

Introduction

Trauma is the leading cause of pediatric mortality in the United States, and TBI causes substantial morbidity in those who survive. Many questions remain about how best to care for children with TBI, and a number of hospital-based medical and surgical therapies are currently under investigation. Understanding how actions taken in the field by pre-hospital providers' effect eventual outcomes of seriously injured children with TBI is an important step to improving pediatric trauma care. For some children with TBI, good quality referring hospital care or transport team care may be more important than getting to a higher level trauma center marginally faster. This study is designed to help determine how best to make transport mechanism decisions for children with moderate or severe TBI. The goal is to test the impact of time to definitive care, on intensive care unit (ICU) and hospital length of stay and mortality in hospitalized children with moderate (GCS 9-12) or severe (GCS \leq 8) TBI. This study qualifies for the late-breaker session because analysis was ongoing at the time of the regular submission deadline.

Methods

Three statewide, population databases from the years 2009 to 2013 were probabilistically linked for this study. Our Emergency Medical Services (EMS) database and Trauma Registry data were obtained from our Department of Health. The EMS database contains information regarding the patient and event, including date and time of dispatch, arrival at scene, departure from scene, and arrival at hospital, reason for dispatch, patient demographics, patient vital signs, and any procedures or medications given to the patient. The trauma registry contains information on all injured patients meeting inclusion criteria (transferred between hospitals, died at the hospital, or were admitted for at least two days). The trauma registry contains detailed information regarding the patient's demographics and vital signs, up to 15 ICD-9-CM codes, and information regarding the mechanism of injury. The Pediatric Hospital Information System (PHIS) data were obtained from the Children's Hospital Association (CHA). PHIS contains additional information regarding resource utilization, time in the intensive care unit (ICU), primary payer, and the patient's disposition at discharge.

To create the final analytical database the EMS data were probabilistically linked to the trauma registry and with PHIS. The EMS database contains information on 985,289 EMS activations in Utah from 2009 to 2013. Because one incident can result in multiple activations it was necessary to conduct an unduplication to reduce it to a person level data set consisting of 860,884 individuals of all ages. This file was linked to the trauma registry database (56,907 admissions), and PHIS database (51,836 outpatient and inpatient admissions). The EMS to trauma registry linkage produced 32,917 matches and the EMS to PHIS linkage resulted in 5,990 matches. Only pairs of records obtaining a probability of being correct of 0.8 or higher were retained as true matches. All other pairs were rejected as false links.

The study population was defined to be children under the age of 18 years, sustaining a moderate (GCS 9 -12) or severe (GCS 3 – 8) TBI who were transported to the only pediatric trauma center in our state. Additionally, we excluded any patient transferred from an out-of-state hospital because information for the EMS transport from the scene to the hospital was missing. These criteria resulted in a linked database of 352 patients.

Analysis

Descriptive statistics are used to summarize time from injury to definitive care, defined as care by a pediatric transport team or arrival at the designated pediatric trauma center, patient's age, patient's sex, TBI severity, hospital discharge disposition, number of days in the ICU, and hospital length. Wilcoxon rank sum and chi-square tests are used to compare time to definitive care's (categorized into quartiles) association with hospital disposition, ICU days, and length of stay within TBI severity groups. A logistic regression was conducted to estimate the effect of time to definitive care on mortality while controlling for TBI severity, patient's age, and sex.

Results

Between 2009 and 2013, the EMS, trauma registry, and PHIS records were linked for 352 children with moderate (130, 37%) or severe (222, 63%) TBI. The mean age was 7.0 years (SD = 5.2) and 210 (60%) of the patients were male. The majority of patients (198, 56%) were transferred from a referring hospital to a pediatric trauma center. No differences were noted between TBI severity and age ($p = 0.06$), sex ($p = 0.211$), or transfer status ($p = 0.358$). Mortality was 18%, and was higher for severely injured patients (25%) compared to those with moderate injuries (5.7%), $p < 0.001$.

Median time to definitive care, our primary exposure, was 115 minutes (IQR 66 – 204 minutes). The median length of stay and ICU time were 4 and 2 days, respectively. Long transport times (> 204 minutes) were more common for children with moderate TBI (31%) compared to severe (22%), $p = 0.03$. Children with severe TBI having transport times in the upper quartile (>204 minutes) were more likely to be discharged alive ($p < 0.001$). Among severely injured patients surviving to discharge, those with longer times to definitive care had shorter lengths of stay ($p = 0.04$), and shorter ICU times ($p = 0.049$). Moderately injured patients with short transport times (<66 minutes) surviving to discharge had longer lengths of stay ($p = 0.001$) and ICU times ($p = 0.002$).

The logistic regression model estimated that patients with a moderate TBI were 0.14 times as likely to die compared to those with a severe TBI ($p = < 0.001$). While patients with time to definitive care in the

first quartile were 7.0 times more likely to die compared to patients with times in the highest quartile ($p < 0.001$), no significant difference was noted between patients with time to definitive care in the second and third quartiles compared to those in the fourth ($p = 0.423$). Patient sex ($p = 0.509$) and age ($p = 0.556$) were also not significantly associated with mortality. An interaction between time to definitive care and TBI severity was initially included in the model but was not significant (0.244).

Conclusions

While patients with severe TBI were more likely to die compared to patients with moderate TBI, those with longer times to definitive care had better outcomes compared to those with the shortest times. Combining databases through probabilistic linkage allows for analyses not possible with a single data source.