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Helicopter Emergency Medical Services Literature 2014 to 2016: Lessons and Perspectives, Part 1—Helicopter Transport for Trauma

Stephen H. Thomas, MD, MPH, Ira Blumen, MD

Recent years have seen significant additions to the emergency medical services (EMS) evidence base addressing the use, benefits, and other aspects of helicopter EMS (HEMS). Indeed, the air transport literature has become so broad (nearly 700 articles are found in a single-year [2014] National Library of Medicine online search) that all-encompassing reviews are not feasible. The sheer numbers of studies are too large to enable comprehensive assessment.

The numbers of studies and the increasing ease of online access to the evidence base have reduced the need for comprehensive reviews updating all studies published during a particular time frame. Past years' annotated reviews such as those initially commissioned by the Air Medical Task Force of the National Association of EMS Physicians (NAEMSP)[1-6] are hoped to have been useful, but their comprehensive aim has become simultaneously impractical and unnecessary. The current editorial review does not attempt to follow the formatting of the previous efforts.

Even if detailed examination of all aspects of the burgeoning HEMS literature is not feasible, the wealth of new HEMS science warrants attention from those who may be interested in the take-home messages from some of the latest studies. *Air Medical Journal* has a long tradition of regularly providing focused annotated bibliographies that update readers on cutting-edge research. It is not the current review's intent to reproduce that approach on the entire spectrum of HEMS research. However, there seems room for an overarching, albeit necessarily selective and editorial, discussion of HEMS' current evidence status.

HEMS remains a resource that is often described with words such as "expensive," "overused," "unproven," "unsafe," or "controversial." The ubiquity of these descriptors is matched by their tendency toward superficiality. All too often, catchphrases condemning (or praising) HEMS are unaccompanied by thoughtful consideration of the available data.

Not least among the issues regarding helicopter air ambulance (HAA) operations is the scrutiny from governmental bodies such as the US Federal Aviation Administration. Questions remain as to the presence and degree of additional vehicle-associated risks attendant to HAA (to use the Federal Aviation Administration's term) operations compared with ground ambulance transport. (For this discussion, HEMS rather than HAA will be used as the preferred abbreviation.)

The ongoing debate surrounding HEMS is characterized by questions that start with triage and follow through to patient care, outcomes, and utilization review. The continuing conversations and debates around so many aspects of air transport indicate the potential usefulness of a review highlighting key findings from selected HEMS studies of the past few years.

In a sense, this editorial is a continuation of the previous series of HEMS outcomes annotated bibliographies initially published by the NAEMSP Working Group. That series, which used a methodology of identifying key outcomes articles and presenting findings with limited commentary, covers the years 1980 through 2013.[1-6] The goal of the current review is to frame the main findings of selected outcomes studies published during the time period of 2014 through 2016.

Rather than serve as an all-encompassing bibliography of recently published outcomes evidence, the current review is intended as a commentary on those studies judged most important by the authors. The inherent subjectivity of article selection and discussion must be clearly acknowledged. It is hoped that, at least in part, disadvantages attendant to that subjectivity are offset by the authors' ability to provide historical context and other lessons gleaned from 60 years of cumulative experience gained during work in HEMS since the mid-1980s.

The studies to be discussed were identified using standard online search approaches (eg, search terms "helicopter" or "air medical transport") as previously described.[1-6] One limitation of the search is that results tend to be weighted toward English-language publications from peer-reviewed indexed literature. The review is strongly weighted toward the inclusion of topics with direct relevance on HEMS' association with an outcome of interest (eg, patient survival and transport safety).

A final study selection issue with this type of editorial review is that discussion subjects were defined not by the reviewers, but rather by the topics of studies published during the index time frame. The aim was to allow discussion topics to be framed by the literature that actually emerged during the years on which the review focused. This approach had the advantage of allowing flexibility but comes at an acknowledged cost of a sometimes meandering journey through the 2014 to 2016 evidence base.

Most of the trauma HEMS literature of 2014 to 2016 focused on air medical deployment for scene (primary) missions. Thus, this editorial's part 1 focus is

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on-scene HEMS use; those studies that included interfacility (secondary) missions will be highlighted as such in the discussion.

Part 1 opens with an assessment of HEMS triage and the developing evidence base contributing to the refinement of HEMS deployment. Following triage topics are sections covering clinical scenarios of HEMS use for multisystem trauma, pediatric patients, and traumatic brain injury (TBI) cases. Subsequent sections report on 2014 to 2016 evidence regarding crew composition, transport logistics, and the use of HEMS in mass casualty incidents (MCIs).

Triage of Injured Patients to HEMS Transport

As with virtually all medical interventions, HEMS comes with costs. HEMS resources should be deployed judiciously, with optimal precision. There is little disagreement over the general principle that helicopters should only be launched for missions with an acceptable likelihood of benefit. However, consideration of all applicable variables rapidly complicates the subject of which cases should trigger HEMS dispatch. This section of the review addresses HEMS issues in the arena of triage and utilization appropriateness.

HEMS Overtriage, When Assessed Retrospectively, Remains Common

In most countries, HEMS' roots lie in the transport of injured patients. The long-established principle of the importance of time savings in trauma has been the primary impetus for increasing HEMS deployment for both scene and interfacility transport of injured patients. Perhaps predictably, the increase in HEMS deployment has been associated with an increase in air transport of cases that, at least in retrospect, should have been transported by ground. A typical single-center 2015 study of 6 years of Arizona HEMS transports (at approximately $18,000 per flight) notes that roughly a third of cases were not seriously injured.[7] The 2015 study implications as to the need for improved triage are obvious, if not new.

In fact, the HEMS literature for the past few years is characterized by multiple studies finding that many helicopter-transported patients are minimally injured. Overtriage is not limited to any one country or to new or old trauma systems. A 2014 report from Brazil notes HEMS overuse in the range of 1 in 5 cases.[8] Recent literature from 2014 and 2015 also indicates the persistence of the problem of overtriage, by as much as 41%, in the pediatric trauma population.[9,10] One limitation common to these articles is that they follow the earlier literature's direction of defining overtriage using data, such as the Injury Severity Score (ISS), that is unknowable at the time of decision making regarding HEMS versus ground EMS (GEMS) transport mode.

Some articles in this review's time frame have based overtriage criticism on defining characteristics besides ISS, but these parameters are also available only in retrospect. An example is provided by a 2016 Vanderbilt University study noting that only a third of HEMS-transported limb replantation candidates actually underwent reconstructive surgery.[11] There is little argument that HEMS did not provide much help for the majority of the transported cohort; the study authors did not answer the question of how referring facilities are supposed to know whom to transfer and whom to keep.

The literature is often inconsistent. As an example in the triage evidence base, within the same clinical arena (extremity replantation) of the Vanderbilt study, there is a 2015 analysis from just a few hundred miles away that disagrees with the Tennessee findings. An Ohio[12] group found 80% of their program's flights for potential replantation resulted in reattachment operations. One in 5 "unnecessary" transports is not ideal, but the Ohio findings open the door to the possibility of some regional triage systems performing acceptably for replantation flights.

In addition to reiterating long-characterized imperfections of HEMS trauma triage, the HEMS trauma literature of the past few years has added meaningfully to the trauma triage evidence base. As an example, evidence-based guides to HEMS use for scene trauma include an excellent *Air Medical Journal* overview of the literature and its lessons.[13]

HEMS Overutilization may be Caused by Decreasing Referring Hospital Trauma Care Resources

One point emphasized in studies in recent years is the fact that trauma systems' smaller hospitals (ie, those other than level 1 or 2 centers) are becoming thinly stretched in terms of adequate trauma specialty coverage. For over a decade, the lack of availability of surgical specialists (eg, neurosurgeons) has been known to be rendering nontertiary centers unable to care for trauma.[14] At least in the United States, literature from the past few years suggests this problem is continuing and may in fact be worsening.[15]

Even though hospitals other than level 1 and level 2 centers are supposedly able (per regional trauma plans) to provide care for some lower-acuity injured cases, there is insufficient specialist coverage in many areas' referring centers. Even outside the United States, this shortage of surgical subspecialists has led to HEMS use to extend the reach of trauma networks.[16]

Problems with rural hospital access to the right physicians are not limited to subspecialists. In British Columbia, a 2014 assessment of rural emergency departments found that only 12% had access to an on-call general surgeon; the findings highlighted the importance of the fact that the same study found a much larger HEMS role in these rural areas compared with other parts of Canada.[17] In the United States, rural hospital emergency departments are often staffed by physicians lacking training in emergency medicine. The lack of airway skills for these physicians was identified in a 2015 Mississippi study as being the reason for a high frequency of HEMS crew rescue endotracheal intubations (ETIs) in patients who had failed pretransport ETI by referring hospital physicians.[18]

Determining retrospectively that referring hospitals should be able to care for certain types of patients (eg, spine injury cases unnecessarily flown to tertiary care because of referring hospital surgeons' unwillingness to operate)[19] is not the same thing as determining that those hospitals will take care of such patients and spare HEMS resources for more suitable missions.

The literature on referring hospitals' physician shortages is noted here because of its direct relevance to triage. It is inappropriate to use HEMS as a replacement for proper physician coverage at referring hospitals, but it is equally problematic to presume better triage guidelines will magically correct this type of HEMS overuse. In fact, because of the limited number of trauma centers and the high rate of inadequate subspecialty coverage in referring hospitals, HEMS has been described as recently as 2014 as being "vitally important."[15]

In countries with limited trauma care capabilities at referring centers, HEMS has been a critical mechanism for system-wide trauma outcomes improvement. An illustrative 2014 South African study identified major concern for undertriage.[20] In the same year, similar concerns were identified by Germans.[21] Furthermore, in rural US states (such as Indiana, where investigators have appropriately stated that HEMS should not be used for isolated skull fractures),[22] it is not clear what capabilities exist at small referring facilities to either provide care locally or execute GEMS transport without losing their prehospital coverage.[23]

Trauma Triage is Difficult and Imprecise

Triage is imperfect for transport mode selection in part because triage remains imperfect for determining which patients are most seriously injured (ie, need level 1