Critical Component of Modern Healthcare Systems: Air Medical Services

A Public Policy Paper by the MedEvac Foundation International
Executive Summary

Struck down by a sudden, lethal illness or injury, patients require immediate access to specific critical care specialty services, the highest level of medical care available in modern healthcare. If immediate access is not possible, because of circumstance and/or geography, then patients experience a sequence of rapid and increasingly sophisticated interventions and transportation by emergency medical services (EMS) until the appropriate level of critical care is reached. This sequential response of healthcare systems to time-dependent emergencies often results in delayed access to these critical-care services when they are needed most. Now, imagine introducing a component to radically change that response time, improve efficiency, integrate and improve access for millions of U.S. citizens to critical care and specialty care services, while reducing healthcare system costs. This critical component is air medical services (AMS) and, particularly, helicopter emergency medical services (HEMS).

Helicopter Emergency Medical Services (HEMS) speed, optimize and integrate the critical care received by patients from the start of their emergency through treatment at the specialty hospital. With HEMS, the processes of diagnosis, decision-making, transportation, emergency stabilization, and critical care are no longer sequential, but occur simultaneously—faster and more effectively. High-quality critical care becomes available through HEMS closer to the point of injury or onset of illness and HEMS makes the highest quality, specialty-center based, critical care accessible to more Americans.

Until comparatively recently in our history, patients stricken by a sudden, catastrophic illness or injury were at great risk of dying. But in the past half century, with the advent of systems of care including modern emergency departments, emergency medical services, and the specialization of emergency medicine, trauma surgery, and other care, this risk has been lowered dramatically. Interventional cardiology, radiology, neonatology, pediatrics and other evolving specialties and sub-specialties now offer critical-care services to further improve the chances of recovery from a medical emergency.

It was once common for critical-care units and services to be found in community general hospitals in towns large and small. But over the past two decades, as further specialization has occurred and the need for certain patient volumes to assure sufficient quality of those services has been established, it has become clear that this deployment is not sustainable at every hospital. Now, critical care services and specialists have largely disappeared from rural America. These services and practitioners are typically sustainable only in urban and suburban centers. This reality has created a disparity between rural and urban settings for patients who require critical-care services for their time-dependent conditions.

In cities and suburbs, those in need of critical care undergo a relatively fast-paced matching of needs to resources—an abundance of resources which are physically close at hand. From the moment of major injury or onset of emergency illness through the sequential steps of EMS encounter, emergency department triage and care, and then specialty intervention and critical care—the urban healthcare system responds in minutes.

By contrast, the rural healthcare system, without specialty critical care resources, can only react by beginning a sequential process of trying to determine the resources needed, arranging to get the patient to those resources, and keeping the patient alive long enough to reach them. In rural areas with only ground ambulances available, remoteness delays system alerting and response. An ambulance brings the patient to a local hospital for initial care. The local hospital staff performs basic diagnostics and initial stabilization, but they are unable to administer the time-dependent specialty care needed. These facilities then must arrange for the patient to be transferred to a specialty care center. Transfer resources are mustered, the patient is eventually transferred long distances by ground ambulance, and the patient arrives at a specialty center where critical care is finally provided (but often too late to make a difference)—the rural healthcare system responds in hours.

The challenge for AMS is to reduce the impact of this urban/rural disparity and it has proven to be a game-changer in this regard. Air medical services are now a resource that bridges geographic barriers to bring patients to specialty critical care with minimal delay. At the same time, they bring critical care intervention to patients in the field and in smaller hospitals. As an essential component of the healthcare system, AMS rallies critical care resources in a new time frame.
of minutes instead of hours, replacing sequential steps with parallel actions. This organizing effect of AMS, and especially HEMS, extends to every specialty critical service targeting time-dependent, life-threatening conditions. These include trauma, heart attack and other cardio-respiratory emergency, stroke, pediatric and neonatal emergency, high-risk obstetrics, and burn specialty systems of critical care. Air medical services allow all patients, regardless of location, to benefit from these systems of care which are anchored in urban areas in order to operate with high volume, high quality, and at lower cost when compared to the older model of attempting to duplicate such services in all communities.

While air medical transport may appear to be expensive on a single-case basis compared with ground ambulance transport, examining the benefits behind the cost—particularly on a system-wide basis—shows that it is very cost-effective. This is especially true when compared to the cost of building new rural specialty care or general healthcare facilities and/or expanding ground ambulance capabilities throughout rural America to meet the need for time-dependent patient care, other emergency readiness, and long-distance transports. Air medical services may also provide access to care when ground ambulance services are not as rapidly available or have no access to an emergency scene. The ability of AMS to service the needs of many communities over wide geographic areas has allowed for significant cost savings by reducing the need for multiple additional ground ambulances to transport patients over the geographic area that one helicopter can service.

In many developing and redeveloping countries, air medical services have become routine considerations in healthcare system strategic planning for new hospital construction. The Czech Republic, for example, after emerging from 25 years of communist rule, chose to rebuild its health system by investing in larger, centralized critical-care hospitals, closing outdated facilities, and building the HEMS system to link its population to these centers. This same healthcare strategy has been repeated in Japan, Hungary, Poland, and in many developing countries. Air medical services have become an integral component of the modern healthcare system. Approximately one out of every 1,000 people in the U.S. require AMS each year. Air medical critical care transport reduces morbidity, improves overall healthcare system efficiency, and saves lives. More importantly, it helps critical care patients regain productivity—reducing the likelihood that a critical care patient will suffer long-term disability as a result of injury or illness. Air medicine does so by getting the patient to the right specialty critical care to determine what the patient needs to optimize recovery.

Improvements in planning, operational coordination between competing regional healthcare systems, complex reimbursement, and regulatory planning are contemporary issues that have repeatedly caused AMS providers to adapt to a changing landscape. Also, safety of AMS is a continual concern. The picture of a helicopter at the scene of a car crash evokes not only HEMS’ life-saving ability, but also the chaotic environment in which these services operate and the potential risks of that environment. Yet, air medical patient care and transportation may actually promise less risk to the patient than does a patient’s ground ambulance ride or hospital stay. MedEvac Foundation International and the Association of Air Medical Services (AAMS) are dedicated to achieving resolution of these contemporary issues, making AMS safe and sustainable so that healthcare systems and patients can benefit.

This paper describes the historical development and contemporary practice of air medicine. It is intended to serve as a resource framework for policy makers and regulatory agencies charged with assuring the provision of high quality air medical services to the public.
In 1926, the United States Army Air Corps used a converted airplane to transport patients from Nicaragua to an Army hospital in Panama, 150 miles away. The routine interhospital military use of airplanes dates to World War II, as does the first air evacuation of U.S. soldiers from the site of injury, which occurred in what was then Burma.

The routine medical evacuation mission of helicopters, however, evolved during the Korean conflict in the 1950s. Because roadways in the fighting front of Korea were often rough and indirect, they could not be relied upon for the rapid and gentle evacuation of troops to the field surgical units. Instead, helicopters on other missions would be rerouted to pick up the critically wounded and fly them quickly and smoothly, often in time to benefit from life- or limb-saving surgical care. Seasoned military physicians in “MASH” (Mobile Army Surgical Hospital) units took note, and soldiers that would have died in World War II were now surviving similar injuries.

The Army, seeing this advantage over ground transportation, rapidly began testing dedicated medical helicopters. During the course of the war, over 22,000 troops were evacuated by helicopter. The focus was on rapid, stable evacuation, as the capability of the aircraft did not allow for in-flight care. It is felt that systems of care involving rapid, smooth field evacuation and the specialized skills offered by surgeons seeing hundreds of patients earlier at the field hospitals contributed to a reduced mortality rate for wounded, hospitalized soldiers, compared with previous wars.

The Vietnam conflict brought further sophistication to the same general concept: fast and smooth air evacuation of the critically injured to field surgery for stabilization. The aircraft changed, as did medical capabilities. Field emergency care, in-flight medical care, and rapid evacuation for over 800,000 troops reduced the war-long mortality rate even further. Military surgeons again took note and brought these concepts back to the United States after the war.

…the landmark National Academy of Science white paper Accidental Death and Disability: The Neglected Disease of Modern Society underscored the profound impact of death and disability caused by injury, particularly in car crashes, and was the impetus that led to trauma systems that were serviced by AMS.

**War time experience leads to improved survivability**

<table>
<thead>
<tr>
<th>War</th>
<th>Deaths per 100 Injured</th>
</tr>
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<tbody>
<tr>
<td>Revolutionary War (1776)</td>
<td>75</td>
</tr>
<tr>
<td>US Civil War (1861)</td>
<td>50 (First system of care)</td>
</tr>
<tr>
<td>World War I (1917)</td>
<td>8.5</td>
</tr>
<tr>
<td>World War II (1941)</td>
<td>4.5</td>
</tr>
<tr>
<td>Korea War (1950)</td>
<td>2.5</td>
</tr>
<tr>
<td>Vietnam War (1964)</td>
<td>&lt;1 (58,000 deaths)</td>
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<tr>
<td>Persian Gulf War (1990)</td>
<td>&lt;0.5</td>
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</tbody>
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**Figure 1 (Source: U.S. Army Military History Institute)**
A theme from WWI through Vietnam began to repeat: stabilize the critically wounded soldier in the field, provide advanced care enroute, and get the patient to a trauma-qualified surgeon in less than an hour, and the extent and impact of injury, including the likelihood of death, can be reduced.\textsuperscript{11}

In 1966, the landmark National Academy of Science white paper Accidental Death and Disability: The Neglected Disease of Modern Society underscored the profound impact of death and disability caused by injury, particularly car crashes.\textsuperscript{12} It also detailed a lack of coordinated response to injury, including the observation that “Helicopter ambulances have not been adapted to civilian peacetime needs.” Simply put, there was no system of trauma care in the U.S. and people were dying unnecessarily because of a lack of timely care.

The National Academy of Science white paper contributed substantially to the development of the modern EMS system and its trauma subsystem and, together with the EMS Systems Act of 1973, was a precursor to significantly increased funding of EMS, trauma, and AMS. Its impact was compounded by the influence of returning military units, and military medical helicopter pilots discharged to law enforcement and other public safety flying roles. These led to the dual-purpose adaptation of military and public safety helicopters to the evacuation of injured civilians, such as the Military Assistance to Safety & Traffic (MAST) program, established in 1970, and the Maryland State Police aviation program which, in 1970, became “the first civilian agency to transport a critically injured trauma patient by helicopter.”\textsuperscript{13}

These early systems would have been the model for all states to deploy these services if hospitals had not begun to adopt this role and develop AMS. The first civilian hospital-based medical helicopter service was established in 1972 at St. Anthony’s Hospital in Denver, Colorado. Nationwide, many hospitals developed these services in conjunction with the implementation of organized trauma systems. This reduced the incentive for state and local governments, as well as the military, to further develop AMS. Today, governmental and other publicly governed AMS is limited to a few states and a few municipalities within the U.S.

By 1980, eight years later, some 32 helicopter emergency medical services (HEMS) with 39 helicopters were flying more than 17,000 patients a year. By 1990, this grew to 174 services with 231 helicopters flying nearly 160,000 patients. Ten years later, 231 helicopter services with 400 aircraft were flying over 203,000 patients each year.\textsuperscript{7} By 2005, 272 services operating 753 rotor-wing (helicopter) and 150 dedicated fixed wing (airplane) aircraft were in operation.\textsuperscript{14} At that point, there were approximately a half-million helicopter and fixed wing transports each year.\textsuperscript{12} In 2010, the Atlas & Database of Air Medical Services, (ADAMS) database of the Association of Air Medical Services reported 309 services operating 900 helicopters and 311 airplanes.\textsuperscript{15}

\begin{table}[h]
\centering
\caption{2005–2010 Summary of Helicopter Assets by State}
\begin{tabular}{|l|c|c|}
\hline
\textbf{State} & \textbf{\# Helicopters} & \\
\hline
\textbf{2005} & \textbf{2010} & \\
\hline
\textbf{AL} & 9 & 14 \\
\textbf{AK} & 32 & 41 \\
\textbf{AZ} & 50 & 61 \\
\textbf{AR} & 12 & 13 \\
\textbf{CA} & 72 & 95 \\
\textbf{CO} & 10 & 14 \\
\textbf{CT} & 2 & 2 \\
\textbf{DC} & 3 & 4 \\
\textbf{DE} & 5 & 6 \\
\textbf{FL} & 44 & 42 \\
\textbf{GA} & 19 & 21 \\
\textbf{HI} & 6 & 3 \\
\textbf{ID} & 10 & 9 \\
\textbf{IL} & 19 & 24 \\
\textbf{IN} & 15 & 19 \\
\textbf{IA} & 9 & 9 \\
\textbf{KS} & 10 & 12 \\
\textbf{KY} & 20 & 27 \\
\textbf{LA} & 9 & 11 \\
\textbf{ME} & 2 & 2 \\
\textbf{MD} & 18 & 18 \\
\textbf{MA} & 4 & 4 \\
\textbf{MI} & 12 & 12 \\
\textbf{MN} & 12 & 16 \\
\textbf{MS} & 3 & 9 \\
\textbf{MO} & 30 & 30 \\
\textbf{MT} & 4 & 5 \\
\textbf{NE} & 7 & 6 \\
\textbf{NV} & 6 & 7 \\
\textbf{NH} & 2 & 2 \\
\textbf{NJ} & 3 & 8 \\
\textbf{NM} & 10 & 11 \\
\textbf{NY} & 28 & 34 \\
\textbf{NC} & 13 & 18 \\
\textbf{ND} & 2 & 3 \\
\textbf{OH} & 28 & 36 \\
\textbf{OK} & 14 & 19 \\
\textbf{OR} & 4 & 7 \\
\textbf{PA} & 32 & 50 \\
\textbf{RI} & 0 & 0 \\
\textbf{SC} & 8 & 9 \\
\textbf{SD} & 4 & 4 \\
\textbf{TN} & 24 & 28 \\
\textbf{TX} & 61 & 73 \\
\textbf{UT} & 8 & 8 \\
\textbf{VT} & 0 & 0 \\
\textbf{VA} & 21 & 20 \\
\textbf{WA} & 10 & 12 \\
\textbf{WV} & 5 & 9 \\
\textbf{WI} & 12 & 12 \\
\textbf{WY} & 1 & 1 \\
\hline
\textbf{TOTALS} & \textbf{753} & \textbf{900} \\
\end{tabular}
\end{table}

\textit{from Atlas & Database of Air Ambulance Services (ADAMS), October 2010.}
The comparability of “service” or “program” numbers over time may suffer from a changing definition of what those are. Consolidation and hybridization of operations have significantly reduced the number of single-base services/programs. Some consolidated providers now have over 100 bases established.

Historically, the typical helicopter EMS service has been operated by or affiliated with a hospital with one or two aircraft. In the past decade, many of these services have become independent, community-based resources with hospital affiliations or have outsourced or hybridized their AMS operations such that the hospitals are no longer program owners.

The need to quickly bring critically injured patients to trauma care within “the Golden Hour” brought AMS (mainly medical helicopters) into existence with experience from trauma air medical evacuation at the battlefront. From its inception in 1972, civilian era AMS experienced a doubling growth of both programs and helicopters every five years or so through the 1980s as programs were initiated around the country by hospitals that were also becoming trauma centers.

The 1990s marked a slower but steady, 10–20% growth of programs and 30–50% increase in helicopters in each half of the decade. As cited below, advances and centralization in critical cardiac and other specialty care services, and recognition that time-dependent care principles extended beyond trauma care increased the need for AMS. Advanced diagnostic procedures and clot-busting (“thrombolytic”) drug administration for heart attacks and strokes, and cardiac surgery (“percutaneous coronary intervention” or “PCI”) for heart attacks had been shown to improve patient outcomes. So too, had timely critical-care interventions for burns, pediatric and neonatal emergencies, and traumatic brain injury. In addition, the concept of the full-service community general hospital in rural areas was increasingly challenged. As specialists and specialty care fled to more urban centers, many rural hospitals converted to limited service critical access hospitals (CAHs) or closed because of financial pressures. This created large geographical gaps in the availability of specialized critical-care resources and more need for AMS. Unfortunately, these rural areas are also the battlefront of the most serious car crashes, where 60% of the fatal crashes in the U.S.
occur, a rate nearly twice that of suburban or urban areas.\textsuperscript{16} Once again, AMS providers were increasingly called upon to close the geographic gaps between rural “battlefront” and definitive care intervention in centers with sufficiently high patient volumes to ensure quality and efficiency.

The rapid growth of AMS during the past 10 years reflects spreading recognition of its value in a variety of time-dependent care applications. Not only can AMS bridge this geographic gap by rapidly bringing patients to definitive critical care, it also brings many aspects of critical care to the patient in the field or small rural hospital. It can encourage many of the diagnostic, operational and clinical decision-making, intervention, and resource-summoning steps to occur in parallel, rather than in the traditional sequential process. In this way, it speeds up, intensifies, and optimizes a healthcare system response to a patient’s need for immediate critical care. Being able to respond and transport much more rapidly than ground services, and to bring critical care to the scene or smaller hospital, also causes changes in overall system planning. Relationships between facilities, EMS system protocols, transport procedures, and emergency department (ED) medical processes in smaller hospitals have changed as a result, making the response more efficient and less costly. But in time-dependent interventional care, the availability and use of AMS demands that the healthcare system organize all the components of its critical-care response to best take advantage of AMS.

Another element of the past decade’s rapid growth began with the Medicare and Medicaid provisions of the federal Balanced Budget Act of 1997 which called for a new ambulance fee schedule beginning in 2000.\textsuperscript{17} The fee schedule which emerged from the resulting negotiated rule-making process between the Centers for Medicare and Medicaid Services (“CMS”) and EMS stakeholders provided a more dependable, and in some cases a more favorable reimbursement plan for AMS for the subset of their patients covered under Medicare and Medicaid. This change meant that some hospital-based AMS services were challenged to reaffirm their financial commitment to directly providing AMS. It also provided incentive for some non-hospital based AMS providers who, in many cases, took over areas from hospitals that closed their AMS programs for financial reasons or who established bases on the outskirts of a traditional program response area.
Research in the early 1970s reinforced the conviction held by wartime physicians that, for critically injured patients, surgical intervention in the first hour after injury reduced death and disability. This “Golden Hour” standard has survived, with minor variation, to the present day. As cited below for AMS’ specific missions, recent research has demonstrated that a “Golden” time period exists for people suffering heart attacks and strokes as well. To one degree or another, this same consideration affects any illness or injury that will kill or maim if inadequately treated in a relatively short period of time.

While healthcare systems in general seek to bring all patients together with the care they need, it is the specific role of the EMS system to do this when the time available is critically short and the negative consequences of delay are potentially great. In other words, EMS is the front end of a healthcare system’s critical-care response.

The essential steps/components include:

**Rapid discovery of the critically ill or injured patient and notification of EMS and specialty responders.**

Rapid response requires timely notification that help is needed. Improvements in telephone and cellular phone 9-1-1 systems have enabled faster, more effective responses to the correct location of the emergency. These capabilities allow planners to establish protocols and systems to simultaneously alert the EMS and specialty responders (e.g., AMS, vehicle extrication, special rescue) and shave additional time off the response of resources likely to be needed. Unfortunately, these critical systems are still not in place everywhere.

New communications devices and services, if deployed universally, can dramatically reduce the time required to “discover” that a life-threatening emergency has occurred. Some examples of this include: in-home and wearable patient monitors; “next generation” 9-1-1 capabilities for text/photo/video communications coming into 9-1-1 emergency centers; and advanced automatic crash notification (CAN) devices in cars, which in the future, will be able to predict and report the likelihood and severity of an injury having occurred.

**Fast response of first responder and ambulance Basic Life Support (BLS) EMS.**

To grow more sophisticated in its patient care, following the guidance of *Accidental Death and Disability*, EMS had to learn to “do no harm” as a first priority in trauma care. Rough handling and insufficient stabilization of breathing, bleeding, spinal injuries, broken bones, and internal injuries can kill or further maim an injured patient. Through the 1970s and 1980s, EMS developed a basic life support (BLS) training standard and capability. This was intended not only to “do no harm,” but also to provide basic stabilizing care such as techniques to minimize the loss of blood, help breathing, immobilize the spine, and splint bones. Emergency medical responders (EMRs) and emergency medical technicians (EMTs) are the primary BLS providers. The EMRs are often fire or law enforcement personnel who arrive at the scene before the ambulance and provide BLS until the ambulance arrives. The
EMT standard is generally accepted as the minimum level of crew level preparation for staffing an ambulance.

**Timely availability of Advanced Life Support (ALS) resources.**

As BLS services began to mature, an advanced life support (ALS) training standard and level of care (provided primarily by “paramedics” and by “intermediate” or “advanced” EMTs) developed in urban and suburban areas that could afford it. This was largely aimed at medical emergencies that could potentially be reversed in the field such as cardiac or respiratory arrest, diabetic crises, and allergic reactions. However, ALS providers could also stabilize injured patients in much the same way military medics did. Examples of ALS care for a trauma patient include replacing lost blood with fluid run into a vein or bone, placing a breathing tube in a compromised airway, and re-inflating a collapsed lung. Many ambulances are routinely staffed by ALS personnel, while in other areas advanced staff will be called when needed to rendezvous with a BLS crew at the scene of an emergency or enroute to the hospital.

**Rapid access to emergency physician level intervention generally found at the closest emergency department.**

ALS care provided by field EMS crews affords many of the interventions found in a hospital emergency department (ED). In many cases, however, physician-level diagnostic and treatment capabilities are required to definitively identify and reverse the life or disability threatening emergency condition. These may be provided in a system of care led by an emergency medicine physician and aided by a team including mid-level practitioners, emergency nurses, radiology and lab personnel, respiratory therapists and others. Because they are often minimally staffed by a single emergency provider, nurse, and a technician, a rural emergency department’s resources can be overwhelmed by a single patient in a time-dependent situation.

**Rapid stabilization and transport to trauma, cardiac, stroke, pediatric or other specialty emergency care centers.**

In some emergencies, the EMS crew can determine, under physician voice direction or by destination protocol, that the patient may require specialty care not found at the closest hospital. If they are able to stabilize the patient adequately for transport to that specialty center, they may bypass the closest hospitals to do so.

In other cases, the nature of the condition may be less clear, or the patient needs stabilizing care that the ambulance crew cannot provide, and transport to the closest ED is required. Subsequently, it may be determined that specialty center care is required, or the patient’s condition may worsen after admission, necessitating transfer to a specialty facility. The system of identifying the right resource, for the right patient, at the right point in the patient’s care is only as accurate as the sophistication of the personnel, equipment and facilities available. When this sophistication is less developed, as with a new EMS volunteer or a critical access hospital ED facility in frontier or rural America, the system necessarily must err in assuming a high need for critical-
care intervention to make sure that patients with such real need are not missed. This can result in bringing patients together with levels of critical care that they did not ultimately require. As the nation’s healthcare systems continue to evolve, the need to move medically unstable, high-acuity, critically ill and injured patients has dramatically increased.

In the past, intensive care unit/ED staff members in some areas of the country were used for the ambulance trip to support these patients with ventilators, multiple infusion medications, invasive cardiac, pulmonary, and neurological monitoring. These crews often were not trained to work in the out-of-hospital environment and available equipment was not designed for use in transport. Each transport became an exercise in “adapt and overcome.” This is not optimal for patient care and increases liability for all. As CMS requirements for the quality of inter-facility transport service have increased, and as more local hospitals have become limited-service CAHs, or otherwise succumb to financial pressures, their ability to provide adequately prepared personnel to go with the ambulance to a distant specialty center decreases.

High level of care through Critical Care Transport (CCT)

As the nation’s healthcare system continues to change, the need to move medically unstable, high-acuity, critically ill and injured patients has dramatically increased. Specially-trained ICU staff is required to support these patients with ventilators, multiple infusion medications, and invasive medical cardiac, pulmonary, and neurological monitoring. Short transfers are provided using specially-equipped ground ambulances known as critical care transport (CCT) ground ambulances. Longer distance inter-hospital transfers rely on dedicated and specially equipped helicopters and fixed wing aircraft.

Effective EMS system planning, coordination, regulation, and quality assessment.

The response described above requires a complex choreography of training, resources, accurate information, communication, medical and logistical decision-making, professional judgment, and regional expertise. The resulting chain of care captures the patients who are really in need and limits resources as appropriate to those in lesser need. To be effective, the response must be guided by a system that ensures all participants have a common set of expectations about those resources, communications, and bases for decision-making. This consistency is provided by medical and operational leaders on the local, regional, state, and national levels through direct oversight and written protocols, agreements, plans, regulations and laws consistent with national and international standards of care. Such oversight is dynamic, and the processes designed to provide that oversight are assessed in an on-going, systematic fashion to continuously improve accuracy, speed, and efficacy. These systems must also have the ability to adapt to extraordinary circumstances such as disasters, pandemics, and acts of terrorism as well as unpredictable circumstances that arise on a daily basis.
In effectively implementing the above elements, the EMS system works within its overall healthcare system to match patient and required care in the “Golden” time frame at the front end of the critical-care response. In turn, EMS depends on its AMS in this response when there are barriers to the accomplishment of one or more of those elements. Air medical services have four major means of accomplishing what other healthcare and EMS system resources cannot. Inherent in at least two of these is an added ability to appropriately determine the ultimate level of critical-care system response based on a high level of expertise not otherwise available in the emergency healthcare system.

1. **Improved Access to Patients Over Dramatically Larger Geographic Areas**

Patients isolated from ground EMS or hospitals by distance, lack of ambulance-passable roads and/or by terrain features such as mountains, canyons, forests, and islands, benefit greatly from air medical service. Helicopter EMS is also a powerful tool in urban/suburban road congestion over sometimes short distances, though its primary advantage is in covering longer distance and greater geographic areas at lower costs than ground EMS.1, 2, 19, 20

A greater number of communities, particularly those in rural areas, are finding themselves cut-off from access to emergency care because of recent changes in the healthcare delivery systems in this country:

- The number of rural community hospitals has dropped from over 2,500 in 1988 to under 2,000 in 2008.21
- During approximately the same period, emergency departments in community hospitals have declined in number from over 5,100 to approximately 4,600.21
- The number of the most sophisticated trauma centers has also declined in the same time period.
- Specialty care and specialists are increasingly housed in urban centers and are less available in non-urban settings.
- Overcrowding of hospital emergency departments and the lack of critical care and specialty beds often causes hospitals to divert EMS patients.21

As a result, AMS, and especially HEMS, has become the healthcare safety net and access point for ED and critical-care services for many non-urban individuals and communities. In some rural and frontier areas, HEMS is the only basic or advanced life support EMS care and transport available, and in others it may simply provide a faster response than ground emergency medical responders.
2. Rapid Access to Definitive Treatment at Specialty Care Centers

Study evidence over time has strengthened the case for early intervention at specialty centers in serious trauma, cardiac, stroke, as well as other emergencies discussed below. Other studies demonstrate the ability of AMS to enable access to these system of care centers for increasing percentages of the American populace within the “Golden” time parameters required. For instance, one recent study cited AMS’ ability to expand the availability of pediatric trauma center care within the “Golden Hour” to 38% more of the population than that which ground ambulances could achieve. Another study states similar findings for critical stroke care.

Helicopter air ambulances are typically used for the transport of patients from the scene of an injury directly to a hospital, and for flights between smaller hospitals and trauma centers or specialty hospitals (e.g., burn or cardiac centers). Fixed wing air ambulances (airplanes) are used for transporting patients on longer inter-hospital flights and, in rare cases, in rural areas for flights from an emergency scene.

Air medical transport is beneficial not only because it provides a higher level of medical care and decision-making to the patient en-route, but also because it provides a speedier response of this level of care to determine what critical-care system response is required. When treating the critically ill or injured, it is usually important to minimize the time that patients are out of a hospital and away from a physician’s direct care. Helicopters fly point-to-point, minimizing the time out of hospital, and avoiding the traffic delays experienced by ground ambulances while bringing physician level care to the patient. Fixed wing air ambulances can cover much more distance in less time than a ground ambulance. The air ambulance can also provide a smoother ride, where less than optimal road conditions result in discomfort for some patients, a significant consideration in the spinal injured patient.

3. Earlier Availability of Key Treatment Equipment and Supply Resources

Air medical services are increasingly used to address other acute local medical care needs as well. The delivery of blood and blood products, specialized drugs, or specialized life-support equipment to outlying hospitals is one example, while bringing emergency medical personnel to a small hospital (staffed perhaps by one physician and nurse) or major incident site to assist local medical personnel with multiple patients is another. Suddenly doubling or tripling the physician-level care and critical-care intervention capabilities in a rural hospital with the landing of a helicopter outside can make the difference between life or death inside.
4. Earlier Availability of Physician-Level Diagnostic, Decision-Making and Treatment Capabilities

Transferring patients from smaller to larger hospitals to access more sophisticated and specialized healthcare system resources has been a common and increasing practice over the past 40 years, particularly as regional and statewide systems of specialty care have become more organized. In addition, transporting patients from the scene of an emergency directly to a specialty center, bypassing a local hospital, has been clearly shown to benefit many life-threatened patients. However, the ground EMS crew making that transport may require physician-level assistance to manage a difficult airway or other complication and cannot bypass the local hospital as a result. System protocols generally dictate that the ambulance divert to the local hospital in these instances, creating delay in reaching definitive specialty care.

The medical crews aboard air ambulances provide significantly more sophisticated skills and equipment than are found on most ALS ground ambulances, eliminating the need for intermediate stops at a local hospital for interventions. These crews bring the additional skills, expertise, medications and equipment common to large, urban critical-care facilities whenever they respond to a community hospital, to the scene of an injury or accident, or to a pre-planned ground ambulance rendezvous point. Critical care for difficult breathing and cardiac complications, blood and blood products, specialized drugs, and more sophisticated patient monitoring tools make medical helicopters closely resemble a flying emergency department, trauma, and critical-care unit. They are not simply an air-borne version of the typical BLS or ALS level ground ambulance. This higher level of care is especially important in rural areas that may have few or no ALS ground ambulances to call upon.

The current configuration for the medical crew on-board AMS in the United States is most typically a specially trained critical care or emergency nurse and paramedic. In some cases, the crew is cross-trained as both paramedic and nurse. Many have received specialty board certification as a certified flight registered nurse and/or as a certified flight paramedic. Other AMS specialist caregivers include respiratory therapists, cardiac bypass perfusionists, and neonatal intensive care nurses. In the past, flight physicians acted as the second crew member in several programs. Some continue to do so, mostly at academic institutions with emergency residency training programs.

Because AMS providers generally only respond to calls involving the most critically ill and injured patients, these caregivers become critical-care specialists like those in trauma and other specialty centers. This is in contrast to ground ambulance providers who respond to a variety of call types, a minority of which are high acuity. Because of this high level of expertise, the potential exists for AMS response to result in a decrease in the level of critical-care resources required by an individual patient who is assessed as stable. This has an associated reduction in cost (compared to the alternative where every patient receives a full system response). The benefits of air transport have been demonstrated to outweigh any stressors that flying might add, even for the sickest trauma and heart attack patients. 39, 42, 48-65
While most people picture a medical helicopter landing at a car crash to help a victim, air medical services have increasingly taken on a variety of new missions in the last decade. In fact, most air medical transports today are hospital to hospital; approximately one-third are scene responses; and the remainder are other types (e.g., organ procurement and specialty/neonatal/pediatric team transport).

Figure 3 shows the breakdown of flights by type for multiple AMS providers utilizing a common information service over a period of nine years in 25 states.

Most scene responses are for injuries. Injuries also result in inter-facility trauma transfers, but inter-facility flights are often for critical illnesses, such as heart attacks or strokes requiring surgical procedures (including invasive cardiac treatment such as catheterization and interventional neuroradiologic procedures). They also include acute respiratory problems requiring prolonged intensive care, sepsis, spinal cord problems, burns, specialty pediatric and neonatal illnesses and complications, limb reattachment, organ transplants, and complications in high-risk pregnancy. These inter-facility missions are showing patient outcome improvements as well.31,38-40,52,53,55,64,66-68 The ability to focus these specialty healthcare resources into fewer highly committed specialty hospitals using AMS provides a volume base which assures expertise and reduces the cost of redundant, low volume, services in a specific geographic area.

**AMS’ First Mission: Trauma**

With the early “Golden Hour” research, the 1966 NAS white paper *Accidental Death and Disability: The Neglected Disease of Modern Society*, and the fresh experience of military medical helicopter success in this arena, it is understandable that civilian HEMS found trauma to be the predominant mission in its early years.12

The white paper led to government funding for the development of a sophisticated EMS system, specialty emergency departments, and regional trauma facilities.12 In parallel, the National Highway Safety Act of 1966 was passed, funding the development of the Department of Transportation to facilitate EMS and trauma system development.69 The EMS Systems Act of 1973, as well as private funding from the

### Types of Medical Care Applications in EMS

- **BLS** Basic Life Support
  - Medical service provided by personnel trained to be Emergency Medical Technicians (EMTs).

- **ALS** Advanced Life Support
  - Medical service provided by personnel trained to be Paramedics.

- **SCT** or CCT Specialty Care Transport or Critical Care Transport
  - Medical service provided by personnel trained to conduct procedures normally beyond the scope of a paramedic.

- **FW** Fixed Wing Air Ambulance
  - Medical care provided in an airplane because the closest appropriate medical facilities are either inaccessible, difficult to reach, or located a great distance away by land vehicle.

- **RW** Rotor Wing Air Ambulance
  - Medical care provided at the ALS or Specialty Care level in a helicopter because the closest appropriate medical facilities are either inaccessible, difficult to reach, or located a great distance away by land vehicle.

### Transports by Nature

![Figure 3](image-url)
Robert Wood Johnson Foundation and other sources, created a federal lead agency in the Department of Health Education and Welfare, and funded nationwide system and pilot project development for the next decade. The evolution of air medical services enhanced this EMS system and trauma subsystem development.70

It has been well demonstrated that organized trauma systems with trauma centers save live.23-26 The Maryland statewide trauma system has served as a sustainable example, and many call upon other systems to emulate it.66,71 In the early 1980s, the first analytical attempts to determine the life-saving impact of HEMS scene response demonstrated significant reductions in mortality compared with ground systems.48-50,72

Since the 1980s, many published medical studies have attempted, through a variety of means, to assess HEMS’ impact on trauma mortality and morbidity. Overall, these studies have demonstrated the power of HEMS to affect improvements in trauma-related mortality and morbidity showing reductions in hospital days and days in ICU, and better hospital discharge dispositions.40-42,44,46,66,67,73 These success markers indicate that HEMS reduces the overall cost of trauma to society and improves the likelihood that HEMS-transported trauma patients will rapidly return to being productive members of society. This is particularly important since many trauma patients are young and have years of productive contribution to society remaining.

As a part of an organized trauma system, HEMS cuts the injury-to-operating-room time significantly. Medical helicopters, dispatched simultaneously with ground EMS, allow over 54% of the U.S. population access to a full-service trauma center within 60 minutes—timely access they would not have without HEMS.74-76 With such access afforded to this population comes the attendant reductions of morbidity, mortality, and costs to society.

Medical helicopters also discourage time-costly, (and sometimes expensive), intermediate stops at small, non-trauma center hospitals. Such stops have been shown to be detrimental to trauma patients, even where HEMS is called from that hospital for the final leg of the trip.77,78 These local hospitals are often not prepared to manage the evaluation of a trauma patient. The diagnostic procedures they do perform often may need to be repeated because of inferior quality or because the resulting studies may not be available to be transported with the patient.

In the future, improvements in cell phone and automatic crash notification technology in cars may cut the time required to discover and report a crash injury to almost zero. Using objective “urgency” indicators generated by automatic crash notification data sent from crashed cars to dispatch centers, along with having special medical protocols in place for assessing the probability of severe injury or death from the crash, will soon provide a rational and effective way for helicopters to be launched within minutes of an accident, thereby further improving the speed and appropriateness of EMS/AMS response to patients.79
Examples of recent HEMS study findings demonstrate that:

- Patients severely injured enough to require inter-facility transfer were four times more likely to die after the HEMS serving that area was discontinued.  
- HEMS reduced injury mortality by 24% in a multi-center study with some 16,000 patients in Boston.
- Even injury patients in urban areas experienced a transport-time benefit by HEMS in 23% of the cases.
- Despite generally dismal results of prehospital intubation of trauma patients by EMS, intubation by HEMS staff contributes positively to patient care and outcome with success rates that approach that of well-prepared anesthesia patients in the operating room.

HEMS is generally effective in trauma care circumstances when:

- There is an extended time period required to access a patient or extricate an entrapped patient.
- The patient needs medical care and stabilization at the ALS level, and there is no ALS-level ground ambulance service available within a reasonable time frame.
- Distance, traffic conditions or hospital availability make it unlikely that the patient will get to a trauma center via ground ambulance within the ideal time frame for best clinical outcome.
- There are multiple patients who will overwhelm resources at a closest trauma center(s).
- There is a mass casualty incident.

In rural and frontier areas, HEMS and fixed wing aircraft play a particularly important role:

- When the nearest ground ambulance is farther, by travel-time, from the scene of injury than the nearest HEMS. In this setting, the air medical service may be the primary responding ambulance.
- When blood supplies, or availability of other medical supplies/equipment are limited or non-existent, jeopardizing the care of the patient, the air medical service can bring these resources to the hospital.
- When the air medical service can also be used to transport specialized medical staff to assist with a local mass casualty event or to augment the rural/frontier hospital’s staff in stabilizing patients needing special care before transport.

Traumatic Brain Injury (TBI) is the leading cause of death and disability in both children and adults in their most productive years. As with any major injury, treatment of TBI is time-critical and a significant reason AMS is used.
Mission: Heart Attacks

A heart attack occurs when an artery in the heart is blocked by a clot, and the heart muscle supplied by that artery is therefore deprived of oxygen. This causes chest pain, and the heart muscle is in jeopardy of dying. Untreated, these blockages can permanently damage the heart, causing death or an otherwise reduced quality of life.

As with critical injuries, there is a window of time (generally thought to be two hours from symptom onset) in which the heart may be effectively treated before it, and the patient, die or are disabled. At any time in this window, the compromised heart may stop, beat abnormally (making it ineffective as a pump), cause congestive heart failure, or otherwise require emergency treatment to keep the patient alive. HEMS medical teams have proven effective in diagnosing and dealing with these emergencies. Ultimately, these patients need further diagnostics to evaluate if the patient is having a true heart attack. Sometimes this means that patients with high likelihood of, or risk factors for, heart disease may need to be transported, (even though ultimately they are found to not have suffered a heart attack), so that those patients who do suffer a true heart attack are given the best chance possible for early intervention. Cardiac specialty center diagnostics may be extensive and complicated, and special medications, sophisticated monitoring, or a surgical procedure at a specialized cardiac intervention center are often needed to reestablish circulation. Done within those two hours, the heart may be undamaged or damage may be limited, allowing the patient not only to live, but to recover a normal life. The scarcity of cardiac intervention centers, particularly outside of urban areas, suggest a role, supported by studies to date, for HEMS in quickly transporting patients, even patients whose hearts have stopped and been restarted, from remote hospitals to these centers.22,27-29,33,51,53,55,56,64

Mission: Strokes

Like heart attacks, some strokes are caused by interruption of blood predominately from a blood clot, only this time in the brain. As in heart attacks, there is a narrow window of time (optimally within 90 minutes but generally no more than four and a half hours) in which rapid diagnosis and clot-busting treatment can result in patients suffering little to no long term damage and disability from these events. Therefore, patients transported to specialty centers for clot-busting treatment of strokes can benefit from a well-coordinated ground and air transport system to accomplish early transfer.30-32,34,37 Differentiating whether the stroke is caused by a clot or by bleeding is currently impossible in the field; thus many apparent stroke patients require transport to a specialty facility which can make this determination and act immediately upon the results. Many U.S. hospitals have attained designation as American Stroke Association primary and secondary stroke centers. At the highest levels, these centers are now on the cutting edge of interventional stroke management using sophisticated neuro-radiologic procedures to remove clots and re-perfuse the brain while the damage is still reversible. In the future, regional systems of care around strokes will exist much the way they do for cardiac care, and they, too, are likely to be a big user of air medical services.

As a part of an organized trauma system, HEMS cuts the injury-to-operating-room time significantly, and reduces the overall cost of trauma.

“AMS turns patients back into people” Kevin Hutton, MD Chairman, MedEvac Foundation International
Mission: Complications of Pregnancy

When a pregnant woman experiences complications, they can be life-threatening for both mother and child, and often require the specialized care found in regional hospitals. Timely AMS transfer to such facilities while the patient(s) receives care from obstetrical/neonatal specialists has been shown to be safe, cost-effective and beneficial, especially compared to the alternative of caring for a severely disabled neonate who potentially requires lifelong care. Neonate ground-ambulance transfer units are widely employed, largely in urban areas. However, when time is critical and a specialty team from the receiving hospital is sent to bring the patient(s) to the specialty center, air ambulance transport minimizes the out-of-hospital time for both the patient and the specialty care givers in a way that cannot be accomplished via ground over the significantly larger geographic areas that HEMS allows.39, 85-88

Mission: Children

Children are very resilient patients who often do not show signs of a severe illness or injury until they are close to death and then they suddenly deteriorate. The newly born have their own set of unique diagnostic challenges including premature infants with respiratory, cerebral, cardiac, and gastrointestinal abnormalities, and neonates with congenital abnormalities. The average emergency physician encounters these high-level pediatric or neonatal problems infrequently and many hospitals no longer care for children because they cannot maintain the expertise. When this occurs, these patients require access to neonatal and pediatric intensive care units and highly specialized physicians. As with other specialties, these services are becoming increasingly limited and centralized into urban centers. Therefore, access to the care for these neonates, premature infants, and young children is another primary use of AMS, with the speed and higher level of care provided en route by an air medical team benefiting these patients over huge geographic areas.45,90 Again, the specialization of these services not only improves the quality of care, but also decreases the cost of redundant services in a given geographic area.

Mission: Traumatic Brain Injury

Traumatic brain injury (TBI) is frequently associated with the severely injured, multiple-trauma patient. It is the leading cause of death and disability in children and in adults in their most productive years, making the resulting economic loss one of the highest in medicine.120 As with other major injuries, treatment of traumatic brain injury is time-critical, principally because of brain swelling. Again, reduced availability of the neurosurgical services required to treat TBI outside of urban specialty centers has posed a challenge to EMS. Air medical transports have proven to be effective over large geographic areas allowing regionalization of systems of care to improve the outcome of

Overall in the U.S., most air medical transports are between hospitals, approximately one-third are scene responses, and the remainder are other types (e.g., organ procurement and specialty/neonatal/pediatric team transport).
TBI and lower the cost to society. Recent studies indicate that early advanced care by air medical crews and rapid air transport to definitive care can overcome this challenge, resulting in significant improvement to moderately and severely traumatic brain injured patients.\textsuperscript{35,50, 89-92}

**Mission: Complex Surgical and Medical Conditions**

Air medical service is indicated for a number of other time-critical patient conditions. Examples of these include dissecting aortic aneurysms, limb reimplantation surgery, burns, major infection, poisoning or overdose, organ transplantation (movement of patients and organs), respiratory complications requiring ventilator support, need for emergency dialysis, or the need for care in a hyperbaric chamber (e.g., carbon monoxide poisoning and diving incidents).\textsuperscript{66,67,93}

**Mission: Mass Casualty Situations and Major Regional/ National Incidents and Preparedness for Disasters**

Helicopters and fixed wing aircraft play a vital role in emergency preparedness because of their ability to rapidly move patients to specialty care across a wide regional area.\textsuperscript{82,83} Hospitals close to a mass casualty site become overwhelmed early in an event with numerous cases of all types. The patients are injured or ill; incapacitated due to long-term electricity failures, lack of fresh water or dwindling supplies and medication; or may even be evacuated due to local conditions and look to hospitals to solve social displacement issues. The chaotic scene of “walking wounded” disaster victims demanding care for non-medical issues as critical patients arrive in mass numbers can saturate even the biggest health system. While it is common practice to send less-injured patients by ground to distant hospitals to reduce pressure on local facilities, medical helicopters and fixed wing aircraft give those at the scene the option of moving severely ill or injured patients to more distant and less overwhelmed hospitals as well, thus allowing local healthcare systems time to adapt.

In cases of impending disaster, helicopters are also useful in evacuating critically ill patients from hospitals in areas threatened by tornado, hurricane or other disaster, and are often utilized to bring medical staff, equipment and critically-needed supplies (such as blood and blood products) to the scene. Fixed wing air ambulances can expand that capacity by meeting with medical helicopters or critical-care ground ambulance units to bring in supplies or transport patients even further distances.

When incorporated into a local, regional or national emergency response plan, air medical helicopters and fixed wing services provide much-needed and highly-experienced resources that can be deployed rapidly in times of disaster. Since most of the air ambulances in the U.S. today are civilian, they augment the nation’s emergency response capacity. In the wake of Hurricane Katrina, there was a recognition that these services needed to be better organized, precontracted, and preplanned. Today, both air and ground resources are indeed better organized, under contract to respond, and are ready to deploy when requested.
Growth in the number of air medical services and the types of missions they tackle bring an increasing amount of attention to the operation of those services and to the growth in their numbers. Though today the nation has better AMS coverage than ever, cost on a per patient basis and sustainability under current reimbursement methods is a constant and growing challenge.

Cost and Cost-Effectiveness

Maintaining the resources necessary to respond with an air ambulance to an emergency is a complex and costly undertaking. Much like that of fire departments and hospital emergency departments, they must be staffed, equipped and ready even when not being used. The high fixed costs of maintaining a critical-care response infrastructure are necessary in order to be ready to serve. In addition, air medical services incur higher variable costs than other responders. These costs include aviation fuel, frequent scheduled parts replacement, constant required maintenance, more expensive medical equipment, and more expensive crews. Low volume AMS programs are significantly more expensive to operate and many are subsidized by hospitals.

This is especially problematic in maintaining rural emergency care services where low volumes of transports are common. Studies from the Capitol Area Health Roundtable and the Government Accountability Office (GAO) have consistently highlighted that current reimbursement does not adequately support the cost of maintaining services.94,95

Currently, AMS providers in the U.S. bill for services similar to the way a taxicab bills. There is a base rate that is designed to pay for fixed costs, and additional charges for the miles over which a patient is carried designed to pay for variable costs. There is no payment for response unless a patient is picked up and transported except for responses to patients in cardiac arrest who are declared dead on scene. Therefore, AMS providers must transport to be paid and depend on authorized requestors to manage appropriateness of transport.

Helicopters and fixed wing aircraft cost millions of dollars to purchase, insure, operate, house and maintain.69 Highly trained crews available on a 24-hour/7 day per week basis, and the infrastructure which governs, trains, funds, supports, and links them and their service to the EMS system, are also very expensive to maintain. As few systems are publicly funded, maintaining the availability of this essential resource means that those who are actually transported by the service shoulder the cost of paying for service readiness for the entire population of the response area. This makes a single patient mission charge seem expensive in comparison with a lower-priced ground ambulance. It has proven a mistake, however, to make such an isolated comparison and to equate the lower charge with cost-effectiveness and the higher charge with cost-prohibitiveness.
In the managed care push of the mid-1990s, AMS was interpreted by some as an expensive system contributing to the high cost of healthcare. They postulated that the industry would shrink and require redesign. In San Diego’s managed care test bed, the impact on hospitals was one of the reasons for the closure in 1995 of Life Flight San Diego, a consortium program sponsored by several trauma hospitals. This program was a victim of the hospitals’ need to dramatically reduce costs to be able to contract for lowest-bidder inpatient managed-care contracts. The fear that managed care would cause further widespread closures of AMS by hospitals was not realized, nor was that version of managed care successful. Today, whether AMS programs are non-profit or for-profit, the phrase “no margin, no mission” emphasizes the financial forces constantly at play in providing AMS.

One recent study which compared patient treatment models for heart attack demonstrated a potential twentyfold savings by having patients transferred to cardiac intervention centers for percutaneous coronary intervention (PCI) rather than expanding PCI capabilities to local hospitals. This is an ambulance-based model in an urban/suburban setting. However, the study is suggestive of potential savings in more rural areas benefiting from AMS, since the cost of equipping rural hospitals with this level of care would be more expensive and patient volumes markedly less. Also, with less institutional experience in performing these procedures, the potential would exist for inferior quality of care. Another recent study demonstrated a general “willingness to pay” by society for the cost of expanding HEMS from a part-time availability to full-time.

At least one carefully constructed economic model comparing helicopter versus ground EMS has been crafted. It demonstrates that on a system level (that is, funding a system of air ambulances versus a system of ground ambulances covering the same large geographic area and volume of calls), the cost per patient transported would be $4,475 for the ground system and $2,811 for the air system (or $7,424 and $4,664, respectively, in 2011 dollars). A cost-effectiveness study of helicopter EMS for trauma patients by Gearhart and colleagues concluded that such service is, indeed, cost-effective. In looking at the cost per year of life saved by 500 emergency medical interventions, another researcher found the average to be $19,000. (By comparison, clot-busting medication treatment for heart attack is $32,678 and kidney dialysis is $40,000.) That study estimated paramedic ground EMS to cost $8,886 per year of life saved while the Gearhart paper establishes a comparable figure for medical helicopter use of $2,454. The impact of AMS on societal healthcare savings is a threefold reduction from the cost of ground EMS and a tenfold reduction from hospital fibrinolytic heart attack treatment.

As our nation faces increasingly difficult decisions about apportioning healthcare dollars in our aging society, AMS should not only be considered cost-effective in its current critical-care support roles, but may increasingly serve medically and geographically isolated populations in new ways. This includes primary through tertiary care without the need to build new clinics, hospitals or critical care centers.
Appropriate Utilization

Because AMS involves expensive resources and influences decisions about what level of system resources are required, where patients are hospitalized, how these patients get to healthcare facilities, and what kind of care they receive en route, providers in the healthcare systems affected often show great interest in assuring that AMS are being properly utilized. This is not always easy, as identifying medical conditions in the field is challenging especially in rural settings where the requestors are generally infrequent AMS users and sometimes minimally trained. Some conditions are asymptomatic in the field yet emerge to be deadly later. Yet, AMS providers depend on authorized requestors to determine medical necessity at the time of the request. Once on scene, there is a strong medical legal justification to transport due to the possibility of hidden injury or illness. Inevitably, some of this use of AMS proves, after the fact, to not have been necessary (“over-triage”). This highest level of transport care is done in order to assure that those who will most benefit from AMS are not “missed” (that is, deprived of the service, or “under-triaged”). This introduces the concept of system necessity versus medical necessity for the use of HEMS. One study reported a 91% appropriate utilization of the regional helicopter system. Another study demonstrated the impact of appropriate scene triage decision-making for automobile crash injury patients, showing that when AMS is not allowed to serve as the decision maker in creating appropriate “patient pathways” to critical care, lives are lost.

In 1990, the AAMS published a “Position Paper on the Appropriate Use of Air Medical Services.” It established a set of circumstance-specific and patient-specific criteria for approving flight requests and for retrospectively reviewing flight performance.

At least four states have used these or similar criteria to review utilization appropriateness and have found compliance with the established criteria to be high. One of these states changed its criteria to expand what was considered appropriate use of AMS based on such a review.

More recently, these triage criteria have been updated by the National Association of EMS Physicians (NAEMSP) in a position paper published in 2003. These “Guidelines for Air Medical Dispatch” were endorsed by AAMS as well as by the Air Medical Physician Association (AMPA), which also has published its own AMS use criteria. These guidelines are available not only to help establish criteria for approving flights but also for reviewing utilization. It is essential that retrospective data on utilization be employed to develop mechanisms and training for prospective flight requests. Retrospective utilization review at the service level, used to educate authorized requestors to continuously improve request decision-making, is the most effective way to improve utilization. It is highly desirable that utilization review also be accomplished on a regional and/or state level where multiple services exist so that system related transports and regional transport policy can be adjusted over time based on the changes in hospital and EMS capability.
Two other tools for utilization appropriateness and improvement exist for system planners. The first is a utilization predictor for HEMS.\textsuperscript{105} Applying this predictor to a selected geographic area, and then comparing its result against actual flight activity, may give planners a better picture of the case mix and appropriateness. The Leonard Davis Institute for Health Economics developed a model for the optimal placement of trauma centers and helicopters called TRAMAH (Trauma Resource Allocation Model for Ambulances and Hospitals).\textsuperscript{106} TRAMAH could be used to model against existing actual patterns of activity for future resource allocation. A recent study using this methodology identified that helicopters significantly increased the number of persons who can reach a trauma center within the “Golden Hour,” but also found that over 46 million persons in the U.S. (15% of the population) cannot reach a trauma center in a timely manner.\textsuperscript{107} Continuing research using the same databases indicates a correlation between lack of timely access to trauma centers and access to HEMS.\textsuperscript{108}

**Safety**

From 1972 through September, 2002, when HEMS safety research by Dr. Ira Blumen of the University of Chicago Aeromedical Network (UCAN) was completed,\textsuperscript{7} HEMS had flown approximately three million hours, transporting some two and three-quarter million patients. In that time, there were 166 crashes involving HEMS, with 183 fatalities.

The UCAN study found that while the number of crashes each year has fluctuated, the number per 100,000 patients flown had dropped from 17.36 in 1980 to 5.5 in 2001. The risk to patients, estimated over the years of the study, is reported as a fatality rate of 0.76/100,000 patients. Subsequent admission to a hospital carries with it a greater risk of death from complications or errors: various recent estimates range from 1.2/100,000 patients to 292/100,000 patients. More recent work suggests that ground ambulance transportation may hold greater peril for patients than AMS, though data on ground transportation safety is inconsistently collected and difficult to compare.\textsuperscript{6} While AMS is highly regulated by the FAA, ground EMS transportation operates outside of this level of federal regulation.\textsuperscript{6} MedEvac Foundation International has funded significant research and education in the areas of flight safety and fatal crash avoidance, as well as on the adequacy of the management of critical conditions and their complications in flight.\textsuperscript{61,64,109,110}

Any form of medical transport incurs inherent risk, and in recent years there have been increased numbers of accidents. While this may be expected because of the increased exposure risk with increased flight volume, it has drawn the attention of federal agencies including the National Transportation Safety Board, the Federal Aviation Administration, and the Government Accountability Office, all of which have responded with proposed changes in safety measures and new regulatory oversight.\textsuperscript{111,112}
In an editorial comment in the UCAN study, a past president of the National EMS Pilot Association emphasized that the causes of crashes haven’t changed over the years. The top three causes are poor decision making in accepting flights, pre-flight planning, and in-flight decision-making, reflecting the unique pressure placed on crews by the condition of the patient, by the feelings of obligation to fly, and a pervasive “can do” attitude. The AMS community has taken significant steps, particularly in the area of air crew resource management (a proven airline industry safety tool) to improve its safety for patients.7 New resources have been brought to the pilot to aid in decision-making. These include better weather reporting, safety risk analysis tools, sharing “turn down” decisions between competing programs, and educating EMS about the dangers of “helicopter shopping” (a practice where EMS calls other HEMS after the first service determines the flight risk is too great). They also feature operational control centers, some with “virtual co-pilots” who use technology to follow the mission and provide real-time, decision-making information to pilots to reduce risk. In addition, many HEMS programs are replacing aging aircraft, flying under Instrument Flight Rules (IFR), and employing new technologies such as night vision goggles (NVGs) and terrain avoidance warning systems (TAWS), especially important when weather conditions abruptly change mid-mission.113 Also of note, eleven competing air medical operators formed the Air Medical Operators Association (AMOA) under the premise that “safety is not proprietary.” AMOA collaborates and voluntarily drives compliance with National Transportation Safety Board (NTSB) and FAA safety recommendations as well as developing new standards and safety management systems to support the industry’s Vision Zero safety goal.

Transport medicine is among the most complex arenas of medicine. The “Vision Zero” initiative and the IHST recognize the need for, and the industry has voluntarily initiated, multi-disciplinary, collaborative, and global efforts towards improving safety. NTSB Board Member Robert Sumwalt publicly stated, as an industry “Air Medical Services has been very responsible in its efforts to improve safety.” (NTSB member Robert Sumwalt, Member, March 2010)
and a comprehensive annotated bibliography of articles on HEMS safety as well as funding several safety related educational meetings to improve the industry’s safety record.\textsuperscript{110}

Premised on the model that providers must work collaboratively, on a voluntary basis, with regulators to identify and accelerate the implementation of best practice standards, these initiatives seek more effective methods and approaches to avoiding errors in complex systems. They focus on developing and implementing strategies using cost-benefit analysis and evidence-based best practices related to safety in order to prioritize investment and financial plans to result in a goal of zero serious injuries or fatalities.

**Need for Improved Planning, Coordination and Oversight**

Air medicine plays a unique control and coordination role as a critical-care facilitator within healthcare systems in the U.S. Its success in this role is contingent on the successful integration with these systems from the perspective of planning, operational coordination, and oversight.

Integrating air medicine into healthcare is essential at the local, state, regional, and national levels. The 2004 national consensus document published by the National Rural Health Association, “Rural and Frontier EMS Agenda for the Future,”\textsuperscript{84} identified AMS as a vital component of rural and frontier EMS systems, and as the only ALS-level service available in many areas of the country. It noted the proliferation of programs and the absence in many states of planning, coordination and regulation of AMS. It formally recommended that systems “plan, integrate and regulate, at the state level, aeromedical, critical-care transport, and other statewide or regional systems of specialty care and transportation.” The 2006 Institute of Medicine report on EMS reinforced this recommendation.\textsuperscript{114}

The National Association of State EMS Officials (NASEMSO), AAMS, and the National Association of EMS Physicians (NAEMSP) joined to produce *Air Medical Services: Future Development as an Integrated Component of the EMS System*, a paper published in 2007.\textsuperscript{115} Its purpose was and is to establish the framework of key areas for integrating and regulating AMS within statewide EMS systems, and for better understanding and coordinating state and federal regulatory responsibilities. This joint task force is currently developing model regulatory language to further the integration and quality of AMS practices within emergency care systems, while facilitating the interstate nature of air medical operations.

In addition, as shown in recent natural disasters such as Hurricane Katrina, civilian air medical services must be (and now are) included as an integral part of regional and national disaster response plans. Because of the organization of air medical programs and the unique range and speed of aircraft, numerous resources are immediately available to aid in disaster response and evacuations within a single state or on an interstate, regional basis. Further work, however, is required to fully integrate other civilian and federal AMS resources, such as the Coast Guard, into this planning.

It is essential that medical leaders and policy makers integrate air medical resources in their response and disaster protocols in order to assure the prompt and coordinated care of critically ill and injured patients, regardless of the size or location of the event.
Maintaining access to care is an ever-increasing challenge for both healthcare providers and policy makers. The AMS critical-care roles in everyday life, and the exceptional regional disaster responses of the last decade have highlighted the need for an effective, available, air medical system. Air medical services have been shown to be cost-effective and something the public is willing to fund. Currently, AMS are largely funded by actual users who bear much of the cost of readiness for the potential users of AMS. Much like other effective healthcare interventions (such as trauma systems), technologies (such as CAT scans), and specialty surgeries (such as those for heart attacks patients), AMS is expensive to maintain (even more so if used infrequently). It is essential that public policy and funding sustain AMS as a critical part of the medical and emergency preparedness safety net in our communities. Maintaining the readiness to respond is as essential as the actual care delivered by AMS. The rapidly evolving regional systems of care approach for improving the quality and affordability of specialized critical-care services is dependent to an increasing extent on the viability of AMS. HEMS sustainability is therefore crucial to the continued evolution of regionalized centers and to timely access to critical care.

The generally increasing need for AMS must also be addressed. The U.S. Department of Health and Human Services estimated that “in 2000 there were 605 million persons worldwide aged 60 years or older. This number is projected to increase to almost two billion by 2050.”116 The trend is particularly noticeable in the U.S., with a rapidly aging population, especially in rural areas. The emergency medical needs of this population are reflected in the growing rates of trauma, as well as the increased occurrence of time-critical conditions such as heart attack, stroke, and surgical emergencies (e.g., abdominal aneurysms, sepsis, and stomach/intestinal bleeding).117 Recent studies examining the response to elderly trauma patients have found that many of these patients have hidden injuries and, currently, do not reach trauma centers in a timely manner.118,119 The need for air medical services to bring that technology to patients, and to bring patients to that technology, will increase as medical science creates new critical-care methods to intervene in emergencies with technology housed in urban centers that must be utilized within a critical window of time.
Financial pressures on U.S. healthcare systems are clearly intensifying. The mismatch between demand and resource availability is becoming more acute and the safety net is increasingly showing signs of failure. These pressures will continue to erode the availability of hospital-based delivery of specialty care and life-saving technologies, particularly in rural areas. The need for increased access to ever-scarcer specialty care resources, and the increased need to make such care mobile will increase the need for AMS, as a critical component of modern healthcare systems.

AAMS and MedEvac Foundation International believe that it is essential to assure that every person has access to quality and sustainable air medical and critical-care transport whenever it is needed. It is imperative that policy and funding support the availability and sustainability of AMS to every community.


21. Avalere Health LLC. TrendWatch Chartbook 2010: Trends Affecting Hospitals and Health Systems. Organizational Trends, Chart 2.1 (Number of Community Hospitals); Utilization and Volume, Chart 3.7 (Emergency Department Visits and Emergency Departments in Community Hospitals); Utilization and Volume, Chart 3.11 (Conditions Hospitals Reported as Number One Factor Contributing to Ambulance Diversions, March 2010). The American Hospital Association, 2010.


95. GAO ambulance services: Medicare payments can be better targeted to less densely populated rural areas. United States General Accounting Office, Report to Congressional Committees, September 2003.
111. Air Ambulance: Effects of industry changes in services and need for changes in oversight authority are unclear. GAO-10-907. United States General Accounting Office. 2010.


113. Dauphinas RK, Wish JR. It’s about time: Case report on IFR implementation at CareFlite Grand Prairie Texas. Rotor Fall 2005; 38-41.


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Glossary

ALS—advanced life support, a more advanced level of medical care provided in an ambulance, usually by paramedics.

AAMS—Association of Air Medical Services, trade association for the air medical services.

AMS—air medical services (provided either by helicopter or airplane).

BLS—basic life support, the most basic level of medical care provided in an ambulance, usually by First Responders and EMTs.

CAH—Critical Access Hospital as defined by the Centers for Medicare and Medicaid Services (CMS).

CCG—critical care ground, a ground ambulance providing a level of medical care higher than ALS, staffed with specially trained nurses and paramedics.

EMS—emergency medical services.

EMS System—an arrangement of medical, public health, and public safety resources to prevent occurrences of emergency illness and injury and to mitigate the impact of such occurrences which can’t be prevented. May be local, regional, state, or national.

EMT—emergency medical technician, a medical caregiver with BLS level training.

Fixed Wing—airplane.

frontier—a rural region of the country that is unexplored or undeveloped.

HEMS—helicopter emergency medical services (helicopter air ambulance providing emergency medical services).

IHST—International Helicopter Safety Team. An international, multidisciplinary team convened to reduce all helicopter accidents by 85%.

inter-facility transport—medical care provided en-route between two medical facilities, usually between a local community hospital and a regional trauma center or other specialty center.

morbidity—the rate and extent of disease.

mortality—the rate of death.

paramedic—a medical caregiver with ALS level training.

Rotor Wing—helicopter.

rural—a region of the country that is outside of urban or suburban areas, with typically longer distances between homes and medical services and more limited hospital and physician services.

specialty care center (also tertiary care hospital)—a hospital designated by a recognized governmental agency and/or accrediting body as qualified to provide treatment services for the most critically ill or injured patients of a certain type (e.g., trauma, pediatric, heart attack, stroke). This requires a specialized, highly technical level of healthcare that includes diagnosis and treatment of disease and disability in sophisticated, large hospitals serving a wide geographic region. Specialized intensive care units, advanced diagnostic support services, and highly specialized personnel/specialist physicians for cardiac, medical, trauma, neurological, pediatric, and neonate/infant care, are characteristic of tertiary healthcare.

trauma—a bodily injury produced by violence or shock.

trauma subsystem—a category of EMS agencies and hospitals serving a larger-than-usual region because they provide specialized care for victims of traumatic injury.