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Conscious status predicts mortality among patients with isolated traumatic brain injury in administrative data

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Abstract

BACKGROUND: Outcome studies in trauma using administrative data traditionally employ anatomy-based definitions of injury severity; however, physiologic factors, including consciousness, may correlate with outcomes. We examined whether accounting for conscious status in administrative data improved mortality prediction among patients with moderate to severe TBI.

METHODS: Patients meeting Centers for Disease Control and Prevention (CDC) guidelines for TBI in the 2006 to 2011 Nationwide Emergency Department Sample were identified. Patients were dichotomized as having no/brief loss of consciousness (LOC) vs extended LOC greater than 1 hour using International Classification of Diseases, Ninth Revision (ICD-9) fifth digit modifiers. Receiver operating curves compared the ability of logistic regression to predict mortality in models that included LOC vs models that did not.

RESULTS: Overall, 98,397 individuals met criteria, of whom 25.8% had extended LOC. In univariate analysis, AIS alone predicted mortality in 69.6% of patients (area under receiver operating characteristic curve .696, 95% CI .689 to .702), extended LOC alone predicted mortality in 76.8% (AUROC .768, 95% CI .764 to .773), and a combination of AIS and extended LOC predicted mortality in 82.6% of cases (AUROC .826, 95% CI .821 to .830). Similar differences were observed in best-fit models.

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CONCLUSIONS: Accounting for LOC along with anatomical measures of injury severity improves mortality prediction among patients with moderate/severe TBI in administrative datasets. Further work is warranted to determine whether other physiological measures may also improve prediction across a variety of injury types.

Traumatic brain injury (TBI) is a major public health concern that is associated with mortality, morbidity, and poor long-term outcomes. Approximately 1.7 million Americans sustain a TBI annually resulting in over 1.4 million emergency department visits and 275,000 hospital admissions. There are roughly 50,000 annual deaths due to TBI, which account for one third of all injury-related deaths.[1] TBI outcome studies using administrative databases, such as Selassie et al study to develop a model that estimates long-term disability, rely on anatomy-based definitions of injury severity to predict outcomes.[2] Physiological factors are also known to be associated with patient outcome, and injury severity scoring systems that incorporate these factors have proven to be effective.[3–5] To date, few outcome studies using administrative databases have incorporated physiological variables.

The International Classification of Disease, ninth revision, Clinical Modification (ICD-9-CM) diagnosis codes provided in most administrative databases that define TBI include fifth-digit modifiers as measures of patient conscious status. Although these physiological measures have been used for TBI case description and identified as a source of injury surveillance data, they have not been routinely included in prior outcome studies examining TBI in large administrative databases.[6,7] We hypothesized that accounting for ICD-9-CM-derived conscious status would improve mortality prediction among patients with moderate–severe isolated TBI in a large administrative dataset.

Methods

The Nationwide Emergency Department Sample (NEDS) is the largest all-payer emergency department database in the United States and is part of the Healthcare Cost and Utilization Project, which is sponsored by the Agency for Healthcare Research and Quality (AHRQ). In 2011, the NEDS provided discharge data from 950 hospitals located throughout 30 US states with approximately 130 million emergency department visits represented annually. The NEDS database represents a 20% stratified sample of EDs in the United States and is designed to be weighted to allow estimations at the level of the US national population. Data are compiled through event-level records and no uniform patient identifiers are available.[8]

Patients meeting CDC diagnostic guidelines[9] for TBI based on ICD-9-CM diagnosis codes in the 2006 to 2011 NEDS were identified. Patient-specific Anatomical Injury Severity—Abbreviated Injury Scale—(AIS) scores were calculated using the ICDPIC program and the Stata statistical package (StataCorp, College Station, TX). All patients with an AIS score ≥ 3 for the head/neck region were isolated, and patients with an AIS score greater than zero in any nonhead body region were excluded. Patients with AIS scores of 5 or 6 for the head/neck region were grouped together, as these injuries were relatively rare. Using the fifth digit of the ICD-9-CM head trauma diagnosis code, patient conscious status was categorized as follows: a fifth digit of 0 indicated unspecified conscious status; a fifth digit of 1, 2, or 9 indicated no/brief (<1 hour) loss of consciousness (nbLOC); and a fifth digit of 3, 4, 5, or 6 indicated extended (≥ 1 hour) loss of consciousness (eLOC) (Fig. 1). Both unadjusted and best-fit multivariable logistic regression models, which controlled for patient and injury-related factors, examined in-hospital mortality for each of 3 different expressions of head injury severity: (1) head-AIS alone; (2) loss of consciousness (LOC) alone; and (3) both head-AIS and LOC. Receiver operating characteristic curves for each of the injury severity expressions were used to compare the ability of each of these 3 groups to predict in-hospital mortality within the study sample.

Results

After weighting to represent the US population, a total of 600,633 patients of all ages met inclusion criteria. Most patients were male (61.1%), median age was 59 years (interquartile range 26 to 79), and most injuries resulted from falls (59.7%). A total of 138,312 patients, representing just under 1 quarter (23.0%) of otherwise eligible patients, were classified as having unspecified loss of consciousness and were excluded. The remaining 462,321 patients had head-specific AIS scores of 3 (47.5%), 4 (48.0%), or 5/6 (4.5%). Among the subset of patients with a specified LOC status, 26.3% had eLOC, and 9.9% died. Proportional mortality was positively associated with head AIS, as 5.6% of patients having an AIS score of 3, 8.2% of patients having an AIS score of 4, and 74.7% of patients having an AIS score of 5/6 died before discharge ($P < .001$). Patients with eLOC were proportionally more likely to die in-hospital than those with nbLOC (28.2% vs 3.4%, $P < .001$).

In unadjusted models, a stepwise relationship between AIS scores for the head and neck region and odds of mortality was observed; patients having an AIS score of 4 demonstrated a 50% increase in odds of death (OR 1.53, 95% CI: 1.46 to 1.61), and patients having an AIS score of 5/6 demonstrated a 50-fold increase in the odds of mortality (OR 51.29, 95% CI: 47.37 to 55.54) compared with patients with a head/neck AIS score of 3. Again, in an unadjusted model, patients classified as having eLOC