Air Medicine: Accessing the Future of Health Care

A Public Policy Paper by the

FARE
FOUNDATION FOR AIR-MEDICAL RESEARCH & EDUCATION


EMERGENCY
PUSH HERE

Executive Summary

The use of air medical services (AMS) has become an essential component of the health care system. Appropriately used air medical critical care transport saves lives and reduces the cost of health care. It does so by minimizing the time the critically injured and ill spend out of a hospital, by bringing more medical capabilities to the patient than are normally provided by ground emergency medical services, and by quickly getting the patient to the right specialty care. Dedicated medical helicopters and fixed wing aircraft are mobile flying emergency intensive care units deployed at a moment's notice to patients whose lives depend on rapid care and transport. While AMS may appear to be expensive on a single-case basis compared with ground ambulance service, examining the benefits behind the cost on an individual and a system-wide basis shows that it is cost-effective. The picture of a helicopter at the scene of a car crash evokes visions not only of the life-saving power of air medical services, but also of the risks of the environment into which they fly. Yet, air medical patient care and transportation actually promises less risk to the patient than does a patient's hospital stay.

"Time is human tissue" is a saying that means death and disability from severe injuries, heart attacks, strokes, medical and surgical complications, and other time-dependent conditions often can be avoided if the right care is provided quickly enough. AMS is a means to bridge geography and time. As technology provides new, time-sensitive care, the need for AMS will increase. As the costs of the health care system continue to rise, and the availability of even routine health care in rural communities is put at risk, AMS will play an increasingly important role in the delivery of health care.

In these days of increased concern about homeland security and emergency preparedness, air medical services provide a valuable medical resource that can transport patients and medical staff long distances, as well as carry medical equipment and medical supplies to the affected area(s). AMS is an integral component of disaster planning and management. The recent experience of hurricanes Ivan, Katrina, and Rita illustrate the essential role of AMS in evacuating critically ill and injured infants and adults from hospitals and nursing facilities as well as providing direct scene support to disaster management teams. Without a prompt and massive AMS response of both dedicated air medical helicopters and fixed wing aircraft to the Gulf Coast, thousands of additional lives would have been placed at risk or even lost.

Integrated air medical resources are an essential component of contemporary EMS systems. Today, financial pressures, insurance issues, changing federal regulations, and competition all are forcing changes, consolidation, and in many cases reduced services or closure of emergency departments, trauma centers, hospitals and specialty physicians. These factors have contributed to the increased

use of AMS to move patients to specialty centers, particularly from outlying areas. As with EMS in general, there has been a general lack of overall system planning and design to guide the development and implementation of needed AMS. Mechanisms that might provide such guidance, such as state EMS or health regulations, certificate of need (CON) processes, and federal aviation and healthcare regulations sometimes conflict with one another, providing a jumble of uncoordinated hurdles to AMS providers.

This paper lays out the historical development and contemporary practice of air medicine, serving as a resource framework for policy makers and regulatory agencies charged with assuring the provision of high quality air medical services to the public.

History of Air Medical Services in the United States

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[1] 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.[2, 3]

The routine medical evacuation mission of helicopters, however, evolved unintentionally during the Korean conflict in the 1950's.[4] 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.

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. It is felt that 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.[4]

The Viet Nam 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 and rapid evacuation for over 800,000 troops reduced the war-long mortality even further.[4, 5]

A theme from WWI through Viet Nam 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.[6]

In 1966, the landmark National Academy of Science white paper *Accidental Death and Disability: The Neglected Disease of Modern Society* [7] underscored the profound impact of death and disability caused by injury, particularly car crashes. It also detailed a lack of coordinated response to injury, including the observation that "Helicopter ambulances have not been adapted to civilian peacetime needs." [7]

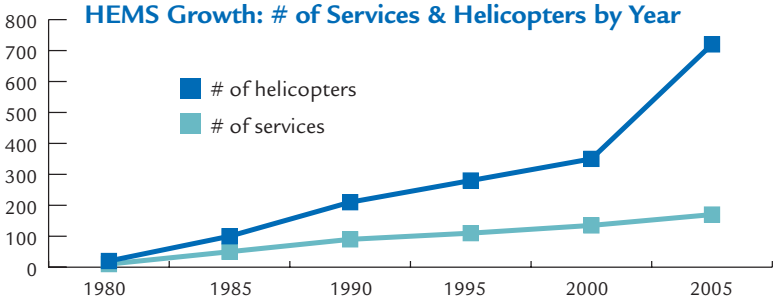
The National Academy of Science white paper contributed substantially to the development of the modern EMS system and its trauma care subsystem. Its impact was compounded by the influence of returning military units, and military medical helicopter pilots discharged to law enforcement and other public

…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.

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 March, 1970, became "the first civilian agency to transport a critically injured trauma patient by helicopter." [8, 9] The first civilian hospital-based medical helicopter service was established in 1972 at St. Anthony's Hospital in Denver, Colorado.

By 1980, some 32 helicopter emergency medical services (HEMS) programs 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.[10] By 2005, 272 services operating 753 rotor-wing (helicopter) and 150 dedicated fixed wing aircraft were in operation.[11] There are now approximately a half-million helicopter and fixed wing transports each year.[12] Historically, the typical helicopter EMS service has been operated by or affiliated with a hospital with one or two aircraft.[12] In the past decade, many of these services have become independent, community-based resources with hospital affiliations.

The rapid growth of AMS, particularly in the late 1980's and again in the last 5 years, can be attributed to changes in the overall health care system. The need to quickly bring critically injured patients to surgical care brought AMS (mainly medical helicopters) into existence. In more recent years, the closure of rural hospitals because of reimbursement and other financial pressures, or their conversion to Critical Access Hospitals (CAH's) with reduced services and fewer specialist physicians, has created large geographical gaps in the availability of specialized surgical resources. Unfortunately, these rural areas are also the location of the most serious car crashes and are where 60% of fatal crashes in the U.S. occur, a rate nearly double that of similar accidents in suburban or urban areas.[13] The use of aircraft with skilled medical crews helps to close these gaps and improves access to specialist care. As more time-dependent medical treatments (e.g. "clot-busting" drugs, angioplasty, or surgery for heart attacks or strokes) have been shown to improve patient outcomes, the absence of specialty care and physicians in these same areas continues to contribute to the increased use of aircraft to get patients rapidly to these life saving treatments at specialty hospitals.



2005 Summary of Helicopter Assets by State

State	# Helicopters
AL	9
AK	32
AZ	50
AR	12
CA	72
CO	10
CT	2
DC	3
DE	5
FL	44
GA	19
HI	6
ID	10
IL	19
IN	15
IA	9
KS	10
KY	20
LA	9
ME	2
MD	18
MA	4
MI	12
MN	12
MS	5
MO	30
MT	4
NE	7
NV	6
NH	2
NJ	5
NM	10
NY	28
NC	13
ND	2
OH	28
OK	14
OR	4
PA	37
RI	0
SC	8
SD	4
TN	24
TX	61
UT	8
VT	0
VA	21
WA	10
WV	5
WI	12
WY	1
TOTALS	753

from Atlas & Database of Air Ambulance Services (ADAMS), October 2005.

AMS' First Mission: Trauma

Levels of Medical Care 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 Specialty Care Transport
Medical service provided by personnel trained to conduct procedures normally beyond the scope of a paramedic. Also known as Critical Care service.

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.

Research in the early 1970's reinforced the notion held by wartime physicians that, for the critically injured patient, surgical intervention in the first hour after injury was crucial. The notion of this "Golden Hour" has survived, with minor variation, to the present day.[14]

With this influence, the *Accidental Death and Disability…*white paper, and the fresh experience of military medical helicopter success in this arena, it is understandable that civilian HEMS adopted trauma as its predominant mission in its early years.

EMS Trauma Care: Basic Life Support (BLS) and Advanced Life Support (ALS)

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 1970's and '80's, EMS developed a basic life support ("BLS") capability. This was intended not only to "do no harm," but to provide stabilizing care such as techniques to combat the loss of blood, help breathing, immobilize the spine, and splint bones. Emergency medical technicians ("EMTs") were and are the primary BLS provider.

At the same time, an advanced level of life support ("ALS", provided primarily by paramedics and intermediate EMTs) began to evolve. This was largely aimed at medical emergencies which 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 into a vein, placing a breathing tube in a compromised windpipe, and re-inflating a collapsed lung.

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 ground ambulances)* while longer distance inter-hospital transfers rely on dedicated and specially equipped helicopters and fixed wing aircraft.

These patient transports are overseen by referring physicians and receiving specialist physicians using guidelines developed by the National Association of EMS Physicians, the Air Medical Physician Association, and the Association of Air Medical Services.[15]

AMS Trauma Care: Speed, Access, and Physician-Level Care

The 1966 White Paper: *Accidental Death and Disability: The Neglected Disease of Modern Society* called for the development of a sophisticated EMS system, specialty emergency departments, and regional trauma facilities.[7] In parallel, the National Highway Safety Act of 1966 was passed, funding the development of the Department of Transportation with the authority to develop EMS and trauma systems.[16] The evolution of air medical services offered the EMS system and the new trauma subsystem a new level of care and transportation benefits.[17]

Higher Level of Care: The crews aboard air ambulances provide more than the ALS-level medical skills and equipment found on ground ambulances. They bring the additional skills and equipment of a tertiary hospital, more advanced drugs, and more sophisticated critical care medical skills whenever they respond to a community hospital, to the scene of an injury or accident, or to a pre-planned rendezvous point with a ground ambulance (a common practice for fixed wing, or airplane, air ambulances). Critical care for especially difficult breathing complications, blood and blood products, and more sophisticated patient monitoring tools make air ambulance helicopters more closely resemble a "flying emergency department" than 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 which may have few ALS ground ambulances to call upon, and even less critical care ground ambulance coverage.

The AMS team generally has physician level capabilities exceeding those of ground ALS providers. The current configuration for the medical crew on-board AMS is most typically a specially trained critical care nurse and paramedic. Other specialist caregivers or physicians may be added to the team as needed. This effectively initiates tertiary hospital care directly at the patient's bedside, whether at the scene of an emergency or at a community hospital. Almost exclusively, the AMS team handles the most critically ill and injured patients, giving these caregivers more hands-on experience in dealing with the most severe cases than the ground EMS responders who see a large population of less emergently ill patients. The benefits of air transport have been demonstrated to outweigh any stressors that flying might add, even for the sickest trauma and, notably, heart attack patients. [18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30]

Speed and Injury Protection

Helicopter air ambulances are used for the transport of patients from the scene of an injury to a hospital, and for shorter flights between smaller hospitals and trauma centers or specialty hospitals (burn or cardiac centers, for instance). Fixed wing air ambulances (airplanes) are used for transporting patients on longer inter-hospital flights.

Air medical transport is beneficial not only because it provides a higher level of medical care to the patient en-route, but also because it provides a speedier response. When treating the critically ill or injured, it is always 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. Fixed wing air ambulances (airplanes) can cover much more distance in less time than a ground ambulance. Sometimes the air ambulance even provides a more comfortable ride, where less than optimal road conditions result in discomfort for some patients.

Air medical transport is beneficial as it provides a higher level of medical care to the patient enroute and also provides a speedier response.

All aircraft—fixed wing and helicopter—conduct about 500,000 patient transports in the United States alone each year, saving millions of lives each decade.

Access: Patients isolated from ground EMS or trauma centers 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 congestion.[31] Bringing patients home and/or to more sophisticated medical care from distant sites of illness or injury (called "repatriation") is one major use of fixed-wing (airplane) air medical service.

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 health care delivery system in this country:

- Emergency departments in community hospitals have declined from just over 5,000 in 1992 to approximately 4,600 in 2002, a trend that is expected to continue.[32]
- The number of the most sophisticated trauma centers has declined in the same time period.
- Specialty care and specialists are increasingly housed in urban specialty 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.

Due to the above factors, AMS, and especially HEMS, is becoming the health care safety net and access point for many non-urban individuals and communities.

Putting it all Together: AMS and the Trauma System

The "Golden Hour" concept provides that along the route to the surgeon's knife in that first hour, a patient should benefit from an organized EMS system which provides increasingly advanced care (e.g. BLS to ALS to the physician-level care provided by air medical crews).

The complete EMS trauma subsystem must include:

- Rapid discovery of the injured patient and notification of EMS.
- Fast response of BLS EMS.
- Early activation by trained and authorized requesters.
- Timely availability of ALS resources.
- Rapid access to physician level intervention through HEMS response or the closest Emergency Department.
- Rapid transport to identified trauma centers.
- Inter-hospital transfer to needed specialty care by critical care ground ambulance helicopter or fixed wing air ambulance as needed.
- Excellent planning and coordination of EMS resources.
- Quality assessment of each component in the combined air and ground emergency response.

A recent paper cites the Maryland system as having these components in place and organized well, and calls upon other systems to emulate it.[33] It has been well demonstrated that organized trauma systems with trauma centers save lives.[34, 35, 36, 37] In the early 1980's, the first analytical attempts to determine the life-saving impact on mortality by HEMS response to injury scenes began to appear, largely demonstrating reductions in mortality compared with ground systems.[18-20, 38]

Since the '80's, there have been many published medical studies which have attempted, through a variety of means, to assess HEMS' impact on trauma mortality and morbidity for both scene and inter-facility flights. Overall, these studies have demonstrated the power of HEMS to affect improvements in trauma-related mortality and morbidity.[39, 40]

As a part of an organized trauma system, HEMS cuts the injury-to-operating-room time significantly. Medical helicopters, dispatched simultaneously with ground EMS,[41] can give over 54% of the US population access to a full-service trauma center within 60 minutes that they otherwise would not have.[42]

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

Medical helicopters also discourage time-costly 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.[43, 44]

In the future, improvements in cell phone technology and automatic crash notification (ACN) technology in cars may cut the time required to discover and report a crash injury to almost zero. Using "urgency" indicators generated by automatic crash notification data sent from crashed cars to dispatch centers, along with special medical protocols for assessing the probability of severe injury from the crash, will soon provide a rational and effective way for helicopters to be launched within minutes of an accident, no matter how remote, thereby further improving the speed of EMS response to patients. [45]

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.

Examples of recent 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.[46]
- HEMS reduced injury mortality by 24% in a multi-center study with some 16,000 patients in Boston.[47]
- Even injury patients in urban areas experienced a transport-time benefit by HEMS in 23% of the cases.[31]

Traumatic brain injury (TBI) is frequently associated with events causing severe, multiple trauma in patients, and is the leading cause of death and disability in children and in adults in their most productive years.[48] As with other major injury, treatment of traumatic brain injury is time-critical. Outside of urban areas, the reduced availability of the neurosurgical services required to treat traumatic brain injury has posed a challenge to EMS. Recent studies indicate that early advanced care by air medical crews and air transport to definitive care by a neurosurgeon can overcome this challenge, resulting in significant improvement to moderately and severely traumatic brain injured patients. [20, 49, 50, 51, 52]

HEMS is generally effective in trauma care circumstances such as when:

- There is an extended period required to access or extricate a remote (e.g. injured hiker, snowmobiler, or boater) or trapped patient (e.g. in a crashed car) which depletes the time window to get the patient to the trauma center by ground.
- Distance to the trauma center is greater than 20 to 25 miles.

- 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.
- 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 the trauma center(s) reachable by ground within the time window.
- EMS systems require bringing a patient to the nearest hospital for initial evaluation and stabilization, rather than by-passing those facilities and going directly to a trauma center. This may add delay to definitive surgical care and necessitate HEMS transport to mitigate the impact of that delay.
- There is a mass casualty incident.[53, 54]

In rural and frontier areas, HEMS and fixed wing aircraft play a particularly important role.[55]

- Where the nearest ground ambulance is further, by travel-time, from the scene of injury than the nearest HEMS, the air medical service may be the primary ambulance for critically ill and injured patients in that area.
- Where the nearest ALS-capable medical facility is further, by travel-time, from the scene of the injury than is a HEMS or a fixed wing provider, the air medical service may be the primary ALS provider for critically ill or injured patients in that area.
- Where blood supplies or availability of other medical supplies or equipment are limited or non-existent, jeopardizing the care of the patient, the air medical service can bring these resources to the hospital with the patient.
- The air medical service can transport specialized medical staff (surgical, emergency medicine, respiratory therapy, pediatric, neonatal, obstetric, and specialized nursing 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.

Diagram of a Fixed Wing Transport

New Missions for Air Medical Services

General Mission Profile

While the public primarily pictures the helicopter landing at a car crash to help a victim with multiple injuries, in the last decade air medical services have increasingly taken on a variety of new missions. In fact, 54% of all air medical transports are hospital to hospital, 33% are scene responses, and 13% are other types (e.g. organ procurement and specialty/neonatal/ pediatric team transport).[12]

Most scene responses are for injuries, but inter-facility flights (or, hospital-to-hospital transports) are often for critical illnesses, such as heart attacks or strokes requiring surgical procedures (including invasive cardiac treatment such as catheterization); acute respiratory problems requiring prolonged intensive care; spinal problems; burns; pediatric and neonatal illness complication; limb reattachment; organ transplants; and complications in high risk pregnancy. These inter-facility missions are showing patient outcome improvements as well.[39, 40, 56]

54% of all air medical transports are hospital to hospital, 33% are scene responses, and 13% are other types (e.g. organ procurement and specialty/neonatal/ pediatric team transport).

Cardiac Care and "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 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 or otherwise require emergency treatment to keep the patient alive. Out of hospital, HEMS ALS has proven effective in dealing with these emergencies. Ultimately, these patients need either special medications or surgical procedures at specialist cardiac intervention hospitals to break up the blood clot, allowing blood and the oxygen it brings to return to the affected heart muscle. 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.

Similar to trauma centers, cardiac intervention centers have been developed to provide the more effective of these increasingly-common surgical treatments. 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.[21, 23, 25, 26, 30, 57, 58, 59]

Cerebrovascular Accidents / Strokes and "Brain Attacks"

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 window of time (optimally within 90 minutes but generally no more than three hours) in which 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 the clot-busting treatment of strokes can benefit from a well-coordinated ground and air system to accomplish early transfer.[60, 61, 62]

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 larger 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. Transfer via critical care ground ambulance is also successfully employed in these kinds of cases. 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. [63, 64, 65, 66]

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 suddenly deteriorate. When this occurs, they require access to neonatal and pediatric intensive care units, which are becoming increasingly limited. Therefore, the care of 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.

Complex Surgical and Medical Conditions

Air medical service is indicated for a number of other time-critical patient conditions. Examples of these include aortic aneurysms, 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).[15, 39, 40]

Mass Casualty Situations and National Preparedness

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. Hospitals close to the mass casualty site will soon become overwhelmed with cases needing attention, whether 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. 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 hospitals as well.

In cases of emergency, helicopters are also useful in evacuating hospitals in areas threatened by hurricane or other disaster, and are often utilized to bring medical staff, equipment and sorely-needed supplies (such as blood and blood products) to the scene when speed is important or roads are impassable. Fixed wing air ambulances can expand that capacity by meeting up 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, either man-made or natural. Since most of the air ambulances in the U.S. today are civilian, they augment the nation's emergency response capacity without cost to the taxpayer.

Photos on this page courtesy of
David Krussow, STARFlight, Austin, TX.

Issues Confronting Air Medical Services and Policy Makers

Growth in the number of air medical services and the types of missions they tackle brings an increasing amount of attention to the operation of those services and to the growth in their numbers.

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. The high fixed costs of maintaining a response infrastructure are necessary in order to be ready to serve.

This is especially problematic in maintaining rural emergency care services. Recent studies from the Capitol Area Health Roundtable and the Government Accountability Office (GAO) have highlighted that current reimbursement does not adequately support the cost of maintaining services. [67, 68]

Helicopters and fixed wing aircraft cost millions of dollars to purchase or lease, operate, house and maintain.[69] Highly trained crews available on a 24-hour/7 days per week basis, and the infrastructure which governs, trains, funds, supports, and links them and their service to the EMS system, are also expensive. As few systems are publicly funded, maintaining the availability of this essential resource inevitably translates into a single patient mission charge that seems expensive in comparison with a lower-priced ground ambulance for the same mission. 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-1990's, AMS was interpreted by some in this way, as an expensive system contributing to the high cost of health care.[69] They postulated that the industry would shrink and require redesign.[69] That did not happen and, as the value of AMS is increasingly demonstrated, reimbursement for air medical services has actually improved and services have expanded in response to other changes in the healthcare system.

At least one carefully constructed economic model comparing helicopter versus ground EMS has been crafted.[70] 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 (1991 dollars). A cost-effectiveness study of helicopter EMS for trauma patients by Gearhart and colleagues concluded that such service is, indeed, cost-effective.[71] In looking at the cost per year of life saved by 500 emergency medical interventions, another researcher found the average to be $19,000 (e.g. clot-busting medication treatment for heart attack is $32,678; 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.[71, 72]

As increasingly difficult decisions about apportioning health care dollars in our aging society are faced, AMS should not only be considered cost-effective in its current roles, but may increasingly serve medically isolated populations in new ways.

Academic studies indicate that air medical transport has the lowest cost per life year saved of all EMS interventions.

Appropriate Utilization

Because AMS affects decisions about where patients are hospitalized, how these patients get to health care facilities, and what kind of care they receive en-route, hospitals and other EMS providers in the areas served often show great interest in assuring that AMS are being properly utilized. This is not always easy: because identifying medical conditions in the field is challenging and some conditions are asymptomatic, there is bound to be some use of AMS for those who prove after the fact to not have needed it ("over-triage") in order to assure that those who will most benefit from AMS are not "missed" (that is, deprived of the service, or "under-triaged").

In 1990, the Association of Air Medical Services published a "Position Paper on the Appropriate Use of Air Medical Services."[73] 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 criteria such as these to review utilization appropriateness and have found compliance with the established criteria to be high.[74, 75] One of these states changed its criteria to expand what was considered appropriate use of AMS based on such a review.[75]

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 the Association of Air Medical Services (AAMS) as well as by the Air Medical Physicians Association (AMPA), which has also separately published 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 mechanisms for prospective flight approval and for retrospective utilization review be in place at the service level. It is highly desirable that utilization review be accomplished on a regional and/or state level where multiple services exist.

Two other tools for utilization appropriateness and improvement exist for system planners. The first is a utilization predictor for HEMS.[76] 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).[77] It 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. cannot reach a trauma center in a timely manner.[78] Continuing research using the same databases indicates a correlation between lack of timely access to trauma centers and access to HEMS.[79]

Safety

From 1972 through September, 2002, when HEMS safety research by Dr. Ira Blumen of the University of Chicago Aeromedical Network (UCAN) was completed, HEMS had flown approximately three million hours, transporting some two and three-quarter million patients.[10] In that time, there were 166 crashes involving HEMS, with 183 fatalities.[10]

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.[10] 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 patents to 292/100,000 patients.[10]

Nonetheless, any form of medical transport incurs inherent risk and in the past few years there have been increased numbers of accidents associated with the increased number of helicopters and transports. In an editorial comment in the UCAN study, a past president of the National EMS Pilot Association emphasizes that

A recent study using the Trauma Resource Allocation Model for Ambulances and Hospitals (TRAMAH) identified that helicopters significantly increased the number of persons who can reach a trauma center within the "golden hour," and also found that over 46 million persons in the U.S. cannot reach a trauma center in a timely manner.

the causes of crashes haven't changed over the years. The top three causes are "risk taking, pre-flight planning, and in-flight decision-making," reflecting the unique pressure placed on crews by the condition of the patient and by the feelings of obligation to fly. The AMS community has taken significant steps, particularly in the area of aircrew resource management (a proven airline industry safety tool) to improve its safety for patients.[10] Some HEMS programs are replacing aircraft, hiring pilots to fly under Instrument Flight Rules (IFR), and employing new technologies such as night vision goggles (NVG's) and terrain avoidance warning systems (TAWS), especially important when weather conditions abruptly change mid-mission.[80]

Transport medicine is among the most complex arenas of medicine, and is characterized by the need to provide immediate access to time-sensitive care for critically ill and injured patients at the same time that operations are conducted in hostile environmental conditions with limited planning time. As Justice Oliver Wendell Holmes once noted: "to be safe does not mean to be risk free." Recognizing that risk cannot be completely eliminated, it is essential both for the public served, and the pilots, nurses, paramedics, physicians, and other health care providers who deliver care, that the practice environment be as safe as possible. To that end, the Association of Air Medical Services has already initiated Vision Zero (http://*visionzero.aams.org*) and has joined the International Helicopter Safety Team (IHST, *www.ihst.org*), led by the American Helicopter Society (AHS), the Helicopter Association International (HAI), the Federal Aviation Administration (FAA), and Transport Canada to reduce helicopter accidents by 80% in the next ten years.

Transport medicine is among the most complex arenas of medicine. Vision Zero and the IHST recognize the need for multi-disciplinary, collaborative, and global efforts towards improving safety.

VISION ZERO

These initiatives seek more effective methods and approaches to avoiding errors in complex systems 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 efforts 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 role within the larger healthcare system. It may be seen as a multifaceted endeavor working with EMS, public safety, public health, and hospitals to create a bridge between the location of a critically injured or ill patient (whether at a scene or in a hospital) and distant specialist care. Air medicine is essential to assuring this access, especially for patients in more rural settings.

Integrating air medicine into healthcare is essential at the local, state, regional, and national level. The recently published national consensus document, "Rural and Frontier EMS Agenda for the

Future," 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.[55] It noted the proliferation of programs and the absence, in many states, of planning, coordination and regulation. It formally recommended that systems "plan, integrate and regulate, at the state level, aeromedical, critical care transport, and other statewide or region wide systems of specialty care and transportation." [55]

The National Association of State EMS Officials (NASEMSO), AAMS, and the National Association of EMS Physicians (NAEMSP) have joined to undertake the development of a "best practices" document for states to use in establishing planning, coordination and oversight mechanisms. When it is available, state EMS agencies should be encouraged to utilize it, as well as to work with other entities with jurisdiction over AMS to better coordinate regulation of these multi-state services.

In addition, as shown in the 2005 natural disasters in the gulf states, civilian air medical services must be included as an integral part of regional and national disaster response plans. Due to the organization of air medical programs and the unique range and speed of medically equipped and staffed aircraft, numerous resources are immediately available to aid in disaster response and evacuations within a single state or on an interstate, regional basis. Over and beyond their integral role in the emergency medical services (EMS) system and their unique function as a bridge between community and specialist tertiary care medical centers, these providers also play an essential and multi-faceted role in the response to major disaster events. Notably, the vast majority of air medical transport services immediately available to a disaster event are non-government provided services.

As illustrated by the problematic evacuation of hospitals in New Orleans and parts of Mississippi following Hurricane Katrina, without these "flying emergency departments," literally thousands of additional lives would have been lost. In any disaster situation, time is of the essence. Prompt response to requests by public safety, emergency medical services (EMS), hospitals, and regional and state Emergency Operations Centers (EOC's) is necessary in order to maximize life saving services. Delays in requests and poor coordination in authorizing response place additional lives at risk prior to or post the disaster event. Plans must include pre-designated authorized requesting agencies in order to facilitate rapid deployment. It is essential that new Regional, State, and Federal disaster response plans incorporate civilian air medical resources to ensure the prompt and coordinated evacuation of critically ill and injured, whether from hospitals or emergency scenes.

Larry Downing/Reuters

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 and evacuation of critically ill and injured patients regardless of the size or location of the event.

The Future

Maintaining access to care is an ever greater challenge for both healthcare providers and policy makers. Natural and man made disasters have highlighted the need for an effective, available air medical system. This was exemplified in the air medical response to victims of Hurricane Katrina in which thousands of lives were saved during both scene response and the evacuation of critically ill patients from hospitals. AMS has been shown to be cost-effective when looking at total medical costs as well as lives saved. 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. 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.

Assuring the availability of effective, sustainable, and available air medical services is essential to the development and implementation of effective emergency response plans for natural and man-made disasters.

According to the US Department of Health and Human Services, "It was 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."[81] 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 non-trauma surgical emergencies (e.g. abdominal aneurysms and stomach/intestinal bleeding).[82] Recent studies examining the response to elderly trauma patients have found that many of these patients do not currently reach trauma centers in a timely manner.[83, 84] As medical science creates new ways to intervene in medical emergencies with technology that must be utilized within a critical window of time, the need for air medical services to bring that technology to patients, or to bring patients to that technology, will increase.

Current financial pressures on the health care system will only increase. The mismatch between demand and resource availability is becoming more acute. 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. The Flying Doctor Service in Australia is one successful model of providing both emergency and routine medical services by air to far-flung populations.

The Association of Air Medical Services believes that it is essential to assure that every person has access to quality air medical and critical care transport when needed. It is imperative that policy and funding support the availability and sustainability of AMS to every community.

References

1. C-47 Hospital aircraft. Available at: *http://www.wpafb.af.mil/museum/modern_flight/c47hsp.htm.* Accessed 2005, December 20.

2. Holmes E. MEDEVAC flight in WWII. Available at: *http://www.helis.com/stories/burma45.php*. Accessed 2005, December 20.

3. Air Force helicopters, past, present. Available at: *http://www-rucker.army.mil/FTS/Helo%20Pages/AF%20Helos.html.* Accessed 2005, December 20.

4. Driscoll RS. New York chapter history of military medicine. U.S. army helicopters in the Korean war. Mil Med 2001;166(4):290-6.

5. Jacobs AR, McLaughlin CP. Analyzing the role of the helicopter in emergency medical care for the community. Med Care 1967 Sept-Oct. Available at: *http://www.emedicine.com/emerg/byname/aeromedical-transport.htm*. Accessed 2005, December 20.

6. Hardaway RM. Wound shock: A history of its study and treatment by military surgeons. Mil Med 2004; 169(4):265-269.

7. Accidental Death and Disability: The Neglected Disease of Modern Society. Committee on Trauma and Shock, National Research Council, National Academy of Sciences. Washington DC, 1966. Available at: *http://www.nap.edu/openbook.php?record_id=9978&chapselect=yo&page=R1*. Accessed 2005, December 20.

8. The history of aviation command, Maryland State Police Aviation Command. Available at: *http://www.mspaviation.org/frames.asp*. Accessed 2005, December 20.

9. Franklin J, Doelp A. Shock Trauma. New York: St. Martin's Press; 1980.

10. Blumen IJ et al. A safety review and risk assessment in air medical transport. Supplement to the Air Medical Physicians Handbook. Air Medical Physicians Association 2002; 2-67. Available at: *www.ampa.org*. Accessed 2005, December 20.

11. Atlas & database of air medical services (ADAMS). 2005 October. Available at: *http://www.adamsairmed.org/.* Accessed December 20, 2005.

12. Frequently asked questions. Association of Air Medical Services. Available at: *www.aams.org.* Accessed 2005, December 20.

13. Safety belts and rural communities report: 2003. National Highway Transportation and Safety Association. Available at: *http://nhtsa.gov/people/injury/airbags/BUASBRuralWeb/index.htm*. Accessed 2005, December 20.

14. Cowley RA. A total emergency medical system for the state of Maryland. MD State Med J 1975;24:37-45.

15. Thomson DP, Thomas SH. Position Paper: National Association of EMS Physicians: Guidelines for air medical dispatch. Prehosp Emerg Care 2003;7(2):265-271.

16. Mustalish AC, Post C. History. In: Kuehl, et. al. Prehospital systems and medical oversight. 2nd ed. St.Louis: Mosby-Year Book, Inc.; 1994. p. 1-27.

17. Delbridge T. et. al. The EMS agenda for the future. National Highway Traffic Safety Administration, DOT HS 808 441 August 1996 NTS-42.

18. Baxt WG, Moody P. The impact of rotorcraft aeromedical emergency care service on trauma mortality. JAMA 1983;249:3047-51.

19. Baxt WG, et al. Hospital-based rotorcraft aeromedical emergency care services and trauma mortality: a multicenter study. Ann Emerg Med 1985; 14:859-64.

20. Baxt WG, Moody P. The impact of advanced prehospital emergency care on the mortality of severely brain-injured patients. J Trauma 1987; 27:365-9.

21. Topol EJ, Fung AY, Kline E, et al. Safety of helicopter transport and out-of-hospital intravenous fibrinolytic therapy in patients with evolving myocardial infarction. Catheter Cardiovasc Diagn 1986;12:151-5.

22. Grines CL, et al. A randomized trial of transfer for coronary angioplasty versus on-site thrombolysis in patients with high-risk myocardial infarction. J Am Coll Cardiol 2002; 39:1713-9(3-11).

23. Kaplan L, et al. Emergency aeromedical transport of patients with acute myocardial infarction. Ann Emerg Med 1987;16:55-7.

24. Tyson AA, et al. Plasma catecholamine levels in patients transported by helicopter for acute myocardial infarction and unstable angina pectoris. Am J Emerg Med 1988;6:435-8.

25. Rodgers G, et al. Helicopter transport of patients with acute myocardial infarction. Tex Med. 1988;84:35-7.

26. Gore JM, et al. Feasibility and safety of emergency interhospital transport of patients during early hours of acute myocardial infarction. Arch Intern Med 1989;149:353-5.

27. Vukov LF, Johnson DQ. External transcutaneous pacemakers in interhospital transport of cardiac patients. Ann Emerg Med 1989;18:738-40.

28. Fromm RE, et al. Bleeding complications following initiation of thrombolytics therapy for acute myocardial infarction: a comparison of helicopter-transported and nontransported patients. Ann Emerg Med 1991;20:892-5.

29. Fromm RE, et al. The incidence of pacemaker dysfunction during helicopter air medical transport. Am J Emerg Med 1992;10:333-5.

30. Straumann E, et al. Hospital transfer for primary coronary angioplasty in high risk patients with acute myocardial infarction. Heart 1999;82:415-19.

31. Shatney CH, Homan SJ, Sherck JP, Ho CC. The utility of helicopter transport of trauma patients from the injury scene in an urban trauma system. J Trauma 2002;53:817–22.

32. The Lewin Group, Inc. TrendWatch Chartbook 2003: Trends Affecting Hospitals and Health Systems. The American Hospital Association 2004; 3:22-34.

33. Wish JR, Edlich RF. Better trauma care: How Maryland does it. J Long-term Eff Med Implants 2005;15(1):79-89.

34. Boyd DR, Cowley RA. Comprehensive regional trauma/EMS delivery systems: the United States experience; World J. Surg 1983;7:149-157.

35. Orme CT et al. Outcome of critically injured trauma patients treated at Level I trauma centers versus full-service community hospitals. Crit Care Med 1985;13:861-3.

36. Smith J et al. Do trauma centers improve outcome over non-trauma centers? The evaluation of regional trauma care using discharge abstract data and patient management categories. J Trauma 1990;20:1533-8.

37. Champion H et al. Improvement in outcome from trauma center care. Arch Surg 1992;20:333-7.

38. Schwartz RJ, Jacobs LM, Juda RJ. A comparison of ground paramedics and aeromedical treatment of severe blunt trauma patients. Conn Med 1990;54:660-2.

39. Thomas SH. Cheema F, Wedel SK, Thomson D. Trauma helicopter emergency medical services transport: Annotated review of selected outcomes-related literature. Prehospital Emerg Care 2002;6:359–371.

40. Thomas SH. Helicopter EMS transport outcomes literature: annotated review of articles published 2000-2003. Prehospital Emerg Care 2004; 8(3)322-33.

41. Wish JR, Davis DP. Auto launch/early activation: a survey of AAMS members and literature review. Air Med J 2005; 24(2):1-6.

42. Branas CC, et al. Access to trauma centers in the United States; JAMA 2005;293(21):2629.

43. Falcone RE et al. Air medical transport of the injured patient: scene versus referring hospital; Air Med J 1998;17(4):161-165.

44. Schwartz RJ, Jacobs LM, Yaezel D. Impact of pre-trauma center care on length of stay and hospital charges. J Trauma 1989;29(2):1611-1615.

45. Champion HR, et al. New tools to reduce deaths and disabilities by improving emergency care: urgency software, occult injury warnings, and air medical services database; NHTSA Paper Number 05-0191; 2005.

46. Mann NC, et al. Injury mortality following the loss of air medical support for rural interhospital transport. Acad Emerg Med 2002;9:694-698.

47. Thomas SH, et al. Helicopter transport and blunt trauma mortality-a multicenter trial. J Trauma 2002;52:136-145.

48. Gabriel EJ, et al. Guidelines for prehospital management of traumatic brain injury. National Highway Transportation Safety Association 2000: 7.

49. Dardis R, et al. A cost-benefit evaluation of helicopter transports to the Beaumont neurosurgical unit. Irish Med J 2000;93:50-1.

50. Macnab AJ, et al. Cost-benefit of trained transport teams: estimates for head-injured children. Prehospital Emerg Care 2001;5:1-5.

51. Di Bartolomeo S, et al. Effects of two patterns of emergency care on the outcome of patients with severe head injury. Arch Surg 2001; 136:1293-300.

52. Davis D, et al. The impact of aero medical response to patients with moderate to severe traumatic brain injury: Ann Emerg Med 2005;46(2):115-122.

53. Jacobs LM et al; The integration of a helicopter emergency medical service in a mass casualty response; Prehospital Disaster Med 1991; 5:451-454.

54. Thomas SH, et al. Helicopter EMS roles in disaster operations. Prehosp Emerg Care 2000;4:338-344.

55. McGinnis KK. Rural and frontier EMS agenda for the future. National Rural Health Association. 2004. Available at: *www.nrharural.org*. Accessed 2005, December 20.

56. Thomas SH, Cheema F, Wedel SK, Cumming M, Thomson D. Nontrauma helicopter EMS transport: annotated review of selected outcome-related literature. Prehospital Emerg Care 2002;6(2):242-55.

57. Werman HA, et al. Helicopter transport of patients to tertiary care centers after cardiac arrest. Am J Emerg Med 1999;17:130-4.

58. Berns KS, Hankins DG, Zeitlow SP. Comparison of air and ground transport of cardiac patients, Air Med J 2001;20:6:33-36.

59. Bellinger RL, et al. Helicopter transport of patients during acute myocardial infarction. Am J Cardiol 1988;61:718-22.

60. Chalela JA, et al. Safety of air medical transportation after tissue plasminogen activator administration in acute ischemic stroke. Stroke 1999;30:2366-8.

61. Conroy MB, et al. Helicopter transfer offers benefit to patients with acute stroke. Stroke 1999;30(12):2580-4.

62. Silliman SL, et al. Use of a field-to-stroke center helicopter transport program to extend thrombolytic therapy to rural residents. Stroke 2003;34(3):729–33.

63. Elliott JP, et al. Helicopter transportation of patients with obstetric emergencies in an urban area. Am J Obst Gynecol 1982;143:157-62.

64. Low RB, et al. Emergency air transport of pregnant patients: the national experience. J Emerg Med 1988;41-8.

65. Van Hook JW, et al. Aeromedical transfer of preterm labor patients. Tex Med 1998;94:88-90.

66. Jones AE, et al. A national survey of the air medical transport of high-risk obstetric patients. Air Med J 2001;2: 17-20.

67. Rural Ambulance Economics. Adapted from "Needed: A 'Low-volume Adjustment' for Medicare Prospective Payment to Small Rural Providers," by permission of the author, J. Graham Atkinson, D. Phil. Capitol Area Rural Roundtable Available at: *http://rhr.gmu.edu*. Accessed 2005, December 20.

68. GAO ambulance services: Medicare payments can be better targeted to trips in less densely populated rural areas. United States General Accounting Office, Report to Congressional Committees, September 2003,

69. Weill TP. Health care reform and air medical transport services. J Emerg Med 1995;13(3):381-387.

70. Bruhn JD, Williams KA, Aghababian R. True costs of air medical vs. ground ambulance systems. Air Med J 1993;12(8):262-268.

71. Gearhart PA, et al. Cost-effectiveness analysis of helicopter EMS for trauma patients. Ann Emerg Med 1997; 30(4);500-506.

72. Teng TO. Five hundred life-saving interventions and their cost effectiveness. Society for Risk Analysis. 1995;15:3.

73. AAMS: Position paper on the appropriate use of emergency air medical services. J Air Med Transport 1990;9:29-33.

74. Benson NH et al. Air medical transport utilization review in North Carolina. Prehospital Disaster Med 1993; 8(2):133-137.

75. Vermont Health Authority Committee. Vermont helicopter committee report. 1997.

76. Macione AR, Wilcox DE. Utilization prediction for helicopter services. Ann Emerg Med 1997; 16(4):391-398.

77. Branas CC, ReVelle CS, MacKensie EJ. To the rescue: Optimally locating trauma hospitals and helicopters. Leonard Davis Institute of Health Economics Univ. of Pennsylvania. LDI Issue Brief. 2000; 6:1. Available at: *http://www.upenn.edu/ldi/publications.html.* Accessed, 2005, December 20.

78. Branas CC et al. Access to Trauma Centers in the United States. JAMA 2005;293(21):2626-2323.

79. Flanigan M. et. al. Assessment of Air Medical Coverage Using the Atlas and Database of Air Medical Services and Correlations with Reduced Highway Fatality Rates, Air Med J 2005;24(4):151-163.

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

81. HHS programs and initiatives for aging America. US Department of Health & Human Services 2000, May 3. Available at: *http://www.hhs.gov/news/press/2000pres/20000503b.html*. Accessed 2005, December 20.

82. Subramanian, R. Top 10 Leading Causes of Death in the United States for 2002, by Age Group. National Center for Statistics and Analysis, National Highway Transportation Safety Administration. Available at: *http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/RNotes/2005/809831.pdf.* Accessed 2005, December 20.

83. Scheetz LJ. Trauma center versus non-trauma center admissions in adult trauma victims by age and gender. Prehosp Emerg Care 2004;8:268-272.

84. Clark DE, Chu MK. Increasing importance of the elderly in trauma. Amer J Emerg Med 2002;20:108111.

Glossary

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

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 EMT's.

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).

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.

tertiary hospital /care—a specialized, highly technical level of health care that includes diagnosis and treatment of disease and disability in sophisticated, large research and teaching hospitals serving a large 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 health care.

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.

Links

Air Medical Physician Association ..... *www.ampa.org*
Air & Surface Transport Nurses Association ..... *www.astna.org*
American Academy of Pediatrics Section on Transport Medicine ..... *www.aap.org/sections/transmed*
American College of Emergency Physicians Air Medical Task Force ..... *www.acep.org*
American College of Surgeons ..... *www.facs.org*
Association of Air Medical Services ..... *www.aams.org*
Commission on Accreditation of Medical Transport Systems ..... *www.camts.org*
Helicopter Association International ..... *www.rotor.com*
International Association of Flight Paramedics ..... *www.flightparamedic.org*
National Association of Communication Specialists ..... *www.naacs.org*
National Association of EMS Physicians ..... *www.naemsp.org*
National Association of State EMS Officials ..... *www.nasemso.org*
National EMS Pilots Association ..... *www.nemspa.org*
National Rural Health Association ..... *www.nrharural.org*
Royal Flying Doctor Service of Australia ..... *www.flyingdoctor.net/who.htm*

SAFETY

Air Medical Safety Advisory Council ..... *www.amsac.org*
HEMS Safety ..... *www.hemssafety.com*
NASA's Civil Helicopter Safety Website ..... *http://safecopter.arc.nasa.gov*
Vision Zero Initiative ..... *http://visionzero.aams.org*

RESEARCH

Foundation for Air-Medical Research and Education ..... *www.fareonline.org*
Institute of Medicine *www.iom.edu/CMS/3809/16107.aspx*

GOVERNMENT

U.S. Army School of Aviation Medicine - Fort Rucker, Alabama ..... *usasam.amedd.army.mil*
Federal Aviation Administration ..... *www.faa.gov*

Acknowledgements

The Foundation for Air-Medical Research and Education (FARE) would like to extend its thanks to the following individuals and organizations who have contributed much to the production of this publication:

Kevin McGinnis, MPS, EMT-P and Thomas Judge, CCT-P, for their careful work in researching and writing this paper.

Editorial Committee

Blair M. Beggan
Amber Bullington
Cheryl Erler, RN, MS
Tom Judge, CCT-P
Dawn M. Mancuso, CAE, MAM
Mark Mennie
John Wish, PhD
Christine Zalar

Members of the Board of Directors of FARE

Tom Allenstein, RN, CMTE
Joan Black, CFRE
Reed Brozen, MD, FACEP
Cheryl Erler, RN, MS
Johnny Delgado, BA, EMT-P, CMTE
Kevin Hutton, MD, FACEP, CHC
Tom Judge, CCT-P
Mark Mennie
Connie Schneider Eastlee, RN, MS, CMTE
D. Gregory Powell, MD, FRCPC
Shirley Scholz, RN, CCRN, EMT-P
Dudley Smith, MSHPA, CMTE
J. Russell Spray
John Wish, PhD
Craig Yale, CMTE
Christine Zalar

Foundation for Air-Medical Research and Education (FARE) | www.fareonline.org
526 King Street, Suite 415, Alexandria, Virginia 22314-3143 USA
(703) 836-8732 telephone | (703) 836-8920 facsimile

ISBN #0-9779331-0-5

Printed in the United States of America.

Photos courtesy of Mark Mennie, Alberta STARS/Mark Mennie (NVG Photo), David Krussow/StarFlight (Katrina Images), REMSA CareFlight, AirLife San Antonio, CareFlite Dallas and LifeFlight of Maine, Larry Downing/Reuters (Pentagon Photo).

FOUNDATION FOR AIR-MEDICAL RESEARCH & EDUCATION

Foundation for Air-Medical Research & Education (FARE)
526 King Street, Suite 415
Alexandria, Virginia 22314-3143 USA
Telephone: 703.836.8732
Facsimile: 703.836.8920
www.fareonline.org