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AIR VERSUS GROUND TRANSPORTATION IN ISOLATED SEVERE HEAD TRAUMA: A NATIONAL TRAUMA DATA BANK STUDY

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☐ **Abstract—Background: The effect of prehospital helicopter emergency medical services (HEMS) on mortality has been analyzed previously in polytrauma patients with discordant results. Objective: Our aim was to compare outcomes in patients with isolated severe blunt traumatic brain injuries (TBIs) transported by HEMS or ground emergency medical services (GEMS). Methods: We conducted a National Trauma Data Bank study (2007–2014). All adult patients (≥16 years old) who sustained an isolated severe blunt TBI and were transported by HEMS or GEMS were included in the study. Results: There were 145,559 patients who met the inclusion criteria. Overall, 116,391 (80%) patients were transported via GEMS and 29,168 (20%) via HEMS. Median transportation time was longer for HEMS patients (41 vs. 25 min; $p < 0.001$). HEMS patients were more likely to have hypotension (2.7% vs. 1.5%; $p < 0.001$), Glasgow Coma Scale (GCS) score < 9 (38.2% vs. 10.9%; $p < 0.001$), and head Abbreviation Injury Scale (AIS) score of 5 (20.1% vs. 9.7%; $p < 0.001$). Stepwise logistic regression analysis identified age ≥ 65 years old, male sex, hypotension, GCS score < 9, prehospital intubation, and head AIS scores 4 and 5 as independent predictors of mortality. Helicopter transportation was independently associated with improved survival (odds ratio [OR] 0.55; 95% confidence interval [CI] 0.47–0.67; $p < 0.001$). Admission to a Level I trauma center was an independent predictor of survival (OR 0.64; 95% CI 0.53–0.82; $p = 0.001$). Regardless of head AIS, helicopter transport was an independent predictor of survival (AIS 3: OR 0.35; $p < 0.001$; AIS 4: OR 0.44; $p < 0.001$; AIS 5: OR 0.76; $p < 0.001$). A prolonged transport time was not an independent predictor of mortality. Conclusions: Helicopter transport, in adult patients with isolated severe TBI, is associated with improved survival.** **© 2017 Elsevier Inc. All rights reserved.**

☐ **Keywords—isolated severe head trauma; helicopter transport; ground transport; outcomes**

INTRODUCTION

Approximately 41 million patients with potential life-threatening emergencies are cared for annually, and nearly 1.7 million of those sustain a traumatic brain injury (TBI) (1). TBI can be a life-altering and severely debilitating injury. For this reason, TBI patients require rapid diagnosis, treatment and, when appropriate, operative intervention to preserve future brain function and prevent secondary brain injury. Despite significant advancements in neurocritical care and neurosurgical interventions, there is still a lack of research regarding best triage practices in TBI patients. Particularly, how to efficiently transport TBI patients to a suitable trauma center.

The utility of prehospital helicopter transport in trauma has been analyzed in several retrospective studies with inconclusive results. Some studies showed that helicopter transport reduced mortality in the trauma patient (2–4). However, other studies reported no difference in mortality and a greater financial cost (5,6). However,

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the majority of these studies included multi-trauma patients, making comparisons between the two transportation modalities difficult (2–4). The current study addresses many of these problems by including only patients with isolated severe blunt TBI.

Severe TBI patients are a distinct subset of trauma patients that require a unique algorithm of care, often necessitating early intervention with targeted resuscitation different from the traditional, polytrauma patient. We hypothesize that helicopter transport of an isolated TBI patient to an appropriate center with neurosurgical services is associated with improved survival compared to those transferred via ground.

METHODS

All patients with an isolated, blunt TBI extracted from the National Trauma Data Bank (NTDB, 2014 version, Committee on Trauma, American College of Surgeons) between 2007 and 2014 were eligible for inclusion in this analysis. The NTDB is the largest available source of trauma registry data in the United States and contains patient records, which have been subjected to screening for consistency and validity. The NTDB remains the full and exclusive copyrighted property of the American College of Surgeons (7,8).

We defined isolated, severe TBI as an Abbreviated Injury Scale (AIS) head score > 2, with a concomitant AIS chest, abdomen, extremities, and external score < 3. Penetrating injury, inter-facility transfers, and patients that were declared dead on arrival to the emergency department (ED) were excluded. Patients who sustained a nonsurvivable head trauma (AIS 6) and missing transportation data patients were excluded. Helicopter emergency medical services (HEMS) and ground emergency medical services (GEMS) were compared in the final 145,559 patient population.

Demographic, clinical, and injury severity data included age, sex, race, injury mechanism, and description (derived from The International Classification of Diseases, Ninth Revision, Clinical Modification e-codes for primary and secondary diagnosis), and AIS for each body region. Comorbidities, such as diabetes, smoking history (current smoker within 1 year), coronary artery disease, hypertension (defined as requiring medications), renal failure, steroid therapy, obesity (body mass index > 30), cirrhosis, and history of previous cerebrovascular accident were reviewed. Trauma scene and ED data included systolic blood pressure, heart rate, and Glasgow Coma Scale (GCS). Total transportation times from the field to ED arrival were also analyzed.

Neurosurgical interventions, including craniotomy, craniectomy, and intracranial pressure (ICP) monitoring were collected. Outcome variables included ventilator days, intensive care unit (ICU) length of stay (LOS), total hospital LOS, and in-hospital mortality. Complications occurring during hospitalization were collected and analyzed.

Statistical Analysis

The normality of distribution of continuous variables was assessed using histograms, skewness, and the Shapiro–Wilk test. Categorical variables were reported as a percentage, while continuous variables were reported as a median with interquartile range. Continuous variables were also dichotomized at clinically relevant cutoff points: age ≥ 65 years old, systolic blood pressure < 90 mm Hg, heart rate > 100 (beats/min), and GCS < 9. Mann-Whitney U test was used to compare medians for continuous data points, while Fisher's exact or Pearson's χ^2 test were used to compare proportions for categorical variables. A direct fitting logistic regression model was performed with potentially causative variables, in which p was < 0.2 in the univariate analysis, to identify independent predictive factors for mortality. The accuracy of the test was calculated using the area under the curve with 95% confidence interval (CI). Variables with $p < 0.05$ were considered significant. Statistical analyses were performed using IBM SPSS Statistics, version 23.0 (IBM Corp., Armonk, NY).

RESULTS

From 2007 to 2014, there were 5,774,836 patients identified in the NTDB, of which 145,559 (2.5%) sustained a severe isolated TBI. Of these patients, 116,391 (80%) were transported via GEMS, and 29,168 (20%) were transported via HEMS. Patient demographics, transport times, level of trauma center, clinical presentation on admission, comorbid conditions, operative interventions, and severity of head trauma are shown in Table 1. Patients transported by helicopter demonstrated significantly worse clinical and neurologic status at presentation, as evidenced by lower GCS, higher head AIS, and greater percentage of hypotension. The prehospital transportation time in the HEMS groups was significantly longer (41 vs. 25 min; $p < 0.001$). The prehospital intubation rate was higher in HEMS patients (29.4% vs. 4.6%; $p < 0.001$). HEMS patients were more likely to access a Level I trauma center (70.7% vs. 51.8%; $p < 0.001$) and were more likely to undergo a neurosurgical intervention with both higher rates of ICP monitoring and additional operative neurosurgical intervention (5.2% vs. 1.9% and 7.4% vs. 5.0%; $p < 0.001$).

The overall in-hospital mortality was 8.6%. Reflective of the increased injury severity, the unadjusted 24-h