



## Erratum

The incorrect version of the below article was published in the November 2014 issue (J Pediatr Surg 2014;49(11):1673-7). The correct version of the article appears below.

## Helicopter overtriage in pediatric trauma



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## ABSTRACT

**Background:** Helicopter Emergency Medical Services (HEMS) have been designed to provide rapid access to trauma center care in cases of life-threatening injury. However, the ideal recipient population of this resource is not fully characterized, and the indications for helicopter transport in pediatric trauma vary dramatically by county, state, and region. Overtriage, or unnecessary utilization, can lead to additional patient risk and healthcare expense. In this study we perform a nationwide descriptive analysis of HEMS for pediatric trauma and assess the incidence of overtriage in this group.

**Methods:** We reviewed records from the American College of Surgeons National Trauma Data Bank (2008–11) and included patients less than 16 years of age who were transferred directly from the scene of injury to a trauma center via HEMS. Overtriage was defined as patients meeting all of the following criteria: Glasgow Coma Scale (GCS) equal to 15, absence of hypotension, an Injury Severity Score (ISS) less than 9, no need for invasive procedure or critical care, and a hospital length of stay of less than 24 h.

**Results:** A total of 19,725 patients were identified with a mean age of 10.5 years. The majority of injuries were blunt (95.6%), injuries primarily resulting from motor vehicle crashes (48%), and falls (15%). HEMS transported pediatric patients were predominately normotensive (96%), had a GCS of 15 (67%), and presented with minor injuries (ISS < 9, 41%). Overall, 27.9% of patients remained in the hospital for less than 24 h, while 33.3% required intensive care. The incidence of overtriage was 17.5%.

**Conclusions:** Helicopter overtriage is prevalent among pediatric trauma patients nationwide. The ideal model to predict need for HEMS must consider clinical outcomes in the context of judicious resource utilization. The development of guidelines for HEMS use in pediatric trauma could potentially limit unnecessary transfers while still identifying children who require trauma center care in a timely fashion.

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Trauma remains the leading cause of death for children in the United States [1–4]. It is well established that regionalizing care to established trauma centers [5–8] and shortening the duration of prehospital transport [9] are primary determinants of improved patient outcomes following severe injury. Regionalized mature trauma system such as what exists currently in the United States has mechanisms of emergency prehospital transport to route injured patients to an appropriate facility as expeditiously as possible, contingent on the severity of the injury.

In circumstances of severe injury or remote location, helicopter can be used for transportation to a trauma center. Helicopter Emergency Medical Services (HEMS) have been shown to improve survival in severely injured adult patients [10–13]; however, concerns have been raised about overutilization in less severely injured patients, overall safety, and cost effectiveness [14–18]. For pediatric trauma, the ideal

recipient population is not fully characterized and indications for HEMS dispatch vary dramatically by county, state and region. Single institution data have shown that children transported by helicopter transport are frequently uninjured and often do not require trauma center admission [19,20]. Given the additional risk and expense of HEMS, it is important to develop an understanding of overtriage, or unnecessary utilization. The purpose of this descriptive study was to perform a nationwide descriptive analysis of HEMS for pediatric trauma and assess the incidence of overtriage in this group.

## 1. Methods

The American College of Surgeons National Trauma Data Bank (NTDB) is the largest trauma database in the United States, with more than 900 participating centers. We retrospectively queried the NTDB for all pediatric trauma patients 16 years old and younger who were transported via HEMS to a trauma center over a four year period (2008–2011 inclusive). Only patients who suffered blunt or penetrating trauma and who were directly transferred from the trauma scene to the

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hospital were included in the analysis. Patients whose ED disposition was unknown or were further transferred to another hospital were excluded from the analysis.

Overtriage has been previously described as a triage decision that results in unnecessary expenditure of resources or personnel [21]. Helicopter overtriage in this study was defined as instances in which patients were transported by HEMS and were found to satisfy all of the following criteria: Glasgow Coma Scale GCS = 15, Injury Severity score (ISS) less than 9, absence of age-adjusted hypotension, no requirement for major intervention or intensive care, and Emergency Department (ED) discharge or a hospital admission of less than 24 h. All vital signs and GCS were retrieved from the earliest entries recorded in the receiving ED. Blood pressure thresholds for hypotension were adjusted for age as described elsewhere [22]. Time from HEMS scene departure to hospital arrival was calculated for all patients. Any patient with an ISS less than 9 was considered to have suffered a minor injury. Aided by the Agency for Healthcare Research and Quality Patient Safety Indicators WinQI software, we were able to identify patients who had operating room and major invasive diagnostic procedures based on ICD9 coding [23]. Overtriage rates and HEMS transfer times were compared between the regions using chi-squared and Kruskal–Wallis tests respectively. Statistical analysis was performed using STATA/Multi Processor version 12.1 (StataCorp LP).

## 2. Results

A total of 412,038 pediatric trauma patients 16 years old and less were identified over the study period (Fig. 1). Helicopter transfer comprised 9.3% of the total transport mode. After applying our inclusion and exclusion criteria, the final study population consisted of 19,725 patients transferred directly from the scene to a trauma center. Patient demographics and characteristics are illustrated in Table 1. The mean age was 10.5 (SD 5.0) years; the majority were male (64.6%) and suffered blunt trauma (95.6%). Motor vehicle crashes (MVC) and falls were the two most common mechanisms of injury (48.6% and 14.9% respectively). The majority of our cohort population presented in hospitals from the South ( $n = 8754$ ; 44.4%). Based on the ISS score, most of the patients suffered minor or moderate injury, with 41.1% presenting with an ISS less than 9 and 69% with an overall ISS less than 15. Helicopter transfer times were available for 13,838 (70.2%) patients. The median transfer time was 41 min (IQR: 31–55). Level designation was available for 19,253 patients. The majority of patients were flown to an American College of Surgeons (ACS) or state designated level I pediatric trauma center ( $n = 9834$ ; 51.1%), followed by a level II ( $n = 2428$ ; 12.6%) and level III ( $n = 5$ ; 0.03%) trauma center. The remaining 6986 (36.3%) received their care in an adult trauma center.

Table 2 contains patient outcomes after helicopter transport. After being evaluated in the ED, 39.5% were admitted to the floor, 33.3% were transferred to the ICU, 16.3% were taken to the operating room and 9.4% were discharged home. The mortality rate in the ED was 1.4%. The mean hospital length of stay was 5.4 (SD 8.6) days. A total of 5512 (27.9%) stayed in the hospital for less than 24 h. The overall mortality rate was 4.6% ( $n = 912$ ).

The overtriage rate was 17.5% ( $n = 2650$ ). For patients meeting overtriage criteria the median helicopter transfer time was 39 min (IQR: 29–53). Figs. 2 and 3 illustrate our outcomes based on the geographical region. The West region had the highest overtriage rate ( $n = 1294$ ; 22.9%,  $p < 0.001$ ). Significant differences were observed in the HEMS transfer times between the different regions in appropriately triaged and overtriaged patients, with the Midwest region reporting the longest flight times (median HEMS transfer time = 48 min, IQR: 34–63,  $p < 0.001$ ).

## 3. Discussion

Helicopter transport of pediatric trauma patients is common, comprising nearly 10% of all pediatric trauma transport in the NTDB.

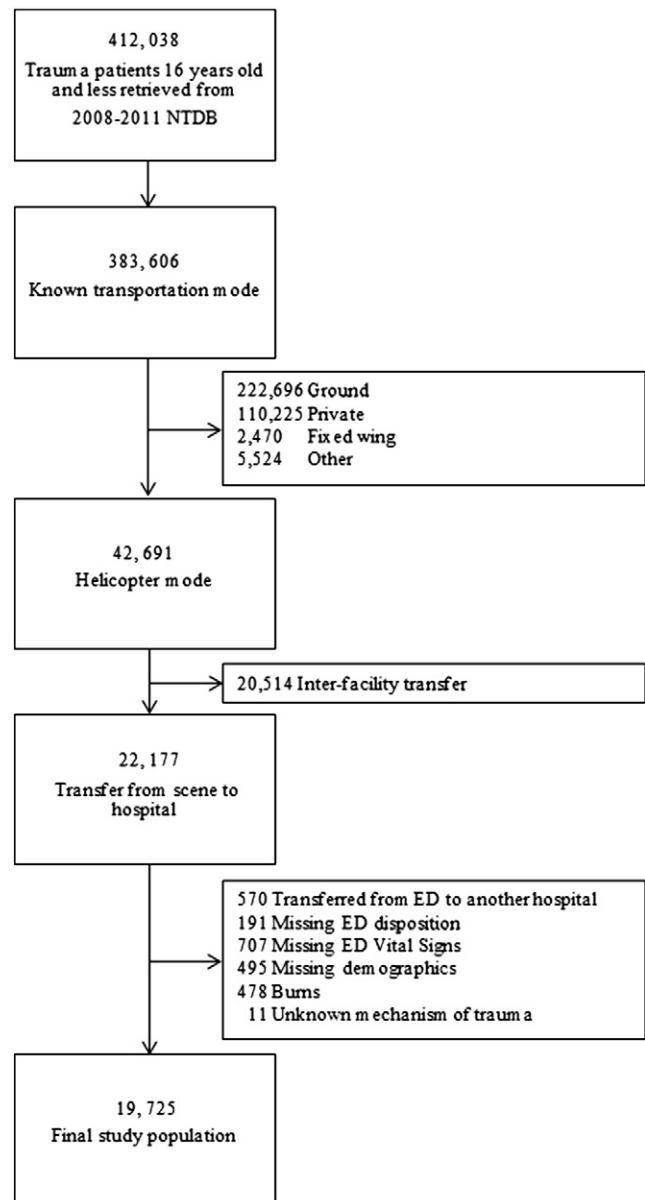


Fig. 1. Patient selection of pediatric trauma patients transferred via Helicopter Emergency Services (HEMS) to trauma centers using the National Trauma Data Bank (NTDB) for the period 2008–2011.

Our results demonstrate that the majority of pediatric trauma patients who were transferred via HEMS suffered minor and non-life threatening injuries and that overtriage, or unnecessary utilization of HEMS, is common. The overtriage rate in this cohort was 17.5%, and over a quarter of patients in this study population stayed in the hospital for less than a day and did not require a major intervention. Our findings echo previously reported conclusions from single center analyses in pediatric populations [24–26]. Although adult literature has shown HEMS to improve survival in severely injured trauma patients [11,27], this benefit has not been demonstrated in children, likely because the high proportion of minimally injured patients attenuates any benefit that might otherwise be noted.

Though some amount of overtriage is purposefully designed in any trauma transport system to avoid missed injury, we think that these data are notable to highlight in order to facilitate a conversation about the utility and indications for HEMS in pediatric trauma. The Center for Disease Control recommendations made by a national expert panel on field triage of injured patients offer dispatch criteria to any trauma

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