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The accuracy of acuity scoring tools to predict 24-h mortality in traumatic brain injury patients: A guide to triage criteria

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ABSTRACT

Background and aim: Prompt identification of traumatic brain injury (TBI) is vital for patients in critical condition; however, it is not clear which acuity scoring tools are associated with short-term mortality. The aim of this study was to determine the accuracy of acuity scoring tools and 24-h mortality among TBI patients in both prehospital and hospital settings.
Methods: This study was an observational, prospective cohort, in which patients with TBI were followed from the accident scene to the hospital. Vital signs and acuity scoring tools, including the Revised Trauma Score (RTS), Injury Severity Score (ISS), National Early Warning Score (NEWS), Shock Index (SI), Modified Shock Index (MSI) and Trauma and Injury Severity Score (TRISS), were collected both on the scene as well as at the hospital. A logistic regression was performed to ascertain the effects of clinical parameters on the likelihood of survival of patients with TBI regarding 24-h mortality.
Results:: A total of 185 patients were included in this study. The mortality rate was 14% (25/185). The logistic regression model was statistically significant at $\chi^2 = 60.8$, $p = 0.001$. A hierarchical forward stepwise logistic regression analysis showed that age, hospital RTS and prehospital NEWS significantly improved mortality predictions. The model explained the 51.2% variance in survival of patients with TBI.
Conclusions: The NEWS and the RTS may be used to triage TBI patients for prehospital and hospital emergency care, respectively. Therefore, because traditional vital signs criteria may be of limited use for the triage of TBI patients, it is recommended that acuity scoring tools be used in such cases.

1. Introduction

Traumatic brain injury (TBI) is the main cause of disability as well as neurologic morbidity in young adults [1]. Severe trauma is considered a serious health problem, because disability affects victims' roles in both family and society [2]. Notably, TBI is also associated with high socio-economic costs [3]. The first hour of trauma management is crucial for TBI patients due to the time-sensitive care required; therefore, mortality may be decreased if critically ill patients are recognized more readily and transferred promptly to trauma centres [4]. Paramedics are generally the first to assess and treat trauma patients in the prehospital environment, which makes them responsible for identifying life-threatening injuries and improving patients' quality of care in stressful situations [5]. As such, it is essential to develop prehospital emergency criteria to promote prompt recognition of severe TBI patients [6].

In the prehospital phase, the initial steps are to assess the level of consciousness (LOC), maintain both the airway and oxygenation, initiate fluid replacement, immobilize the spine and promptly transfer the patient to a high-level trauma centre [7]. Trauma scoring systems are useful for the recognition of critically injured patients and are a prerequisite for establishing performance improvement among paramedics, which results from better outcome prediction and triage allocation as well as choosing the optimum hospital destination [8]. Trauma scoring systems are also useful for risk stratification. This is especially true for paramedics because they are usually working with little clinical information in the field. Paramedics must prioritise by transferring severe TBI patients for advanced care sooner than other TBI

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patients with lower priorities.

Most previous studies have focused on the accuracy of the trauma scoring system and long-term outcomes; therefore, the associations between clinical criteria and short-term outcomes remain unclear. Notably, only short-term outcomes are specific for the triage of TBI patients in both prehospital and emergency settings, while trauma-specific triage guidelines for TBI patients have rarely been developed [9]. Evidence that supports the trauma scoring system based on 24-h outcomes is thus required. To be more specific, the Glasgow Coma Scale (GCS) was found to be a good prognostic factor of long-term mortality among TBI patients in the emergency department (ED); conversely, its value in the prehospital setting remains unclear. Several studies have shown that the GCS improved the prediction of 48-h mortality, and motor scores were also significant predictors of long-term mortality (2 weeks to 6 months) [2,7,10–14]. However, the validity of these findings regarding 24-h outcomes are unclear.

Overall, an accurate tool is needed to identify the severity of TBI during early trauma, especially regarding 24-h outcomes, which could be employed for more accurate clinical decisions. In addition, because traumatic injuries are increasingly recognized as a leading source of morbidity and mortality in developing countries, context-specific research is necessary to identify opportunities for prevention and improved treatment. Therefore, the aim of this study was to determine the accuracy of acuity scoring tools and 24-h mortality among traumatic brain injury patients in both the prehospital and hospital settings.

2. Methods

2.1. Design

This study was an observational, prospective cohort that followed TBI patients from the accident scene to the hospital between February and September 2016.

2.2. Ethics

Data collection was carried out after receiving approval from the ethics committee at Mashhad University of Medical Sciences (No. 940948).

2.3. Setting

This study was conducted in the Hasheminezhad Hospital in Mashhad, Razavi Khorasan, Iran, which is the second largest Level 1 trauma centre (320 beds) in the city. The hospital provides several specialties, including neurosurgical, emergency medicine, orthopaedic, surgical and internal medicine services, 24 h per day. The hospital ED receives 14,500 trauma patients annually, most of whom arrive by ambulance. All nurses in the ED have both a Bachelor of Science (B.S.) in nursing and Trauma Certified Registered Nurse (TCRN) certification. All emergency physicians in the ED are specialists in emergency medicine. Emergency medical services (EMS) are provided by professional individuals who are trained to provide basic trauma life support, such as immobilization, airway management and intravenous fluid therapy, during ambulance transfers. All paramedics must have a B.S. in emergency medical services. They transfer trauma patients from the scene to the EDs in the shortest possible time with the aim of reducing morbidity as well as mortality.

2.4. Data collection

TBI patients who were received by ambulance and admitted to the ED were assessed. Patient records were used to collect relevant data, including age, gender, mechanism of injury, medical history, GCS, respiratory rate (RR), oxygen saturation (SpO_2), temperature (T), heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP) and pupillary status display (size and reaction to light), in both the prehospital and hospital settings. The data were documented by paramedics in the prehospital setting and by emergency nurses in the ED. The Injury Severity Score (ISS) was documented by emergency physicians in the ED. To assess in-hospital mortality, we examined death rates in the first 24 h post-injury. All included patients were followed up for mortality over 24 h in the ED. Therefore, TBI patients were divided into two groups based on their outcome (dead or alive) in the first 24 h post-injury.

2.5. Patient selection

During the study period, TBI patients who met the following criteria were included in the study: the mechanism of injury (MOI) was a traffic accident, they were transported directly from the scene by an emergency medical services ambulance, they had an ISS > 9, they were older than 18 years but less than 85 years of age and they had at least one vital sign parameter higher than zero at the scene (in order to include only cases without clinical death). Exclusion criteria included incomplete data in either the prehospital or hospital patient records (i.e., vital signs parameters), pregnancy, comorbidities (diabetes, cardiovascular disease, chronic obstructive pulmonary disease etc.), transfer time from the scene to the hospital of more than 60 min and transfer of patients to other health care centres in the first 24 h.

2.6. Variables

GCS is used to assess the level of consciousness in patients with brain injuries. This scale is composed of three subscales that independently measure motor response, eye opening and verbal response. Scores range from 3 to 15, with a score of 3 indicating the lowest degree of consciousness and a score of 15 indicating alertness [4]. Mean arterial pressure (MAP): MAP is used as an indicator of blood flow. It may represent tissue perfusion better than SBP because it considers diastolic pressure. The Shock Index (SI) and Modified Shock Index (MSI): Both the SI and MSI have been used for prompt identification of hypovolemic shock in patients with trauma. The SI normal range varies from 0.5 to 0.7 in healthy adults [15]. The Injury Severity Score (ISS): The ISS is an anatomical scoring system that represents an overall score for trauma patients. Each injury from six body regions (head, face, chest, abdomen, extremities including pelvis and external) has a relevant Abbreviated Injury Scale (AIS) score. Only the highest AIS score in each body region is used to calculate the ISS [10]. The Revised Trauma Score (RTS): The RTS is the sum of 12 weighted, coded values for the GCS score, RR, and SBP [4]. The trauma and injury severity score (TRISS): The TRISS is used to determine the probability of survival by using the ISS, the RTS and the patient's age. It includes both anatomic and physiologic criteria to predict survival in relation to the severity of the injury [10]. The National Early Warning Score (NEWS): The NEWS is used to assess critically ill patients, especially in the prehospital setting. It compromises six physiological factors including the RR, SpO2, T, SBP, HR and level of consciousness. Each factor scores from 0 to 3, except supplemental oxygenation. The NEWS ranges from 0 to 20 [16].

2.7. Confounders analysis

We considered several potential confounders of the association between severity of head injury and mortality during the first day of admission. These included mechanism of injury, an ISS lower than 9 and other life threatening injuries. For purposes of analysis, traffic accident survivors (driver, passenger, motorcycle, bicycle and pedestrian) were included in the study. Other MOIs were excluded because they may have coincided with different patterns of injury. TBI patients with a minimum ISS score of 9 were included only if that score belonged to a brain injury. TBI is often associated with a high-velocity circumstance; hence, injuries to other parts of the body are more commonly seen.