Emergency Access to Neurosurgical Care for Patients with Traumatic Brain Injury

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BACKGROUND: Traumatic brain injury (TBI) is one of the most common causes of injury-related morbidity and mortality. Access to neurosurgical services is critical to optimal outcomes through reduction of secondary injury. We sought to evaluate variations in access to neurosurgical care across a regional trauma system.

STUDY DESIGN: This is a population-based retrospective cohort study of patients who sustained isolated severe TBI from 2005 to 2009. Administrative datasets capturing all emergency department visits and hospitalizations were linked deterministically. Differences between access to a trauma center (TC), defined as direct transport from scene or transfer from a nontrauma center (NTC) as opposed to no access, were evaluated; this included patient level determinants of access to TC and delineation of mortality differences between TC and NTC care. Transfer patterns from NTC to TC were also evaluated.

RESULTS: We identified 9,448 patients with isolated severe TBI. Almost two-thirds (60%, n = 5,701) received initial care at an NTC. Of these patients, 30% (n = 1,737) were subsequently transferred to a TC. Thirty-day mortality rates of patients treated at a TC vs NTC were 19% vs 18%, respectively ($p = 0.19$). Among patients younger than 65 years, 67% received TC care; only 41% of patients older than 65 were treated at a TC ($p < 0.01$). Mechanism, age, brain hemorrhage, and injury severity were associated with TC care.

CONCLUSIONS: Considerable variation in delivery of initial care to TBI patients was identified. Factors such as age and injury characteristics were associated with TC access. Because early TC care in TBI confers survival benefits, the demonstrated variability necessitates improvements in access to care for patients with severe head injuries. (J Am Coll Surg 2014;218:51−57. © 2014 by the American College of Surgeons)

Severe traumatic brain injury (TBI) is a significant public health concern. The annual incidence of severe TBI in the United States is 11.4 per 100,000 people,[1] and severe TBI accounts for one-third of all trauma-related deaths.[2] The effects of TBI extend beyond the injured because caregivers for these patients require significant economic and social support once the patient is discharged from the hospital.[3] Patients with severe TBI also represent a considerable economic burden. The direct and indirect costs associated with TBI in the US amount to approximately $60 billion per year[4] and approximately $7 billion per year in Canada.[5]

Protocol-driven care can reduce mortality and cost in severe TBI through application of the Brain Trauma Foundation guidelines.[6] Application of these guidelines requires specialized surgical and medical care that can only be delivered at a trauma center. Effects of this specialized care are realized through the prevention of secondary injury, which is the modifiable phase of the acutely head injured patient. Adherence to the Brain Trauma Foundation guidelines has been shown to reduce cost and improve outcome in TBI.[7] The ability of trauma centers to provide specialized care and implement the

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Abbreviations and Acronyms

AIS = Abbreviated Injury Score
ED = emergency department
EDH = epidural hematoma
ISS = Injury Severity Score
MVC = motor vehicle collision
NTC = nontrauma center
SAH = subarachnoid hemorrhage
SDH = subdural hematoma
TBI = traumatic brain injury
TC = trauma center

Brain Trauma Foundation guidelines in their entirety improves care for TBI patients at these designated centers.

Due, in part, to the resource-intensive nature of neurosurgery and neuro-critical care, these centers are highly regionalized in Canada. In Ontario, 9 of the 11 adult neurosurgical centers are also level 1 trauma centers. Access to these trauma centers, and ultimately, definitive neurosurgical care, are realized either through direct transport of the head-injured patient from the scene of injury to a trauma center or indirectly through transfer of the patient to a trauma center after initial triage and transport to a center without neurosurgical resources (a nontrauma center).

Given the regionalization of trauma center and neurosurgical centers along with the importance of prompt neurosurgical care in TBI, we sought to evaluate access to trauma center care for patients with severe TBI. Specifically, we evaluated if patients had access to a trauma center within the first 24 hours of injury, either directly from the scene or through transfer from another institution. Of the patients who were first taken to a nontrauma center, we aimed to identify the proportion that were subsequently transferred to a trauma center. We further attempted to understand patient level factors associated with transport and transfer.

METHODS

Design

A population-based retrospective cohort study design was undertaken to evaluate access to neurosurgical care for patients with TBI. The outcomes of interest were overall access (direct and indirect) to a trauma center as well as transfer to a trauma center for those patients who were initially triaged to a nontrauma center.

Study setting

There are approximately 13 million persons in Ontario, spread out over a geographic area of 1 million square miles. Although the majority of the population lives in major metropolitan areas, approximately 20% of Ontarians live more than 60 minutes from any specialty medical care.[8] There are more than 190 hospitals, 11 of which provide adult neurosurgical care. In Ontario, 7 of these 9 neurosurgical centers are located at designated trauma centers in an attempt to regionalize care. In Ontario, the provincial government is the only insurance provider; therefore, all residents of Ontario have comprehensive medical insurance under the tenants of the Canada Health Act.

Data sources

There are 2 administrative databases in Ontario relevant to this work. The National Ambulatory Care Reporting System (NACRS) includes every visit to an emergency department (ED) in the province. The Discharge Abstract Database contains information on all patients admitted to acute care hospitals in Ontario. Each of these databases contains patient demographic information and ICD-10 diagnostic and procedure codes. Records in the National Ambulatory Care Reporting System can be deterministically linked by means of a unique patient identifier to the Discharge Abstract Database. This linkage provides the unique opportunity to follow patients from first ED presentation through to the same facility admission or through interfacility transfer to admission at another hospital.

Study subjects

Adult patients (18 years or older) presenting to the ED between 2002 and 2010 with an Injury Severity Score (ISS) >15 were identified. Because our goal was to understand triage and transfer practices related to a need for neurosurgical evaluation and management, we limited this analysis to patients with isolated severe brain injury, defined as an Abbreviated Injury Score (AIS) ≥ 3 in the head region and an AIS ≤ 2 in all other body regions. Abbreviated Injury Scores were derived using a previously validated ICD-10 to AIS crosswalk algorithm.[9] Patients who presented dead on arrival or those who died within 30 minutes of ED arrival were excluded from analysis because these outcomes are typically not modifiable through improved access to neurosurgical care.

Outcomes

We considered 2 outcomes. The first was any trauma center access, defined as trauma center access either directly from the scene or indirectly as a transfer from a nontrauma center. In patients who were transported to a nontrauma center, the second outcome was trauma center access via transfer within 24 hours.