] showed that high-risk patients with acute myocardial infarction who were air transported for PTCA had a reduced length of stay (6.1 vs 7.5 days), less ischemia (12.7% vs. 31.8%) and fewer complications (8.4% vs. 13.6%) than patients who were transferred to a tertiary center following intravenous thrombolytic agents. These findings were noted despite a difference in symptom onset to intervention difference of nearly two hours.

Clearly, more studies are needed to define the role of air medical transport in acute management of acute coronary syndromes. The parameters under which helicopter transport of patients with an acute myocardial infarction for angioplasty have also been elaborated.[57] Intuitively, it makes sense that the ability to provide rapid transport to a tertiary center with invasive catheterization capabilities will become a central tenet in management of acute cardiac disease, especially as a central role for early mechanical revascularization unfolds.

CARDIOPULMONARY ARREST

Air medical transport would be a reasonable option to provide highly trained personnel to patients in cardiac arrest. This would be particularly so in areas where only basic life support personnel are available to provide care.

Lindbeck et al.[58] reviewed the experience of their air medical program in responding directly to the scene in cardiac arrest. Of the 84 patients studied, only 10 (11.9%) survived to hospital admission. Efforts at resuscitation were terminated on scene in 55 cases. Only one patient survived to hospital discharge and this patient had been successfully resuscitated at the scene prior to the arrival of the helicopter. Johnson and Falcone[59] reviewed their ten-year experience with scene responses for medical cardiac arrest. These authors concluded that there was not sufficient success to justify air medical response to the scene and that these transports were not cost-effective.

Werman et al.[60] have studied inter-hospital transport of 170 patients following adult cardiac arrest by helicopter over a 4 year period. Patients with primary cardiac disease had a much greater likelihood of ultimate survival when compared to non-cardiac causes of cardiopulmonary arrest. In fact, 45% of patients with primary cardiac arrest survived to hospital discharge. There was no cost-benefit analysis performed, but the study suggests that inter-hospital transport of cardiac arrest survivors may be justified, particularly in patients with primary cardiac arrest. Further study is needed to define the benefits of transport in patients with non-cardiac causes of arrest, including drowning, medical illness, suffocation, electrocution and smoke inhalation.

Thus, it appears that direct scene response for patients in cardiac arrest is not supported by the medical literature. Patients who have been successfully resuscitated and have been stabilized in a local health care setting appear to benefit by transport to a tertiary care setting, particularly those with primary cardiac disease. Further study is needed in this area to define the role of air medical response to the scene of a successful resuscitation and for inter-hospital transport of patients with non-cardiac causes of arrest. Also, the role of air medical transport in support of areas served by only BLS providers may merit further study.

NEUROLOGIC

The treatment of patients with acute cerebrovascular events has also undergone revolutionary changes in the past few years, with the finding that early thrombolysis improves outcomes.[61] Specialized centers have developed that are capable of providing early thrombolysis given intravenously within the first 3 hours of symptom onset or intra-arterially within six hours of onset under the direct supervision of specially trained neurologists and interventional radiologists. The time-dependent nature of this condition makes consideration of air medical transport obvious.

There have been few studies investigating the role and benefit of air transport in this setting. Chalela et al.[62] showed that air medical transport could safely transport patients who had received or were receiving thrombolytic agents for acute stroke. Conroy et al.[63] further demonstrated that helicopter transport had an important role in transporting candidates for acute neurologic intervention. Only 3% of patients were excluded because of time considerations. However, 48% of patient did not receive thrombolytic therapy because of other exclusions. Both Silliman et al.[64] and Thomas et al.[65] have described their experience using air medical transport in interhospital and scene response to stroke victims. Silbergleit et al.[66] determined that it costs about $3700 per quality-adjusted life-year for air medical transport to a tertiary stroke center and concluded that this was a cost-effective intervention. The National Association of EMS Physicians and Air Medical Physician Association have developed position papers supporting the use of air transport in acute cerebrovascular disease.[67]

Clearly, more study in this area is needed, but it appears that air medical transport has a potential role in acute stroke. The costs and benefits of providing air transport services to these patients need further analysis.

OBSTETRIC

High-risk obstetrical patients often require care in specialized settings. Additionally, such patients typically require careful monitoring during transport and often have a time-dependent condition. Patients in active labor should experience limited out-of-hospital time. Only a few studies have evaluated the use of air transport in this population. Elliott et al.[68] described their experience in transporting high-risk obstetrical patients using a specialized crew and compared outcomes to a cohort of non-transported patients. The authors noted that there were no maternal deaths among the 100 patients transported and 14 neonatal deaths. These results were comparable to the non-transport group. The study authors supported the potential use of air medical transport in this population.

Low et al.[69] conducted a national survey of air medical programs in 1985 to determine the experience in perinatal transport. The authors reported no incidence of precipitous delivery in flight; seven transports were aborted for rapid progression of labor. The authors concluded that perinatal transport of high-risk pregnancies with delivery in a tertiary care center is cost-effective and that air medical transport plays a significant role in this system.

Recently, Van Hook et al.[70] reported on their one-year experience in the transport of 22 high-risk pregnancies. They had no deliveries or significant complications among this population. The authors were unable to find any significant differences among those patients who delivered after transport and those whose contractions abated. The authors supported a role for air transport in a regional perinatal care system.

These studies support the safety of air medical transport in high-risk obstetrical patients. However, further studies comparing outcomes between air and ground transported patients and a cost-benefit analysis are needed.

OTHER CONDITIONS

The use of air transport in other time-dependent medical illnesses has been studied in only a few other settings. Kent et al.[71] described the safety of air transport in patients with abdominal aortic aneurysm. In particular, the transport of patients directly to the operating suite was touted by the authors. There is a paucity of data addressing the role of air transport in the treatment of aortic vascular disease, vascular occlusive disease and other surgical emergencies, despite the widespread use of air transport in these conditions.

Hypothermic patients are occasionally transported by air medical services. A review of 17 patients transported for treatment of hypothermia showed no adverse consequences resulting from helicopter transport.[72]

Air transport has allowed the delivery of specially trained neonatal nurses and appropriate medical equipment from the tertiary care center to the community setting. Pieper et al.[73] described their experience using rotary and fixed-wing transport to provide specialized care to 52 neonates. These authors found a lower mortality rate among air transported patients when compared to ground transported patients. This study supported the delivery of specialized neonatal services to the newborn in improving outcome. Berge et al.[74] described their 14-year experience in transporting critical neonates in central Norway. They were able to provide neonatal specialty services to a wide variety of neonatal problems.

Since the major benefit of air medical transport is the rapid provision of specialized care to the bedside, Werman and Neely[75] described the use of air medical transport as a method of delivery with ground transport being used to transport the stabilized infant and team to the tertiary center.

Interestingly, there have been few studies to evaluate the use of air medical transport in transporting critically-ill pediatric patients. In this setting, the specialized training of air medical crews in this area may provide additional benefit over ground crews that are less comfortable with this population.

Finally, the use of air medical transport in support of disaster efforts[76] and as part of search and rescue operations[77,78] has only recently been addressed.

FUTURE DIRECTIONS

There is a significant body of literature that supports the benefit and cost-effectiveness of using air medical transport in trauma. There is some support for the use of air transport in pediatric trauma. Future studies must help us define more specifically the patients who truly benefit from air transport by eliminating those patients who are either so mildly injured or severely injured that the mode of transport or skills of the crew do not provide significant benefit.

Similarly, there is some support for the use of air transport in acute cardiac and neurologic conditions in providing timely care to these patients. Determining the cost-effectiveness of air transport in these conditions

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and finding methods to define the appropriate populations need further study.

There continues to exist gaps in our understanding of the role of air transport in other conditions in which time-savings and special skills may have an impact on outcome. Obviously, this area is wide open for further study. At this time, we must continue to rely on discussions among the referring and receiving physician along with the air medical service program director to determine the appropriateness of air transport for a variety of medical and surgical conditions.

UTILIZATION REVIEW

While it is true that many patients appear to benefit from air medical transport, over-utilization of air transport services continues to have both economic and safety consequences. Consider victims of trauma in which studies have clearly shown a survival advantage using air transport. Moront et al.[79] demonstrated that air medical transport of pediatric patients resulted in 11 lives saved per every 1,000 patient transports. This study also showed, however, that 86% of patients were over-triaged to helicopter transport. Others studies have concluded that there is a high rate of over-triage for air medical transport, particularly among pediatric patients.[80] Similarly, Hotvedt et al.[81] found that 76% of medical and surgical patients transported gained no benefit from air transport since they received no specialized intervention during or immediately after transport. In trauma patients, reliance on strict local or regional trauma triage criteria based on those developed by the American College of Surgeons (Figure 3-2) will help to minimize over-triage.

Each air medical program has the responsibility to conduct an analysis of the appropriate utilization of air transport. Transports should be scrutinized to evaluate appropriate indications for use of air medical transport by the local and regional health care providers. It should be noted that some degree of over-utilization of air transport is inevitable; currently, however, there is no universally accepted standard for over-utilization.

The Commission on Accreditation of Medical Transport Systems (CAMTS) has proposed screening criteria that can be used to determine inappropriate use of air medical transport (Table 3-3). All transports should be screened against these criteria. Any transports that fall out must be carefully reviewed by the program medical director. An alternative approach is to review each transport against the broad medical indications provided by the Air Medical Physician Association (see Figure 3-4). Many programs require written verification by the referring physician of the medical necessity of air transport based on the patient's underlying medical or surgical condition. This documentation can be invaluable in the retrospective review of such transports.

- Patients discharged home directly from the Emergency Department or discharged within 24 hours of admission
- Patients transported without an IV line or oxygen
- Patients who had CPR in progress at the referring location
- Patients who are not transferred from a critical care unit
- "Scheduled transports"
- Patients who are air transported more than once for the same illness or injury within 24 hours
- Patients transported from the scene of injury with a trauma score of 15 or greater or which fails to meet area-specific triage criteria for a critically injured patient
- Patients treated at the scene but not transported
- Interfacility transports in which the receiving facility is not a higher level of care than the referring facility
- Patients flown initially by fixed-wing and transported from the airport to the receiving facility by helicopter
- Patients transported from the scene of injury to any hospital which was not the closest appropriate and available trauma center
- Patients ground transported with red lights and sirens
- Patients who are not transported by an appropriate aircraft (FW or RW) or appropriately trained team
- Patients flown by airplane where the ambulance that met the aircraft to continue transport did not have the level of care, equipment and supplies appropriate to the patient's specific needs

Table 3-3: CAMTS Utilization Review Criteria

Remedies for problems identified by this approach can include individual counseling, outreach education, medical screening, and policy and protocol revision.

SUMMARY

The air medical transport industry has grown significantly in the past several years. With this growth comes pressure to utilize air transport for both scene and interhospital responses. Air medical transport can be justified when the speed of the aircraft, the special skills of the crew or the smoothness of flight is thought to benefit the patient. In addition, helicopters and airplanes may be utilized under conditions of limited access. Adverse weather and safety concerns may preclude the use of air medical transport even when clinically indicated. There is strong evidence that air medical transport is both clinically useful and cost effective when used in patients with significant traumatic injuries. A growing body of evidence supports the use of air transport in selected cardiac and acute stroke patients. Many other patients may benefit due to the time critical nature of their illness, the need to minimize out-of-hospital time and the special skills of the crew. The medical direc-

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Surgical	• Acute surgical emergencies requiring urgent/time-sensitive interventions not available at the sending facility • Acute vascular emergencies requiring urgent/time-sensitive interventions not available at sending facilities • Transplantation patients (fixed-wing vs. helicopter) • Potentially life- or limb-threatening trauma requiring treatment at a trauma center, including penetrating eye injuries • EMS regional or state-approved protocol identifies need for on-scene air transport
Burns	• Burns requiring treatment in a burn treatment center
Medical	• Critically ill patients with compromised hemodynamic/respiratory function who require intensive care during transport and whose time of transfer between critical care units must be minimized during transport • Patients requiring care in a specialty center not available at the sending facility • Patients with electrolyte disturbances and toxic exposure requiring immediate life-saving intervention
Cardiac	• Acute cardiac emergencies requiring emergent/time-sensitive intervention not available at sending facility
Neurologic	• Acute neurological emergencies requiring emergent/time-sensitive interventions not available at the sending facility
Neonatal/Pediatric	• Critically ill neonatal/pediatric patients with potentially compromised hemodynamic/respiratory function, a metabolic acidosis greater than 2 hours post delivery, sepsis, or meningitis
Obstetric	• Critically ill obstetric patients who require intensive care during transport and whose time of transfer between facilities must be minimized to prevent patient/fetal morbidity
Other	• Conditions requiring treatment in a hyperbaric oxygen unit • EMTALA physician-certified interfacility transfer (not a patient request)

Figure 3-4: Medical Condition List and Appropriate Use of Air Medical Transport (AMPA Board of Directors: Medical condition list and appropriate use of air medical trawwnsport. Air Med J 22:1-9, 2003)

tor is responsible for developing an active utilization review process to assure appropriate use of air medical resources.

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