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Original Contributions

PREDICTOR OF ISOLATED TRAUMA IN HEAD: A NEW SIMPLE PREDICTOR FOR SURVIVAL OF ISOLATED TRAUMATIC BRAIN INJURY

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☐ **Abstract—Background: Mortality prediction in patients with brain trauma during initial management in the emergency department (ED) is essential for creating the foundation for a better prognosis. Objective: This study aimed to create a simple and useful survival predictive model for patients with isolated blunt traumatic brain injury that is easily available in the ED. Methods: This is a retrospective study based on the trauma registry data of an academic teaching hospital. The inclusion criteria were age ≥ 15 years, blunt and not penetrating mechanism of injury, and Abbreviated Injury Scale (AIS) scores between 1 and 6 for head and 0 for all other body parts. The primary outcome was 30-day survival probability. Internal and external validation was performed. Results: After univariate logistic regression analysis based on the derivation cohort, the final Predictor of Isolated Trauma in Head (PITH) model for survival prediction of isolated traumatic brain injury included Glasgow Coma Scale (GCS), age, and coded AIS of the head. In the validation cohort, the area under the curve of the PITH score was 0.970 ($p < 0.0001$; 95% confidence interval 0.960–0.978). Sensitivity and specificity were 95% and 81.7% at the cutoff value of 0.9 (probability of survival 90%), respectively. Conclusions: The PITH model performed better than the GCS; Revised Trauma Score; and mechanism of injury, GCS, age, and arterial pressure. It will be a useful triage method for isolated traumatic brain injury in the early phase of management.** © **2018 Elsevier Inc. All rights reserved.**

☐ **Keywords—traumatic brain injury; prognosis; survival probability; emergency department**

INTRODUCTION

Traumatic brain injury (TBI) is the most common cause of death by trauma throughout the world (1,2). Early diagnosis and determination of the proper treatment strategy are crucial for patients with brain trauma. Mortality prediction of patients with brain trauma during initial management in the emergency department (ED) is essential for creating the foundation for a better prognosis.

Several predictive scales have been developed to predict the prognosis of patients with TBI (Table 1). The Glasgow Coma Scale (GCS) is the traditional tool used most commonly for detecting TBI; it measures severity, guides choices of treatment options, and

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Table 1. Comparison of Injury Scoring Systems

Injury Scoring System	Acronym	Variables Included
Abbreviated Injury Scale	AIS	1, minor; 2, moderate; 3, serious; 4, severe; 5, critical; 6, unsurvivable
Injury Severity Score	ISS	AIS values AIS score allocated to one of six body regions (head, face, chest, abdomen, extremities [including pelvis], external) Only the highest AIS score in each body region Squared score of the three most severely injured body regions
Revised Trauma Score	RTS	GCS, SBP, RR RTS = 0.9368 GCS + 0.7326 SBP + 0.2908 RR Range 0–7.8408
Mechanism, GCS, age, arterial pressure	MGAP	Mechanism of injury, GCS, age, SBP Blunt, +4, penetrating, 0; GCS, 3–15; Age < 60 y, +5; Age > 60 y, 0; SBP > 120 mm Hg, +5; 60 < SBP < 120 mm Hg, +3 Low risk: 23–29, moderate risk: 18–22, High risk: < 18
Trauma-Related Injury Severity Score	TRISS	RTS, ISS, age Probability of survival = $1/(1 + e^{-b})$ b = b0 + b1 (RTS) + b2 (ISS) + b3 (Age Index) Coefficients b0, b1, b2, b3; blunt/penetrating Age Index: ≥ 55 y, 1; < 55 y, 0
International Mission for Prognosis and Clinical Trial	IMPACT	Core: age, GCS motor score, pupillary reactivity; Core + CT: hypoxia, hypotension, CT classification, traumatic SAH on CT, epidural mass on CT Core + CT + lab: glucose (mmol/L), Hb (g/dL)
Corticosteroid Randomization after Significant Head Injury	CRASH	Age, GCS motor score, pupillary reactivity, major extracranial injury
Predictor of Isolated Trauma in Head	PITH	GCS, age, coded AIS of the head Probability of survival = $1/(1 + e^{-b})$ b = 2.7429 + 0.4754 × GCS + (−0.0421) × age + (−1.6320) × coded AIS of the head (coded as 1 when AIS of head = 1 and 2 when AIS of head >1).

CT = computed tomography; GCS = Glasgow Coma Scale; Hb = hemoglobin; SBP = systolic blood pressure; RR = respiratory rate; SAH = subarachnoid hemorrhage; TBI = traumatic brain injury.

predicts patient outcomes (3). The Glasgow Outcome Scale has also shown promising results, but its clinical applicability is limited because it takes 24 h after the trauma to draw a conclusion (4). The International Mission for Prognosis and Clinical Trial (IMPACT) and Corticosteroid Randomization after Significant Head Injury (CRASH) models were developed recently and are the most promising prognostic predictors for TBI. Both were derived from a very large population and have the advantage of being valuable at the point of admission (5,6). The two models were verified to have high external validity in several studies (7–11). However, it is challenging to collect the sophisticated information needed to implement the CRASH or IMPACT models in a busy, crowded ED. The Trauma-Related Injury Severity Score (TRISS) is the most powerful scoring system to predict survival in patients with multiple traumas (12). The TRISS was also revealed to show good performance in predicting the survival of patients with TBI, but it is difficult to measure during the initial phase of triage (13).

Therefore, we aimed to create a simple and useful survival predictive model that is easily available during ED management and is based on several parameters for patients with isolated blunt TBI, which we named Predictor of Isolated Trauma in Head (PITH).

MATERIALS AND METHODS

Study Design and Setting

This is a retrospective study of the trauma registry that contains prospectively collected data from an academic teaching hospital located in a suburban area. Our hospital is the sole tertiary medical center and treats a large number of patients in this area. Trauma registry data were recorded from July 1, 2011 by professional health information managers in our ED. Demographic characteristics, including age and sex; vital signs, including systolic blood pressure (SBP), heart rate (HR), respiratory rate (RR), and peripheral oxygen saturation (SpO_2) on initial presentation to the ED; and in-hospital mortality were derived from the electronic medical record. The Revised Trauma Score (RTS) was automatically calculated from data recorded by emergency triage nurses. Abbreviated Injury Scale (AIS) scores were calculated according to clinical presentations, imaging and intervention results, and operative records. Injury descriptions and score recordings were supervised by emergency attending physicians. The derivation cohort consisted of patients who presented to the ED from July 1, 2011 to October 31, 2013. The data for external validation were derived from a trauma registry cohort consisting of the