Expert Panel Review of Helicopter Utilization and Protocols in Maryland

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EXECUTIVE SUMMARY

The state of Maryland Helicopter Emergency Medical Service (HEMS), operated by the Maryland State Police, has for years been a model system of medical air transport in the United States. In operation since 1970, and with a longstanding record of safety, Maryland HEMS program has provided emergency medical transport for victims of trauma and other conditions to its regional hospitals. In the aftermath of a HEMS crash in September of 2008, the Maryland Institute of Emergency Medical Services Systems (MIEMSS) organized and convened a multidisciplinary panel of seven experts from around the country to meet and review Maryland's field triage protocols related to HEMS transport, review patterns of helicopter utilization for the field transport of trauma patients within the state of Maryland, and make recommendations for further review and improvement in the Maryland HEMS program. Members of the panel were supplied with materials relevant to the goals and objectives of the review program prior to arriving in Baltimore for the meeting. On November 24th - 25th, the panelists met in open session, to hear presentations by a number of the MIEMSS staff as well as public comment on the helicopter program in the state of Maryland. Following these public meetings, the seven panelists met in closed session for purposes of further review of the material presented, discussion & debate where necessary, and the consensus derivation of the key elements of the report including principles & underlying assumptions, findings/opinion, and recommendations. During these deliberative sessions by the panel, additional requests for information were made of the MIEMSS staff, but at no time were either any of the MIEMSS staff, or members of the MIEMSS board, or anyone else outside of the seven invited experts, present for the discussions and final deliberations by the panel.

Just prior to public presentation of the panel findings, the MIEMSS staff was given the opportunity to review the written summary solely for purposes of identifying and assisting with the correction of any factual errors or inconsistencies. The findings and recommendations of the panel were not derived from the opinions of any single panelist or

subset of panelists, but represent a true consensus of all seven of its members. Participation in this panel of experts was entirely voluntary and done without payment or honoraria of any sort. None of the panelists have a financial or other proprietary interest in the findings or final outcome of the report.

The remainder of this executive summary contains a final version of the principles and underlying assumptions, findings, and recommendations presented in public forum on November 25, 2008. The report that follows the summary provides a background of the material upon which the findings and recommendations of the panel were made. A brief biographical summary of each panelist is contained in the appendix.

PRINCIPLES / UNDERLYING ASSUMPTIONS

- HEMS is an essential component of a contemporary EMS system. Its use improves outcomes in a high risk population of trauma patients.
- Both aviation and critical care medicine are high consequence endeavors a (high risk, high cost, high benefit). HEMS programs must operate at the highest levels of safety practically possible. The safety of patients and of crew members must incorporate a comprehensive systems approach to risk management.
- The configuration of the HEMS system, including overall mission profile and the number and location of aircraft should be determined primarily on the distribution of the population, injury patterns, and the geography of the state.
- HEMS utilization should consider relative costs (opportunity costs as well as financial costs), overall safety including transport safety and patient safety, and potential reductions in morbidity and mortality across the entire system of care.
- HEMS programs nationally have evolved from placing an emphasis solely on rapid transport and minimizing time-to-definitive-care to placing a more balanced emphasis that includes the early delivery of critical care in the field and during transport.
- In order to minimize patient morbidity and mortality, a level of over-triage is necessary and appropriate. Established or agree to benchmarks defining a specific target level of over-triage do not yet exist, especially for HEMS transport.
- Effective HEMS programs incorporate the following:
    i. A comprehensive and robust system of regulatory performance oversight
    ii. Cost effective integration into the healthcare system
    iii. A critical care level scope of practice
    iv. Mode of transport decisions dictated by case specific objective evaluation of distance, circumstances, and logistics of transport
    v. Measured compliance with national consensus standards for dispatch and post transport case review

vi. Meeting standards consistent with the Commission for the Accreditation of Medical Transport Systems (CAMTS) with operations conducted under Part 135 of Federal Aviation Rules
vii. A comprehensive risk and safety management system for all operations.

FINDINGS/OPINION

- Maryland's publicly funded trauma HEMS system (MIEMSS) provides a unique and long recognized national model. It integrates all of the components of the system from first responder to tertiary care and has provided the citizens of Maryland with effective, equitable, and comprehensive access to trauma services.
- Survival outcomes for trauma patients in the State of Maryland, as compared with national norms, suggest that the trauma system performance meets and likely exceeds the national average. Any changes made to the current system of triage and transport should not compromise this level of performance.
- The Maryland State Police Aviation Command has an established safety record and has been recognized nationally and internationally. Improvements are necessary however, to enable the MSP to continue its leadership role in the provision of HEMS services for the state of Maryland.
- The centralized access, communications, and coordination of services provided by SYSCOM are unique system assets and are a model for coordination of HEMS services. The role of SYSCOM should be strengthened as the Maryland's trauma and EMS system continues to evolve.
- The current published field triage scheme used in the state of Maryland is consistent with national standards.
- The recent modification of the field triage process, with the implementation of medical consultation for mechanism-only and co-morbidity-only patients (category 'C' and 'D'), is a reasonable approach and appears to be associated with a reduction in HEMS transport of non-critical patients. It is premature to judge the impact of this change on patient outcomes, however.
- Current utilization review of compliance with triage guidelines and HEMS transport decisions appears to be occurring primarily at the local medical director's level, and the degree to which utilization review is occurring is uncertain. Variability in compliance with triage guidelines may account for some over-triage and use of HEMS for non-critical patient transport.
- A comparison of the rates of 24 hour patient discharge and injury severity for HEMS transported patients in Maryland with similar data reported from other regions in the United States suggests that a level of over-triage is occurring that exceeds that of other comparable systems.
- While no definitive benchmarks exist for HEMS utilization, there is a high likelihood that opportunities exist for reductions in Maryland HEMS transports of trauma patients without compromising patient outcomes or the quality of care. These opportunities potentially exist in patients with injuries that are less time or intervention sensitive.

- It appears that the Maryland HEMS program remains predominately a time-oriented system for rapid transport versus one that places more emphasis on the delivery of pre-hospital critical care in the field.
- While the design of the Maryland HEMS is largely based around transport time to care, there is a lack of related data on the total time to definitive care from point of injury to delivery to the definitive care setting. Without these data it is difficult to assess the appropriateness of resource allocation and/or transport decisions.

RECOMMENDATIONS:

- The EMS board should establish a multidisciplinary task force to determine the optimal number and distribution of HEMS assets based on population needs, geography and current location and capabilities of existing hospitals. This process should be informed by a systematic analysis of the available data and current techniques for optimizing resource allocation.
- The Maryland HEMS program should take the necessary steps to achieve accreditation by the Commission for the Accreditation of Medical Transport Systems (CAMTS). This will help ensure that the Maryland HEMS program maintains processes & procedures consistent with optimal national standards.
- All Maryland HEMS operations should be conducted under Part 135 of the Federal Aviation Regulations, including Federal Aviation Administration's Air Ambulance Operations Specifications. This will help assure that all flights will be operated at the highest levels of medical transportation safety standards.
- MIEMSS should continue their comprehensive and prospective evaluation of the recent modifications to the triage process (medical consultation for category 'C' & 'D' patients) examining over-triage, under-triage, secondary triage, time-to-definitive-care, and patients outcomes.
- The current indicators for the appropriateness of HEMS transport (injury severity, hospital stay less than 24 hours) being collected and used by MIEMSS are appropriate and should be comparatively analyzed on an ongoing basis to monitor system performance.
- The Maryland HEMS program should evolve to a program which emphasizes time-driven critical care goals. This recommendation has implications for crew configuration, education, and expansion of the mission profile to include provision of direct scene response for STEMI and stroke intervention to underserved areas of the state.
- MIEMSS should perform rigorous and regular utilization review on pre-hospital transport to ensure compliance with established triage process and criteria – particularly for HEMS transport.
- MIEMSS should provide enhanced oversight of helicopter utilization and compliance with published triage criteria.

BACKGROUND & PURPOSE OF THE EXPERT PANEL REVIEW

The State of Maryland operates a comprehensive statewide emergency medical services (EMS) system that includes the components necessary to assure residents and visitors of access to high quality, state-of-the-art, emergency medical care. The system origins can be traced to the early 1970s and the state's role, in general, is to provide overall system organization, regulation, and support functions.

Initially, the Maryland EMS system organizational function was housed within the Maryland Institute for Emergency Medical Services System (MIEMSS) at the University of Maryland Medical System (UMMS). UMMS provided training and support services to the statewide system and also provided an organizational home for the state's initial trauma center. In 1992, a Governor's EMS Commission recommended changes to the EMS system to prepare it to be more successful and effective in the future. In 1993, House Bill 1222 in the Maryland General Assembly reorganized the state EMS system. An independent state EMS Board was formed with 11 members that are appointed by the Governor. A 29-member State EMS Advisory Committee (SEMSAC) was created to support the work of the EMS Board. Finally, MIEMSS was removed from UMMS and became an independent agency responsible for overall administration and regulatory oversight of the state's EMS system. Today, the system oversees the training and certification of more than 30,000 EMS providers, licenses commercial ambulance services, implements statewide medical protocols, develops and implements standards for trauma care (including designation of trauma and specialty centers), operates the statewide EMS communications system (SYSCOM), and partners with local governments and other state agencies to operate the overall EMS system.

The trauma system in Maryland grew out of the pioneering work of R Adams Cowley, MD who opened the Center for the Study of Trauma at the University of Maryland Hospital in 1969. His work suggested that injured patients should be rapidly transported, bypassing local hospitals, and treated at hospitals uniquely prepared and experienced to deal with trauma. In 1997 MIEMSS promulgated regulations for the designation of trauma and

specialty centers and formal designation of trauma centers under the new regulations began in 1998. Today, the system is composed of a statewide network of trauma and specialty referral centers designed to provide quick access to appropriate trauma care anywhere in the state. The trauma system includes the Primary Adult Resource Center (the R Adams Cowley Shock Trauma Center at UMMS), one Level 1 trauma center the Johns Hopkins Hospital Adult Trauma Center in Baltimore, four Level 2 trauma centers (John Hopkins Hospital Bayview Medical Center, Prince George's Hospital Center, Sinai Hospital, Suburban Hospital), three Level 3 trauma centers (Washington County Hospital, Western Maryland Health System – Memorial Campus, Peninsula Regional Medical Center), ten specialty referral centers for the treatment of trauma, and a variety of other specialty referral centers for perinatal, poisoning, and stroke.

Dr. Cowley's early work with trauma was based on the concept that it was essential to deliver critically injured trauma patients to a trauma center very quickly in order to reduce morbidity and mortality. At the time, the Maryland State Police (MSP) was operating a fledgling aviation program to support their law enforcement mission. Dr. Cowley and the MSP developed a partnership that resulted in the MSP aviation division becoming the first civilian agency to transport a critically injured trauma patient by helicopter on March 19, 1970. Rapid transportation to a trauma center was the essence of the partnership. That landmark event significantly altered the mission of the MSP aviation program. Today, the MSP aviation program performs five separate missions: EMS medical transportation (HEMS), aerial law enforcement, search & rescue, homeland security, and disaster assessment. However, as identified by the Office of Legislative Audits of the Maryland General Assembly, the vast majority of activity for the MSP aviation unit is in support of the HEMS program. Three other air medical programs also operate in the state, but the MSP HEMS program is almost exclusively the HEMS agency for the state EMS system.

Currently, the Maryland HEMS program operates 11 Dauphin helicopters from 8 bases. The program employs 50 pilots (civilian or state police), 45 flight paramedics (all MSP troopers), and 23 helicopter mechanics. The HEMS system responds to 8,500-10,000 missions per year, resulting in the transportation of 4,000-5,000 patients per year. 98% of the transports are direct from the scene to a trauma center. More than 125,000 patients have

been transported since the program flew its first HEMS flight in March 1970. The Maryland HEMS program operates under Part 91, general aviation rules, of the Federal Aviation Administration's regulations, generally considered to be less stringent than the Part 135 commuter/on-demand regulations under which commercial air medical/HEMS programs must operate.

The flight crew for the MSP HEMS program consists of two personnel: the pilot and a flight paramedic. Medical care on MSP helicopters is provided by flight paramedics. Each flight paramedic is a fully trained Maryland State Police trooper - law enforcement professional. In addition, they are required to have ground EMS experience and must complete more than 1,200 hours of training, including 600 hours of flight training. Medical care, as well as patient destination decisions, is guided by Maryland's statewide EMS protocols.

In early 2008, the Office of Legislative Audits of the Maryland General Assembly conducted an audit of the MSP aviation program. In the final report dated August 14, 2008, the auditors identify that the program is "extremely dedicated to accomplishing their mission of providing timely medevac services…is highly regarded throughout the country….and it has an extraordinary safety record." The auditors also identify a number of issues concerning management oversight, efficiency, and effectiveness which are enumerated in the full audit report.

In fiscal year 2007, the MSP aviation program operated on a budget of $22.3 million. 59% of that total was for salaries and benefits. Unlike programs operated by commercial helicopter services, patients are not billed for the HEMS transportation. Instead, funding to support the program comes from a special motor vehicle registration surcharge (80%) and from the state general fund (20%). The safety record of the MSP HEMS program is exemplary by any standard. The program operates a fleet of 11 American Eurocopter Dauphin helicopters that were purchased between 1989 and 1999.

In September 2008, an MSP HEMS aircraft crashed in Prince George's County, resulting in the death of the pilot, flight paramedic, a ground EMT, and a patient. A second patient survived the crash with serious injuries. Although there have been a number of minor incidents in the unit's history, prior to this fatal crash, the last reportable accident with

injuries and damage to a helicopter occurred in September 1989. The last helicopter crash with a fatality occurred in September 1986. Both of these incidents occurred prior to the fleet transition to the Dauphin helicopters.

The recent fatal crash, combined with an impending need to replace the aging helicopter fleet at a significant cost, has focused a great deal of public, media, and political attention on the HEMS program in Maryland. The attention and debate in Maryland echoes the current ongoing debate throughout the country about the safety and efficacy of HEMS transportation. 2008 was a dismal year for HEMS program nationwide with a record number of crashes and fatalities. The National Transportation Safety Board hearings in February of this year reflect the level of national concern regarding HEMS safety.

Immediately following the September 2008 crash, MIEMSS initiated a comprehensive review of the protocols involving the decision to transport a patient by helicopter to a trauma center, as well as the process for requesting helicopter transport. The review process involved an external review of protocols and processes used in other states, as well as an internal review of the data from within the state of Maryland.

Existing triage and transport protocols at the time of the crash identified four categories of patients in the trauma decision tree:

- Category A: Emergency critical physiologic pathology and anatomic injuries
- Category B: Time sensitive injuries or specialty center attention
- Category C: Mechanism of injury or high-energy impact that suggests a 20% or higher likelihood of significant injury (without meeting the criteria for either ‘A’ or ‘B’ above)
- Category D: Patients who do not manifest signs and symptoms of injury, but who have bleeding problems or who do not have the normal compensation mechanisms due to altered physiology or medications that inhibit those manifestations. (without meeting the criteria for any of the categories above)

Under the protocols in place at the time of the crash, the guidance provided for Category C and D patients specified that patients within 30 minutes drive time of a trauma or specialty center should go by ground, but added that helicopter transportation should be considered “if of clinical benefit”. The protocol review process resulted in a change in this

language such that it now states that "receiving trauma center medical consultation is required when considering whether helicopter transport is of clinical benefit." Under the previous protocol, the decision about appropriate use of HEMS transport was primarily a field decision. Under the revised protocol, there has been a shift of the decision-making authority to a physician. Following revision of the protocol, MIEMSS engaged in a statewide education process to reach all prehospital providers with the content and rationale behind the protocol revision. A system was also put in place to specifically monitor the results, if any, of the protocol change.

In a continuing effort to assure the safety, appropriateness, and effectiveness of the Maryland HEMS system, the Governor of Maryland and MIEMSS convened an expert panel to conduct a review of the HEMS program operated in Maryland. The purpose of the panel was threefold: 1. Review Maryland field triage protocols specific to the use of helicopter transport of trauma patients from the scene of an incident; 2. Review trends in helicopter utilizat6ion for scene transport of trauma patients in Maryland; and 3. Make recommendations for changes or improvements

The panel convened in Baltimore on November 24 and 25th, 2008, have been previously provided with data and supporting documentation concerning the HEMS program. Verbal testimony was provided by MIEMSS staff and other interested parties, including members of the public-at-large. Following the public portion of the meeting, the panel of seven experts met in closed session. This was done for purposes of allowing unfettered discussion and debate and to ensure that the resultant findings represented a true consensus of all the panelists.

TRAUMA FIELD TRIAGE

The establishment of regional systems of trauma care in which more acutely injured patients are transported in a timely fashion to a limited number of specialty referral centers (trauma centers), has been widely advocated as an approach for improving trauma outcomes. Several studies have now documented the effectiveness of a regionalized approach to trauma care [1-7]. Most recently, the National Study on the Costs and Effectiveness of Trauma (NSCOT) showed that the risk of death is 25% lower when care is provided in a regional, level I trauma center than when it is provided in a non-trauma center hospital [1].

However, not all patients need treatment at a level I or level II trauma center. Indeed the majority of all injured patients (an estimated 75%-85% of all injured persons) can be effectively treated at a lower level of care (a non-trauma center hospital or a hospital designated as a level III/IV trauma center). For this reason, coupled with the reality that trauma center care is expensive, it is critical that appropriate triage criteria be established to ensure that the right patients get to the right level in the right amount of time.

SCHEME	CRITERIA
Amended MTOS	traumatic deaths + need for OR within 24hrs + ICU admission
West et.al.	ISS > 9 AND 3 day LOS
LOS	Hospital discharge (not transfer) within 24 hours
ISS method	ISS > 15
MacKenzie 1990	(ISS > 15) or AIS3 injury to head, spine, thorax, abdomen, pelvic fracture, crush to extremities, vascular injury or age > 55 with ISS ≥ 9 (excluding hip fractures) or age < 5 with any ISS ≥ 9

Table 1: Various criteria for determining triage targets

The American College of Surgeons Committee on Trauma (ACS-COT) published the first set of triage criteria in 1986 with subsequent updates published in 1990, 1993, 1999 and most recently, in 2006. The 2006 revisions were based on a comprehensive review of the existing evidence and involved a national expert panel representing EMS providers, EMS medical directors, emergency physicians and nurses, trauma surgeons, public health personnel and relevant federal agencies. The recommendations that evolved from this comprehensive review were based on these expert opinions and the best evidence

available at the time. [Center for Disease Control, MMWR, January 23, 2009]. While advocating for the adoption of these criteria by trauma systems nationwide, the panel recognized the need to adapt them to local environments and local circumstances. It should be emphasized that the ACS-COT criteria do NOT include criteria for making decisions to transport by helicopter or ground. Currently there are no nationally accepted standards for making these 'mode of transport' decisions in the field, although consensus guidelines exist identifying the clinical and operational circumstances under which medical helicopter dispatch is appropriate. [54] Over the years, the ACS-COT criteria and have been adapted for local implementation by state and regional EMS and trauma systems around the country, and represent as close to a "national standard" for field triage as possible. There are minor difference in triage scheme between that utilized in Maryland and the ACS/CDC scheme which are consistent with expected regional variations. The overall approach to field triage used in Maryland, therefore, is quite consistent with national standards.

Under ideal conditions, all persons with life or limb threatening injuries would be transported to and managed at a level I or level II trauma center. Persons with less serious injuries would be ideally be transported to and treated at designated facilities with less extensive resources (level III/IV trauma centers or participating community hospitals). Completely accurate triage, however, is impossible to achieve due to a variety of reasons. The primary goal of any triage scheme has been to minimize under-triage (taking more seriously injured patients to non-trauma centers), and avoiding the risks of secondary transfers to higher level centers, while making an effort to avoid excessive rates of over-triage, (taking too many patients with minor injuries to trauma centers), which may place undue burdens on higher level designated centers.

It is well recognized, however, that in order to minimize under triage, trauma systems must maintain a certain level of over triage. Acceptable percentages of over triage have been estimated to range from 25% to 50%, but this is based more now on estimation and expert opinion rather than on actual outcome data. It is notable that the National Trauma Database, a compilation of data from predominately Level I and Level II trauma centers reports the aggregate percentage of patients with an injury severity score of less than eight (one recognized measure of over-triage) at approximately 77% (NTBD report, 2007,

American College of Surgeons), suggesting that the long-standing 'target' for over-triage of 25-50% may be vastly under-estimated for operating trauma systems.

Unfortunately, there is no uniform standard by which to measure over- and under-triage, with a variety of schemes being utilized over the years (Table 1). The most accessible data for regional trauma systems tends to be either hospital discharge data or injury severity data, both used in Maryland. The incidence of air transported trauma patients discharged home from Maryland hospitals within 24 hours (FY2007) was reported to be approaching 41% which appears to be high relative to that reported for some other regions of the country. Additionally, the incidence of patients with an ISS < 8 transported by air was reported at approximately 51%. By comparison, the aggregate total of all trauma patients with an ISS < 8 reported by the NTDB was only 45%, also suggesting that a disproportionate number of patients with relatively minor injuries were utilizing HEMS transport in the state of Maryland. It is likely that the majority of these fall into the field triage category 'C' or 'D' as described above. The recent steps taken by MIEMSS mandating physician review of HEMS transport decisions for these categories of patients appears to be a prudent and reasonable approach in curtail air transport of more minor trauma patients. The early experience with these changes indicate a drop in flight transports that will likely result in a sustained reduction of non-essential HEMS utilization.

HELICOPTER UTILIZATION FOR THE TRANSPORT OF TRAUMA PATIENTS

There is a sufficient body of evidence to support a contention that real-world HEMS utilization is associated with improvements in trauma outcome. There are a number of studies addressing this issue. A summary of the literature is beyond the scope of this report. Such detailed reviews are available from the prehospital literature (NAEMSP reviews covering 1980-2006) [8-10] and in an independent 2007 report commissioned by the Alberta (Canada) health ministry. [11] All of these reviews conclude that judiciously utilized HEMS is associated with clinically significant improvement in outcome.

Mechanisms for HEMS benefit

Research studies focusing on the earlier delivery of a higher level-of-care made possible with HEMS transport demonstrate improved outcomes associated with HEMS. These findings are most notable in studies for which the main focus was some factor other than transport mode. Studies assessing prehospital intubation (ETI) have provided important evidence supporting HEMS' salutary impact on outcome. [12-13] For those cases in which ETI is involved, assessment of peri-intubation respiratory physiology provides clues to mechanism for outcomes improvement associated with HEMS. As an example, in an investigation of rapid-sequence intubation (RSI) in severely head injured patients,[14] HEMS ETI was found to be associated with improvements in blood pressure, oxygen saturation, and end-tidal carbon dioxide levels as compared with pre-ETI levels. By comparison, ground EMS ETI data indicate disturbing trends towards worsening of outcomes, the most recent data on air medical crew ETI continue to support the notion that HEMS ETI is similarly safe and effective as ETI in the acute care hospital setting. [15] These peri-intubation physiologic derangements have been invoked to explain the fact that ground EMS ETI worsens outcome in head-injured patients, whereas prehospital HEMS crew ETI improves morbidity and mortality. [16] Additionally, recent prehospital airway research has bolstered arguments that, even when ETI is performed by ground ALS, HEMS transport improves outcome as compared with ground transport because of post-ETI

ventilation practices. [17]

The favorable impact of air medical transport on trauma mortality is demonstrated in a wide variety of studies, from around the world. The overall picture of the data is consistent with a reduction in mortality of between 1 and 10 patients per 100 transports. This estimate is sufficiently precise to allow for exploratory calculations in cost-effectiveness (see next section).

Cost/Financial considerations

Even the most ardent HEMS critics acknowledge that helicopter utilization is useful in some settings, and a larger debate is not over the question of whether HEMS has any associated benefit but to what degree HEMS utilization is cost-effective.

The assessment of costs and benefits is complicated, involving medical and non-medical considerations that are too complex to be covered in detail in this report. Some of these benefits are directly related to outcomes improvement (*e.g.* decreased need for long-term care for head-injured patients). [18] A Canadian Institute of Health Economics report reviewing evidence available at that time, concluded that "air medical services appear to be expensive on a single-case basis but not at a system level." [11] This report was prepared by an independent governmental advisory body with no apparent bias in the HEMS debate. Another study from Norway, calculating cost-benefit for the entire spectrum of HEMS transports, concluded: "The analysis indicates that the benefits of ambulance missions flown by helicopters exceeds the costs by a factor of almost six." [19] Similarly, in a Finnish report authors calculated that the cost of HEMS was within their criteria for cost-effectiveness, [20] and an English governmental analysis also concluded that HEMS costs fell well within the cost-benefit range defined as acceptable. [21] In the United States, economic analyses have concluded that HEMS response to the scene (with direct transport to trauma centers), is both beneficial and cost-effective. [22]

The preponderance of available evidence suggests that HEMS use, in relatively mature and well-organized systems, is cost-effective. The literature is not conclusive, but the similarity of various estimates for cost-effectiveness adds weight to the overall conclusion, that health outcome rewards justify wise allocation of (increasingly scarce)

healthcare resources to HEMS.

Opportunity costs associated with prolonged ground transport

It is generally recognized that HEMS utilization may augment ground ALS transport coverage. One air medical vehicle can cover roughly the geographic area of seven ground ALS ambulances, [23] potentially preserving other ground ALS coverage in rural areas where such coverage is thin. Some regions have come to rely on HEMS as a means to assure they will not lose ALS coverage for a prolonged period of time should a patient requires ALS-level transport to a distant receiving hospital. The use of HEMS to preserve ground EMS capabilities is a system-level issue, and the solution will require system-level planning with careful consideration of the risks of losing ground EMS units that are out of service for an extended period (*i.e.* while performing a longer-distance transport. [24]

Safety & risk/benefit balance

While safety is the most important goal for any HEMS (or ground) prehospital operator, risk cannot be completely eliminated. Therefore, operational risk management efforts should ideally be complemented by ongoing efforts to use HEMS – and incur its attendant risks – in cases where benefit is most likely. Recognizing the lack of nationally sponsored or accepted guidelines for HEMS utilization, it falls to local or regional EMS systems to develop their own modification of field triage schemes incorporating guidelines for HEMS versus ground transport utilization. Compliance monitoring and periodic assessment of under- and over- triage related to HEMS transport should be integral components of such a program. [25-26]

HEMS OPERATIONS IN THE UNITED STATES

The use of helicopter EMS in the United States has evolved directly from the military experience in the Korean and Viet Nam conflicts. The use of rapid medical evacuation—medevac—to trauma specialists resulted in significant reduction in mortality and morbidity of injured soldiers. The first civilian uses of the concept were Maryland Shock Trauma System working in conjunction with the Maryland State Police (1970) and St. Anthony's Hospital in Denver (1972). These early operations have since grown into a complex although sometimes not well integrated air medical system in the United States.

Growth in the number of medical helicopters has been steady since the 1970's with periods of rapid growth in the 1980's and a further period of rapid growth since 2000 in which the fleet has more than doubled. Collectively these services provide about 3% of all ambulance transports in the US. [27] While individual HEMS programs' mission profiles vary, on average (in the U.S.) a HEMS program will perform 54% inter-facility (hospital) transports, 33% scene runs or "modified" scene of a rapid emergency trauma transfer from a small hospital to trauma center, and 13% "other" mission types (e.g. neonatal, pediatric, transplant-related). [28]

Currently there are 839 identified dedicated medical helicopters operating from 698 bases in the United States. The rotor craft fleet is supplemented for long distance and repatriation transport with 293 fixed wing air ambulances operating from 155 bases across the US. [29] HEMS integration into EMS systems is variable and there does not seem to be a readily observable pattern to areas with multiple helicopters and areas with few helicopters across the US. The mid-Atlantic area has a high concentration of helicopters as compared nationally and Maryland is well covered with four provider agencies including the Maryland State Police and 3 private hospital aligned provider agencies operating 18 aircraft from 14 bases within the state.

Approximately 85 percent of the provider agencies in the US are private with a variety of corporate configurations. While historically, most systems have been hospital based, non-profits in which the hospital contracts for aviation services from a certificated air

carrier, (traditional model) more recent growth has been independent program models in which the air carrier employs the medical crew, (community model). Independent programs are a mix of non-profit and for-profit corporate configurations with a handful of large multi-state for profit organizations own and operate nearly 50% of the medical helicopters as independent models. With the exception of only a few of the largest for-profit entities that operate more than fifty aircraft each, most air operations are small with less than 5 aircraft.

Both the periods of rapid growth have been associated with increases in the number of crashes which has led to widespread concern among regulators, the NTSB, and the public about the safety of the air medical system. Of note, 2008 was the single worst experience in fatal injuries incurred during medical helicopter transport with 9 of 14 incidents incurring 28 fatalities, including a mid-air collision of two medical aircraft over the medical center in Flagstaff, AZ.

While there is renewed and ongoing debate regarding the HEMS system both within Maryland and nationally, due to concerns about safety, appropriate use, and growth, drivers for growth and use are multi-factorial. Growth in numbers of aircraft which has been partially driven by improved reimbursement is tied to structural changes in the healthcare system, especially affecting rural areas. Factors include:

- closure of hospital emergency departments which have declined from just over 5,000 in 1992 to approximately 4,600 in 2002, a trend that is expected to continue [30-31]
- a reduction in trauma centers [32-33]
- reduction in the availability of specialist care, especially as regards night coverage;
- the continued concentration of specialist care into urban centers
- closure of rural hospitals due to financial pressures and/or conversion to critical access hospital status
- emergency department and hospital overcrowding with increasing tight capacity for critical care and specialty beds causing diversion of EMS patients to more distant hospitals. [34]

While the original premise for helicopter use was rapid evacuation during which time was the critical element and with limited advanced emergency care, the focus of use has now shifted to the concept of earlier, more advanced care being critical. As the system has generally evolved away from hospital based helicopters, the personnel and equipment have also matured into a framework of specialist teams and equipment. The aircraft in this

setting brings the capabilities and expertise of the tertiary center directly to the patient whether at an accident scene or in a smaller hospital. By and large flight teams operate with sophisticated, physician level scope of practice with ready access to medical technology (ventilators, infusion pumps, invasive hemodynamic monitors), and a pharmacological formulary that resembles an emergency department or ICU rather than a ground ambulance. In global terms the evolution has been focused on providing immediate critical care rather than immediate transport. This is probably best seen in Europe where helicopter staffing configuration and scope of practice is specialist physician level. It is interesting to note that some of the best results in outcome studies are from European systems.

The most common operating configuration in the United States is a single pilot and two medical crew (93%) with a small number using either one medical provider (3%) or three medical providers (4%). The most common medical crew configuration is one flight nurse and one flight paramedic (67%). Less commonly used configurations are flight nurse/flight nurse (8%), flight nurse/flight physician (5%), flight paramedic/flight paramedic (5%), flight paramedic only (<2%), and flight nurse only (<1%). [35]

Regulations and Standards for HEMS Programs

HEMS regulations and standards are a combination of federal (air) and state (medical transport) requirements with additional voluntary best practice standards articulated by the Commission for the Accreditation of Medical Transport Systems (CAMTS.)

Federal requirements:

Federal Aviation Rules (FARS) govern all of civilian aviation including public use aircraft. The FARS are divided into multiple sections with provider requirements matched to activity. HEMS regulations are governed primarily in three areas: Part 91- General Aviation, Part 135- Commercial Air taxi, unscheduled commercial passenger for hire, and Part 145- Maintenance facilities. As the MSP Aviation Command does not charge patients for services they are able to operate under Part 91 General Aviation Requirements, (versus those commercial operators providing patient-billed for services who must comply with Part 135

standards). This situation creates disparity between the regulatory requirements for MSP Aviation Command and commercial providers elsewhere in the United States.

In general Part 135 FAR's are more restrictive in a series of areas including:

- Administrative Leadership Qualifications
- General Operations Documentation and Policy Requirements (General Operations Manual)
- Flight and duty times
- Weather minimums
- Maintenance and documentation requirements
- Maintenance personnel qualifications

The panel noted that a recent audit of the MSP Aviation Command had recognized that the service was already voluntarily adopting a number of Part 135 requirements. As the NTSB has recommended that all HEMS patient related flights be conducted under Part 135 Rules and the FAA has recently adopted Air Ambulance Specifications (AO21) that incorporate this recommendation, the panel believes that adherence to the stricter Part 135 standards for HEMS missions is warranted.

HEMS operations are divided into operations that use visual flight rules (VFR) in which ground reference must be maintained by the pilot and instrument flight rules (IFR) in which the aircraft can operate without ground reference in the clouds or periods of lower visibility. All commercial passenger transport (scheduled airlines) and most fixed wing medical transport providers operate under IFR rules.

The MSP Aviation Command operates under the more stringent IFR rules. IFR operations require more sophisticated twin engine, stabilized aircraft with redundant navigation and electrical systems. Single pilot IFR operations require the aircraft to be stabilized with a multi-axis auto-pilot. In addition, due to law enforcement and homeland security operations, the MSP aircraft have enhanced infra-red vision systems, night vision goggles, and due to the flight restrictions around the Capitol the latest ADSB flight tracking systems, and are in the implementation of the addition of terrain avoidance technology (HTAWS) to the aircraft.

The FAA estimates that a relatively small percentage of HEMS aircraft (< 15%) in the US consistently operate with IFR (instrument flight rules). Unlike the MSP, HEMS

growth nationally in the last decade has primarily been single engine and VFR (visual flight rules) only operations as the costs incurred for operation are significantly lessened. VFR aircraft are particularly vulnerable to inadvertent flight into meteorological conditions that require instrument-guided flight, where the pilot workload is significantly and rapidly increased. Lack of night vision also increases vulnerability in very dark or poor visibility conditions. Poor visibility for ground reference, especially at night is the highest associated condition for HEMS accidents and fatal accidents. Approximately 30% of HEMS operations currently use night vision technology and very few operations have yet adopted terrain avoidance technology such as H-TAWS.

Commission on Accreditation of Medical Transport Services (CAMTS)

Accreditation is a voluntary assumption of externally measured compliance with best practice standards. Accreditation is awarded for up to three years with annual verification requirements. CAMTS is comprised of multiple professional organizations (www.camts.org) and has established a broad series of general business, clinical and quality, and operations standards. In general, while a number of states require CAMTS accreditation, the standards substantially exceed minimum state licensing requirements. Currently about 40% of the medical flight programs in the United States and Canada are accredited by CAMTS. It should be noted that commercial air medical operators in the State of Maryland, but not the MSP, are required under state licensing rules to be CAMTS accredited (COMAR Section 30, Subtitle 09, Chap. 13).

Significant to the discussions of the panel in the review of the Maryland system were the CAMTS requirements for two medical crew configuration and the incorporation of critical care into the system. While CAMTS accreditation is voluntary and will require significant changes to MSP operations the panel firmly believes that the MSP medical operations to patients will be substantially enhanced by adoption of this self imposed requirement. The panel also noted that MIEMSS and the MSP have already taken initial steps to evaluate the CAMTS accreditation option

HEMS OPERATIONS IN MARYLAND

Maryland State Police Aviation Command

The Maryland State Police (MSP) Aviation Command was established in 1961. In 1970, the MSP aviation division expanded its mission to include emergency medical services (EMS) responses as a part of the evolving Maryland trauma care system. Initially, the MSP aviation division utilized Bell 206 Jet Ranger aircraft and later changed to Eurocopter AS365 Dauphin aircraft beginning in 1990.

The MSP Aviation Division operates 11 Eurocopter AS365 Dauphin helicopters. These are located at 8 bases throughout the state with 3 aircraft in reserve. [36] In addition to a primary HEMS capability, the MSP provides a broad range of additional integrated services including search and rescue (SAR), law enforcement, and homeland security duties. The IHS LifeFlight program in Salt Lake City, UT, is the only non-public HEMS provider in the US providing SAR and hoist capability.

Aviation Safety Record

The safety record of the MSP Aviation Command has been well recognized with an experience of EMS (HEMS) missions spanning nearly four decades. They have had 3 fatal accidents and 2 non-fatal accidents since undertaking HEMS operations as a part of their mission:

10/28/1972—2 fatalities (VFR flight into adverse weather),

01/19/1986—2 fatalities (VFR flight into adverse weather),

09/09/1989—4 injuries (Failure to use maximum performance takeoff),

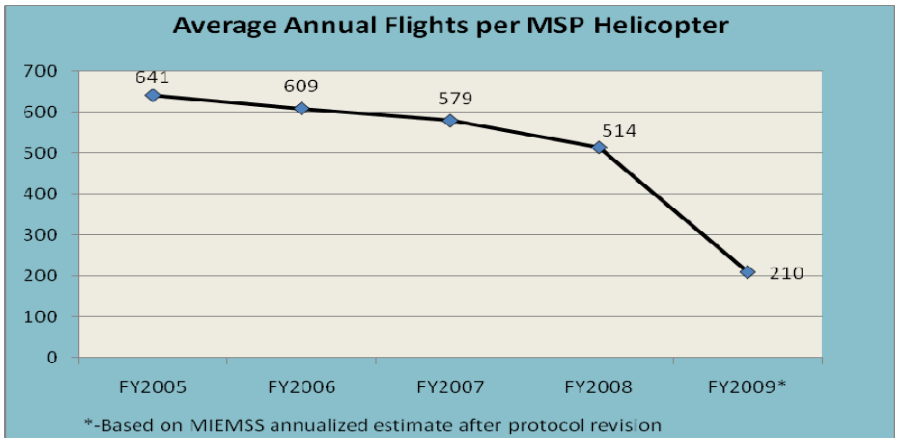
04/XX/2000—0 injuries (Rotor struck bunker on roof of hospital) [37]

08/27/2008—4 fatalities, 1 injury (Investigation pending). [38-39]

Despite these incidents, the safety record of the MSP Aviation Command has been exemplary when compared to trends in HEMS crashes in the United States over the last decade.

While the accident rate is one aspect of HEMS safety, there are other components of the Maryland system that must be considered. The Maryland Medevac system is unique in that only one medical crew member staffs the helicopter. In most HEMS operations there are two medical crew members. The practice of staffing the Maryland helicopters with only one medical crew member is concerning. Critically-injured trauma patients can be labor-intensive in terms of medical care. An additional medical person on board can certainly enhance the care provided while en route to the trauma center. Historically, when additional medical help is required, the MSP paramedic will recruit a second crew member from ground EMS providers on scene. This practice is problematic in that ground personnel may not be familiar with helicopter operations—especially in regard to safety.

Maryland HEMS Usage Patterns



Trauma registry numbers represent all aeromedical scene transports regardless of flight service utilized. The overwhelming majority of these were flown by the MSP Aviation Command. The medevac dispatch software (CAD) numbers include burn, hand trauma, eye trauma, and medical patients flown from the scene in excess of the trauma registry patient set. In addition, it is possible that the trauma registry data may be under-reported secondary to data coding errors. [40] These transport numbers increased from 1998 and peaked in 2005. Since 2005, there has been a general decline in flights. (Table 2)

YEAR	SCENE TRANSPORTS	% DECLINE FROM PRIOR YEAR
FY 2005	5,126 patients	
FY 2006	4,874 patients	4.9%
FY 2007	4,634 patients	4.9%
FY 2008	4,114 patients	11.2%

Table 2: Trends in HEMS scene transports

Usage data for the MSP Aviation Command for EMS missions are available for fiscal years 2005-2008. Overall, there was a steady decline in HEMS usage each year (which is supported by the trauma registry data). [41] Overall, by FY2008 (July 1, 2007-June 30, 2008), there was a 20% reduction in HEMS usage in Maryland during this interval.

Following the crash of Trooper 2 in September 2008, a policy was instituted by MIEMSS to limit HEMS usage for Category C and D trauma patients. This policy revised the prehospital trauma triage protocol and mandated that prehospital providers who were caring for patients classified as Category C or D would consult with a physician before HEMS transport was summoned. For the first 7 weeks after the protocol change, there was a marked reduction in HEMS usage within the state of Maryland. Of the 396 requests for HEMS during this 7 week period, 42.7% were not flown for various reasons. Based on these data, albeit premature, MIEMSS staff predicted that the annualized air transport number would be approximately 1,679. There have been no reports of changes in mortality or morbidity as a result of this protocol change as yet. [42] However, it is important to point out that there have not been enough patients treated and transported under the new triage scheme to determine, with statistical validity, whether system mortality and morbidity have truly been unaffected by these changes.

Prior to the crash of Trooper 2, the MIEMSS and MSP systems were well on their way to decreasing HEMS usage. In fact, prior to the crash of Trooper 2, HEMS in Maryland had declined by 20% compared to FY2005. Based upon MIEMSS predictions, HEMS usage may decline by 67.2% following the new prehospital triage category.

HEMS: Maryland versus other systems

There are a number of unique characteristics in the Maryland system as compared with other areas of the country including the organization, coverage, tasking, staffing, and funding of air medical services. The panel recognized MIEMSS and Maryland's leadership and contributions to the evolution of modern trauma and emergency care in the United States. As there is no true national databank it is difficult make precise comparisons among systems as to the effect of design on outcome. The panel was presented with some comparative data from San Diego County during the review meeting but a more accurate

comparison may be Massachusetts which is similar in population, geography; numbers of major trauma hospitals, organization of the EMS system, and along with Maryland consistently achieves one of the lowest fatality rates from motor vehicle crashes year per year. [43] The comparison is also apt as the primary tasking reason for MSP response is motor vehicle crashes. While different in numbers of aircraft, coverage, and system organization both systems have tight integration of the HEMS programs within the overall EMS system.

Despite assertions to the contrary regarding access to care, it is essential to note in comparing national fatality rates from trauma there is no correlation to the numbers of helicopters per population or per square mile of coverage despite many systems using very similar triage guidelines. In addition, there is widespread variation in use patterns and there is inconsistent integration of HEMS within the medical system.

State	Services Headqrtd in State	Out of State Services w/Bases in State	Bases with RW	Bases with FW	Total Bases (1)	RW Aircraft (2) (3)	FW Aircraft (2)	Total Aircraft (2)	State Pop. (Y2000)	Total State Area (Sq Mi.) (4)
Maryland	1	3	14	1	14	18	2	20	5,296,486	12,407
Mass.	2	0	3	1	3	4	1	5	6,349,097	10,555

Table 3: HEMS services in Maryland & Massachusetts

General statistics:

	Maryland	Massachusetts	National Avg.
Population density sq. mi.	427	601	74
HEMS density population	378,320	1,587,274	335,425
HEMS density sq. mi.	689	2639	4514
% population 10 min. fly circle from HEMS base	100%	80%	74.8%
% population 20 min. fly circle from HEMS base	100%	99.6%	92.33%
% population 30 min. fly circle from HEMS base	100%	100%	96.54%
% sq. mi. in 10 min. fly circle from HEMS base	95.2%	53.5%	19.2%
% sq. mi. in 10 min. fly circle from HEMS base	100%	97.3%	46.9%
% sq. mi. in 10 min. fly circle from HEMS base	100%	100%	64.2%
MVC Fatalities per 1000/injuries	10.0	8.1	12. 2
MVC fatalities per 100K population	11.6	6.7	14.2
MVC fatalities per 1 million miles traveled	1.16	.78	1.41
% reduction in MVC fatalities 2007 as compared with 2002-2006 avg.	- 4.6	- 8.0	-4.3

Table 4: HEMS statistics for Maryland & Massachusetts & national averages

HEMS Organization:

Maryland has a long recognized unique publicly funded, operated, and well integrated trauma system including air medical services provided by the Maryland State Police. The MSP, a multiple role agency, is the system designated primary provider for all scene direct to trauma center services (98% MSP HEMS flights) as well as providing an aviation platform for specialty team (neonate) hospital to hospital services. (2% MSP HEMS flights).

Although there are other public agencies providing HEMS in the US, the MSP model is unique to the country as the only state wide and state provided HEMS system. It is also distinguished by separating a primary scene provider agency, operating at an advanced ALS level medevac configuration, from other agencies that are primarily providing inter-hospital transports including secondary trauma transfers in a critical care configuration.

Massachusetts, in comparison, has two agencies both hospital based, Boston MedFlight an independent non-profit owned by a consortium of the major teaching hospitals in Boston and the University of Massachusetts LifeFlight, a state owned and operated provider agency. Both MedFlight and LifeFlight provide direct scene to trauma center response and inte-hospital transfer. Boston MedFlight has Sikorsky aircraft similar in size to the MSP Dauphin aircraft that is used for long distance specialty team transfers.

HEMS Coverage:

Maryland, is a relatively a small state with a mixed urban rural population. The state encompasses a very mixed geography and demographic density including areas of low mountains along the West Virginia border and the eastern shore separated from the central portion of the state by the Chesapeake Bay. Geographic considerations and rural, low population areas are important components in the need for air medical services. [44]

As evidenced by very short flight time durations Maryland has ready access to medical helicopters with four agencies provide HEMS services in Maryland operating 18 aircraft from 14 base sites.[1] The three agencies, (MedSTAR Transport, Washington

Medical Center / Air Methods; Johns Hopkins / Stat MedEvac; University of Maryland Express Care / PHI Air Medical), in addition to the MSP are all operated by hospitals with a mixed basing at hospitals and off site airports. There are also significant numbers of helicopters, including commercial providers and the U.S. Park Police, operating in adjoining state areas of Pennsylvania, Delaware, Virginia, West Virginia, and the District of Columbia. Unique also to Maryland due to its proximity to the nation's capitol, are multiple other public agencies that provide multiple role emergency helicopters services.

Massachusetts also has a mixed urban rural geography and while the Chesapeake Bay is a unique geographic feature, Cape Cod and the offshore islands of Nantucket and Martha's Vineyard provide a partial equivalent to the isolation of the Eastern Shore.

HEMS Tasking:

Maryland is distinguished by its robust central SYSCOM access system for HEMS tasking. All public safety personnel within the state are allowed to request an MSP response via standing orders through the SYSCOM centralized communication center. Under this system, the MSP is the primary provider for virtually all scene responses involving direct transport to a trauma center. For requests that will result in a > 25 minute delay in response to scene or for multiple casualty events the MSP control center has Memorandums of Understanding with the private providers for response. While recognizing the value of the existing centralized system there were concerns on the part of some panel members regarding the degree of integration of total system assets. Opportunities for a greater degree of integration of system assets likely exist, and with all requests for medical flights flowing through the SYSCOM system, a high degree of system integration and coordination is possible.

Massachusetts allows EMS personnel to request an aircraft from either Boston MedFlight or LifeFlight depending on geographic location. There is close alignment among the providers in the New England region and closest aircraft are tasked if primary response aircraft are not available.

HEMS Staffing:

The MSP Aviation Command performs multiple mission types including law enforcement, homeland security, and SAR in addition to its HEMS services. MSP HEMS activity accounts for approximately 60% of total flight activity. The MSP standard operation is a single pilot operating a medium twin engine Dauphin model aircraft under a combination of visual flight rules (VFR / ground reference must be maintained) and instrument flight rules (IFR / ground reference is not required). Concurrent with this report there has been long time planning on a major replacement of the aircraft fleet.

Standard staffing for the MSP is a single pilot and single paramedic with advanced skills. As noted earlier, less than 3% of systems nationally staff with a single provider. The expert panel noted that there was significant use (> 1200 /annually) of additional (*ad hoc)* ground paramedics being placed on the aircraft to assist with either an active resuscitation or with the transport of two patients. The panel was concerned that this is a less than ideal staffing model for both patient and operational safety and quality assurance.

A single paramedic configuration in general terms may be applicable for ALS care with short duration flights, but is not consistent with best practice guidelines in the provision of critical care. Despite the extensive training and medical supervision of the MSP paramedics, current recommendations from the Commission for the Accreditation of Medical Transport Systems (CAMTS) require at least two providers with at least one provider at a higher level scope of practice than a paramedic. It is also noted that under Maryland licensing rules, commercial HEMS operators must have a crew of 2 clinical care providers that meet CAMTS standards for the licensed scope of practice. While recognizing the challenge of expanding the existing MSP configuration to two providers per aircraft as well as extending the scope of practice, the panel believes there is potential to significantly enhance the current system with revised staffing configuration.

HEMS Triage

Several variables may be considered in the context of assessing triage efficacy or accuracy. These include: percentage of patients discharged in 24 hours, mortality, need for life-saving interventions, Injury Severity Score (ISS) and similar strategies. All of these

measures are inaccurate for various reasons. However, they can be used as a general overview of how one system compares to another.

The discharge of a patient within 24 hours, transported by helicopter, is often used as a measure of the trauma triage efficacy. However, this variable is highly dependent upon factors that do not directly relate to system operations (e.g., location of closest trauma center, medical sophistication of ground EMS providers, local protocols). For the 10-year period of 1998-2007, the average percentage of patients transported by air in Maryland who were discharged in 24 hours or less was consistently 40-45%. [45] (Table 5) For FY2007, MIEMSS reported their triage efficacy, based upon this criterion, as detailed below. [46]

Patient Priority	Patients	Discharged 0-12 Hours	Discharged 13-24 Hours	TOTAL DISCHARGED 0-24 hrs. *
One	813	13.9%	5.0%	18.9%
Two	2,725	32.9%	12.8%	45.7%
Three	162	51.2%	18.5%	69.7%
TOTAL	3700	29.5%	11.4%	40.9%

* These numbers do not include patients who died in the first 24 hours or who were transported to other facilities.

Table 5: 24 hour discharges for HEMS transport patient

It is clear that some degree of over-triage is desirable to assure that most outliers will be provided definitive trauma care. Review of the medical literature has found the following percentage of all patients (not the subset of those transported by air) discharged in 24 hours or less to be as detailed below. (Table 6)

Author	City	Percentage Discharged < 24 Hours
Amatangelo [47]	Boston, MA	4%
Eckstein [48]	Los Angeles, CA	30.2%
Melton [49]	United Kingdom	41.0%
Shatney [50]	Santa Clara, CA	32.9%
Wills [51]	Australia	6.7%[1]
Wong [52]	China	55.3%

Table 6: Reported incidence of discharge at 24 hours

Based upon this review, the percentage of patients discharged in the MIEMSS/MSP system is higher than other centers in the United States.

Injury Severity Score. The Injury Severity Score (ISS) or the Trauma Injury Severity Score (TRISS) are often used as objective indicators of trauma severity and thus have some applicability in evaluating prehospital trauma triage schemes. In Maryland, recent TRISS analysis revealed that the mortality rate of patients transported by air was generally better than the national norm for all trauma patients. The "Z" statistic was 5.64 (compared to 3.69 for ground EMS)

and indicated that HEMS transported patients had better outcomes than the national average. The "Z" statistic is an epidemiological tool that measures how survival in a given trauma system compares to national norms. The "W" statistic was 1.61 (compared to 0.44 for ground EMS) and demonstrated that trauma patients transported by air had better survival than would be predicted based upon national norm. The "W" statistic reflects the difference between actual trauma system survivors and expected trauma system survivors. It essentially identifies unexpected survivors of trauma in a given system. Overall, these findings indicate that the MIEMSS system may be saving more lives than the national norm. However, it is difficult to tease out the impact of HEMS transports *per se*, from overall system performance. Also, the reliability of these statistics has never been thoroughly evaluated.

When looking specifically at ISS, the ACS and the literature define major trauma as any patient with an ISS> 15 and thus patients with an ISS ≤ 15 are considered to have minor trauma (however, older patients and those with pre-existing medical conditions may certainly benefit from trauma center care even with an ISS ≤ 15.) Data for FY 2003-2007 are available for the Maryland system through the Maryland State Trauma Registry. The percentage of patients with an ISS ≤ 15 transported by HEMS in Maryland has consistently been in the 75-77% range. This percentage is higher than found in a recent meta-analysis where the percentage of HEMS transported patients with an ISS ≤ 15 was 60% in a cohort of 37,350 patients. [53] Similarly and as was previously noted, a comparison between Maryland HEMS transported patients with an ISS < 8 (a non-critical trauma patient by most measures) and a similar cohort from the National Trauma Database shows a higher rate for Maryland HEMS transport (51% versus 45%).

The percentage of patients transported by ground EMS with an ISS > 15 was consistently in the 13-14% range. Some of these patients may have been transported during periods where weather precluded MSP flights and cannot be used to help define the undertriage rate. While it is recognized that the ISS is a score that is assigned to a patient retrospectively and cannot be used as a field triage decision tool these comparative rates suggest that the degree of over-triage occurring with Maryland HEMS transported patients exceeds that of comparable systems and likely exceeds national norms.

Recent strategies to decrease HEMS transport for patients with less severe injuries (Category C and D patients) have resulted in a significant reduction in HEMS utilization. It is unclear as to what effect this has had, if any, on patient outcomes, but the strategy is a reasonable one given the degree of HEMS over-triage. Careful study will required to assure that these strategies do not adversely affect trauma morbidity and mortality in the state.

The number of helicopters in the Maryland system is eight (8 staffed and 3 in reserve). The actual number of helicopters required is a decision as yet to be determined, but is beyond the scope of this panel to recommend. There are however, a variety of factors to consider, including geography and population, when selecting the number of helicopters for EMS in a state such as Maryland, including the general trend over the last five years of a steady reduction in flight demand.

The number of aircraft needed for HEMS operations is also only one consideration in establishing the total MSP fleet and basing criteria. While HEMS has been a primary operating mission of the MSP, in evaluating the number of helicopters needed in the Maryland system, the additional duties of search and rescue, law enforcement, homeland security, and integration with the national needs of the U.S. Capitol must also be considered in designing the Maryland system.

SUMMARY, CONCLUSIONS, & RECOMMENDATIONS

PRINCIPLES / UNDERLYING ASSUMPTIONS

- HEMS is an essential component of a contemporary EMS system. Its use improves outcomes in a high risk population of trauma patients.
- Both aviation and critical care medicine are high consequence endeavors a (high risk, high cost, high benefit). HEMS programs must operate at the highest levels of safety practically possible. The safety of patients and of crew members must incorporate a comprehensive systems approach to risk management.
- The configuration of the HEMS system, including overall mission profile and the number and location of aircraft should be based primarily on the distribution of the population, injury patterns, and the geography of the state.
- HEMS utilization should consider relative costs (opportunity costs as well as financial costs), overall safety including transport safety and patient safety, and potential reductions in morbidity and mortality across the entire system of care.
- HEMS programs nationally have evolved from placing an emphasis solely on rapid transport and minimizing time-to-definitive-care to placing a more balanced emphasis that includes the early delivery of critical care in the field and during transport.
- In order to minimize patient morbidity and mortality, a level of over-triage is necessary and appropriate. Established or agree to benchmarks defining a specific target level of over-triage do not yet exist, especially for HEMS transport.
- Effective HEMS programs incorporate the following:
    i. A comprehensive and robust system regulatory performance oversight
    ii. Cost effective integration into the healthcare system
    iii. A critical care level scope of practice
    iv. Mode of transport decisions dictated by case specific objective evaluation of distance, circumstances, and logistics of transport
    v. Measured compliance with national consensus standards for dispatch and post transport case review
    vi. Meeting standards consistent with the Commission for the Accreditation of Medical Transport Systems (CAMTS) and operations conducted under Part 135 of Federal Aviation Rules
    vii. A comprehensive risk and safety management system for all operations.

FINDINGS/OPINION

- Maryland's publicly funded trauma HEMS system (MIEMSS) provides a unique and long recognized national model. It integrates all of the components of the system from

first responder to tertiary care and has provided the citizens of Maryland with effective, equitable, and comprehensive access to trauma services.

- Survival outcomes for trauma patients in the State of Maryland, as compared with national norms, suggest that the trauma system performance meets and likely exceeds the national average. Any changes made to the current system of triage and transport should not compromise this level of performance.
- The Maryland State Police Aviation Command has an established safety record and has been recognized nationally and internationally. Improvements are necessary however, to enable the MSP to continue its leadership role in the provision of HEMS services for the state of Maryland.
- The centralized access, communications, and coordination of services provided by SYSCOM are unique system assets and are a model for coordination of HEMS services. The role of SYSCOM should be strengthened as the Maryland's trauma and EMS system continues to evolve.
- The current published field triage scheme used in the state of Maryland is consistent with national standards.
- The recent modification of the field triage process, with the implementation of medical consultation for mechanism-only and co-morbidity-only patients (category 'C' and 'D'), is a reasonable approach and appears to be associated with a reduction in HEMS transport of non-critical patients. It is premature to judge the impact of this change on patient outcomes, however.
- Current utilization review of compliance with triage guidelines and HEMS transport decisions appears to be occurring primarily at the local medical director's level, and the degree to which utilization review is occurring is uncertain. Variability in compliance with triage guidelines may account for some over-triage and use of HEMS for non-critical patient transport.
- A comparison of the rates of 24 hour patient discharge and injury severity for HEMS transported patients in Maryland with similar data reported from other regions in the United States suggests that a level of over-triage is occurring that exceeds that of other comparable systems.
- While no definitive benchmarks exist for HEMS utilization, there is a high likelihood that opportunities exist for reductions in Maryland HEMS transports of trauma patients without compromising patient outcomes or the quality of care. These opportunities potentially exist in patients with injuries that are less time or intervention sensitive.
- It appears that the Maryland HEMS program remains predominately a time-oriented system for rapid transport versus one that places more emphasis on the delivery of pre-hospital critical care in the field.
- While the design of the Maryland HEMS is largely based around transport time to care, there is a lack of related data on the total time to definitive care from point of injury to delivery to the definitive care setting. Without these data it is difficult to assess the appropriateness of resource allocation and/or transport decisions.

RECOMMENDATIONS:

- The EMS board should establish a multidisciplinary task force to determine the optimal number and distribution of HEMS assets based on population needs, geography and current location and capabilities of existing hospitals. This process should be informed by a systematic analysis of the available data and current techniques for optimizing resource allocation.
- The Maryland HEMS program should take the necessary steps to achieve accreditation by the Commission for the Accreditation of Medical Transport Systems (CAMTS). This will help ensure that the Maryland HEMS program maintains processes & procedures consistent with optimal national standards.
- All Maryland HEMS operations should be conducted under Part 135 of the Federal Aviation Regulations, including Federal Aviation Administration's Air Ambulance Operations Specifications. This will help assure that all flights will be operated at the highest levels of medical transportation safety standards.
- MIEMSS should continue their comprehensive and prospective evaluation of the recent modifications to the triage process (medical consultation for category 'C' & 'D' patients) examining over-triage, under-triage, secondary triage, time-to-definitive-care, and patients outcomes.
- The current indicators for the appropriateness of HEMS transport (injury severity, hospital stay less than 24 hours) being collected and used by MIEMSS are appropriate and should be comparatively analyzed on an ongoing basis to monitor system performance.
- The Maryland HEMS program should evolve to a program which emphasizes time-driven critical care goals. This recommendation has implications for crew configuration, education, and expansion of the mission profile to include provision of STEMI and stroke intervention to underserved areas of the state.
- MIEMSS should perform rigorous and regular utilization review on pre-hospital transport to ensure compliance with established triage process and criteria – particularly for HEMS transport.
- MIEMSS should provide enhanced oversight of helicopter utilization and compliance with published triage criteria

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APPENDIX – BIOGRAPHICAL SKETCHES

Robert C. Mackersie, M.D.,FACS (Panel Chair)

Dr. Mackersie received his undergraduate degree in Mechanical Engineering from the University of California, Berkeley; his medical degree from Michigan State University, and completed his residency in General surgery at the University of California San Francisco, including a two year NIH sponsored lab fellowship. He previously served on the faculty of the University of California, San Diego, and is boarded in General Surgery and Surgical Critical Care.

Dr. Mackersie has lectured extensively in the United States as well as internationally. He has had a long involvement in the educational aspects of trauma, and has supervised fellowship programs in trauma, critical care, and violence prevention. He has led and/or participated in ACS Trauma Systems Consultations in several states including Rhode Island, Wyoming, Nevada, North Carolina, and Hawaii, and has also participated in NHTSA State EMS Assessments. He has served as a Trauma Center re-verification surveyor for the American College of Surgeons, for the State of Washington, and for the State of Pennsylvania. He has consulted on trauma systems development in Marin, Napa, Santa Barbara, Santa Clara, and Sacramento counties in California. He currently serves as a Commissioner for the State of California EMS Authority.

Dr. Mackersie has authored or co-authored numerous publications, mostly on trauma-related topics, and is a contributing author to the 2006 Federal Document "Model Trauma System Planning and Evaluation", and the 2006 ACS trauma center guidelines: "Resources for Optimal Care of the Injured Patient". He has had a long involvement in academic and professional aspects of trauma and surgical care

Bryan E. Bledsoe, DO, FACEP, EMT-P

Dr. Bryan Bledsoe is an emergency physician and EMS author from Midlothian, Texas. He is Clinical Professor of Emergency Medicine, Department of Emergency Medicine, at the University of Nevada School of Medicine and the Department of Emergency Medicine at University Medical Center in Las Vegas. He is co-chair of the Curriculum and Evaluation Board (CEB) for the United States Special Operations Command (USSOCOM) at MacDill AFB, FL. Dr. Bledsoe was recently named a "Hero of Emergency Medicine" by the American College of Emergency Physicians as part of their 40th anniversary celebration. He was also named a "Hero of Health and Fitness" by *Men's Health* magazine in November of 2008 as part of their 20th Anniversary issue. Dr. Bledsoe has a B.S. from the University of Texas and a D.O. from the University of North Texas. He completed a residency at Texas Tech University Health Sciences Center and at Scott and White Memorial Hospital/Texas A&M College of Medicine. He is board-certified in emergency medicine.

Dr. Bledsoe has served as the Medical Director for two hospital emergency departments as well as for numerous EMS agencies in north Texas. He is the author of numerous EMS textbooks including: *Paramedic Care: Principles & Practice, Paramedic Emergency Care, Prehospital Emergency Pharmacology, Anatomy and Physiology for Emergency Care,* and many others. He is a frequent contributor to EMS magazines and presenter at national and international EMS conferences. Dr. Bledsoe is often interviewed by the national media including *The New York Times, The Wall Street Journal, USA Today, The NBC Nightly News with Brian Williams* as well as regional papers and media outlets. He is married and lives in Midlothian, Texas as well as Las Vegas, Nevada. He enjoys salt-water fishing.

Thomas Judge

Thomas Judge is a practicing paramedic and is the lead administrator for LifeFlight of Maine and the LifeFlight Foundation. LifeFlight, is an independent private non-profit and is the sole provider of helicopter critical care air and ground medical services in the Maine. He has previously served as the President of the Association of Air Medical Services and is currently on the Board of the Foundation for Air Medical Research and Education. He has worked extensively nationally and overseas in the development of EMS and air medical systems including an Atlantic Fellowship in Public Policy posted with the Medical Care Research Unit at the University of Sheffield and the Scottish National Ambulance Service in the UK. He also currently serves on the National EMS Advisory Council for the federal Department of Transportation, leads a work group for the International Helicopter Safety Team project, and is a practicing paramedic with a rural volunteer fire-rescue on the coast of Maine.

Ellen MacKenzie

Dr. MacKenzie is the Fred and Julie Soper Professor and Chair of the Department of Health Policy and Management of the Johns Hopkins Bloomberg School of Public Health. She is a graduate of the School of Public Health where she earned Master of Science and doctoral degrees in biostatistics. She joined the Hopkins faculty in 1980 and holds joint appointments in the School's Department of Biostatistics and with the departments of Emergency Medicine and Physical Medicine and Rehabilitation at the Johns Hopkins University School of Medicine. In addition to her faculty appointments, Dr. MacKenzie served as Senior Associate Dean at the School from 1996 to 2000 and Director of the Center for Injury Research and Policy from 1995-2005. Dr. MacKenzie completed a term as chair of the National Advisory Committee for Injury Prevention and Control and is currently President of the American Trauma Society.

Dr. MacKenzie's research focuses on the impact of health services and policies on the short- and long-term consequences of traumatic injury. She has contributed to the development and evaluation of tools for measuring both the severity and outcome of injury, which have been used to evaluate the organization, financing and performance of trauma care and rehabilitation. Her research has advanced the knowledge of the economic and social impact of injuries and the understanding of how personal and environmental factors influence recovery and return to work. Dr. MacKenzie's ongoing research includes a national evaluation of the cost and effectiveness of trauma care and efforts to develop and evaluate self management programs for people living with a disability.

Her awards include the A.J. Mirkin Service Award from the Association for the Advancement of Automotive Medicine, the Ann Doner Vaughan Kappa Delta Award from the American Academy of Orthopaedic Surgeons, the Distinguished Career Award from the American Public Health Association (Injury Control and Emergency Health Services Section) and the American Trauma Society's Distinguished Achievement Award. She is also an honorary fellow of the American Association for the Surgery of Trauma.

William Metcalf

Bill Metcalf is the Fire Chief for the North County Fire Protection District in the suburbs of San Diego, California and has served in that capacity since 2003. He started his fire service career with the Anne Arundel County (Maryland) Fire Department in 1974 and has also served with the North Lake Tahoe Fire Protection District (Nevada).

On a national basis, Chief Metcalf serves on the Board of Directors of the International Association of Fire Chiefs as Treasurer. In addition, he has served the IAFC as chair of the Emergency Management Committee, vice-chair of the National Centers Task Force, vice-chair of the National Fire Service Mutual Aid Task Force, as a member of the Homeland Security Council and on the Executive Committee of the Emergency Medical Services Section. Currently, Chief Metcalf also serves on the Board of Directors of the International Fire Service Policy Center and Research Institute.

During his 34 year career in the emergency services field, Chief Metcalf has also worked as the Director of Emergency Medical Services for the State of Colorado and as Associate Executive Director, Policy for the American College of Emergency Physicians.

Chief Metcalf has earned an Associate's Degree in Paramedic Sciences, a Bachelors Degree in Management, and a Masters Degree in Organizational Leadership. In addition, he is a graduate of the Executive Fire Officer program at the National Fire Academy and has been designated a Chief Fire Officer by the Center for Public Safety Excellence.

John Morris, M.D.,FACS

Dr. John Morris is a Professor of Surgery, Vanderbilt University School of Medicine, and Professor of Biomedical Informatics. He has served as past EMS Medical Director for the State of Tennessee Department of Health & Environment. He current heads the Division of Trauma & Surgical Critical Care at Vanderbilt, and also directs the LifeFlight Air Ambulance Program operated by the University. Dr. Morris is widely recognized for this expertise in air medical programs and is the author of numerous scientific articles.

Stephen H. Thomas M.D., MPH

Stephen H. Thomas MD MPH practices Emergency Medicine at Massachusetts General Hospital, and is an Associate Professor of Surgery at Harvard Medical School. He completed an Air Medical Fellowship after Emergency Medicine residency. He has an MPH with a concentration in Quantitative Methods. His academic focus has included helicopter EMS, specifically with respect to outcomes improves and utilization appropriateness. He has been, since 1994, Associate Medical Director of Boston MedFlight. In January 2009, he assumed the position of George Kaiser Family Foundation Professor and Chair of the Department of Emergency Medicine at the University of Oklahoma College of Medicine in Tulsa.