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Choice of injury scoring system in low- and middle-income countries: Lessons from Mumbai

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ABSTRACT

Introduction: Injury is a major cause of morbidity and mortality in low- and middle-income countries. Effective trauma surveillance is imperative to guide research and quality improvement interventions, so an accurate metric for quantifying injury severity is crucial. The objectives of this study are (1) to assess the feasibility of calculating five injury scoring systems – ISS (injury severity score), RTS (revised trauma score), KTS (Kampala trauma score), MGAP (mechanism, GCS (Glasgow coma score), age, pressure) and GAP (GCS, age, pressure) – with data from a trauma registry in a lower middle-income country and (2) to determine which of these scoring systems most accurately predicts in-hospital mortality in this setting.
Patients and methods: This is a retrospective analysis of data from an institutional trauma registry in Mumbai, India. Values for each score were calculated when sufficient data were available. Logistic regression was used to compare the correlation between each score and in-hospital mortality.
Results: There were sufficient data recorded to calculate ISS in 73% of patients, RTS in 35%, KTS in 35%, MGAP in 88% and GAP in 92%. ISS was the weakest predictor of in-hospital mortality, while RTS, KTS, MGAP and GAP scores all correlated well with in-hospital mortality (area under ROC (receiver operating characteristic) curve 0.69 for ISS, 0.85 for RTS, 0.86 for KTS, 0.84 for MGAP, 0.85 for GAP). Respiratory rate measurements, missing in 63% of patients, were a major barrier to calculating RTS and KTS.
Conclusions: Given the realities of medical practice in low- and middle-income countries, it is reasonable to modify the approach to characterising injury severity to favour simplified injury scoring systems that accurately predict in-hospital mortality despite limitations in trauma registry datasets.

Introduction

Injury accounts for at least 10% of the global burden of disease, with 5.8 million deaths due to injury annually [1]. In India, it is estimated that 10% of deaths and 13% of disability-adjusted life years lost are due to injury, which is likely lower than the true burden of injury [2]. As in other low- and middle-income countries, major challenges to trauma care include inadequate manpower, limited physical and financial resources and uncoordinated healthcare systems [3,4]. Effective trauma surveillance is imperative to guide further research and quality improvement interventions, and trauma registries are critical research tools to describe the true burden of injury [5–7]. The World Health Organization and the International Association for Trauma Surgery

Abbreviations: AIS, abbreviated injury score; AVPU, alert, voice, pain, unresponsive; GAP, GCS, age, pressure; GCS, Glasgow coma score; ISS, injury severity score; KTS, Kampala trauma score; MGAP, mechanism, GCS, age, pressure; ROC, receiver operating characteristic; RTS, revised trauma score.

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and Intensive Care recognize trauma registries as an essential aspect of trauma care [8].

One key component of a trauma registry is a metric for quantifying the severity of injuries and predicting the probability of in-hospital mortality. This is essential for assessing the burden of trauma and the quality of care that is being provided, which can inform quality improvement and advocacy strategies [9]. Multiple injury scoring systems are used in low- and middle-income countries [10]. The most common is the Injury Severity Score (ISS), an anatomic score that incorporates multiple Abbreviated Injury Scores (AIS), which reflect the severity of injuries to different body regions [11]. A popular alternative is the Revised Trauma Score (RTS), a physiologic score that reflects a patient's systemic response to injury measured through Glasgow Coma Score (GCS), systolic blood pressure and respiratory rate [12]. It is the current standard physiologic scoring system used in trauma research and quality improvement in both high-income countries and low- and middle-income countries [13]. The Kampala Trauma Score (KTS) is a simplified injury scoring system that reflects patient age, systolic blood pressure, respiratory rate, neurologic status and number of serious injuries, which was developed in Uganda specifically for use in resource-limited settings [14].

The MGAP score and the GAP score are two novel, simplified scoring systems that are not yet widely used in low- and middle-income countries. The acronym MGAP stands for "mechanism (of injury), GCS, age, (systolic blood) pressure," and the MGAP score differs from RTS by including patient age and injury mechanism but excluding respiratory rate. The MGAP score was initially developed and validated in France as a pre-hospital triage score to 30-day mortality [15]. It has also been shown to be effective in predicting prolonged ICU stay and massive haemorrhage in a European cohort [16]. The GAP score modifies the MGAP score to exclude injury mechanism – the acronym GAP represents "GCS, age, (systolic blood) pressure." The GAP score was validated in a sample from the Japan Trauma Data Bank [17].

While ISS and RTS have been widely studied in high-income countries, none of these injury scoring systems have been rigorously validated in low- and middle-income countries [18,19]. There are substantial logistical demands associated with implementing the ISS, including detailed medical records, extensive radiographic studies and autopsy results, which are often unavailable in resource-poor settings [20]. We hypothesise that anatomic scoring systems do not perform well in trauma registries in low- and middle-income countries, and physiologic scoring systems more effective in predicting in-hospital mortality in this context. The objectives of this study are (1) to assess the feasibility of calculating five injury scoring systems – ISS, RTS, KTS, MGAP and GAP – with data from a trauma registry in a lower middle-income countries (Table 1) and (2) to determine which of these scoring systems most accurately predicts in-hospital mortality in this setting.

This study was approved by the Lokmanya Tilak Municipal General Hospital institutional ethics committee, the World Health Organization Ethics Review Committee, and the University of California San Francisco Committee on Human Research.

Patients and methods

Five injury scoring systems – ISS, RTS, KTS, MGAP and GAP – were compared using data collected in the institutional trauma registry of Lokmanya Tilak Municipal General Hospital, an urban Level I trauma center in Mumbai, India, between October 2010 and February 2012. All severely injured patients presenting to the hospital with life- or limb-threatening injuries according to the criteria of the World Health Organization Trauma Care Checklist study were evaluated and received standardized care from surgical registrars in the Trauma Ward (see electronic supplement). At the time of triage, the surgical registrars completed an intake form, which included the patient's age, vital signs, neurologic status and injury mechanism. For three 8-h shifts per month, an independent senior observer accompanied the primary observer to check for consistency of the GCS scoring. Other data including disposition and in-hospital mortality were recorded during the hospital stay. Gunshot wounds, stab wounds and lacerations were classified as penetrating, while all other injury mechanisms were classified as blunt. Patients with minor or isolated limb injuries, such as superficial soft tissue injuries or uncomplicated, closed fractures, were not included in this analysis.

Trauma registry data were entered into the EpiInfo 6 software (CDC Statistical package), transferred to Excel (Microsoft, Redmond, Washington: 2007) for editing, and then imported to Stata 13 statistical software (StataCorp, College Station, TX: 2013) for analysis. Anonymous, de-identified data were shared with authors at the Center for Global Surgical Studies, University of California San Francisco Department of Surgery for analysis. AIS values were coded at the World Health Organization Headquarters in Geneva, Switzerland by a single coder who was trained in AIS coding by the World Health Organization Injury and Violence Prevention division. RTS, KTS, MGAP and GAP score values were calculated retrospectively based on available data. All values were calculated according to published formulas [11,12,14,15,17].

Minor modifications were made to the KTS score so that it could be calculated retrospectively. The number of serious injuries for each patient was determined based on a list of final diagnoses by a member of the research team with expertise in trauma care. Because no standardised conversion from GCS to AVPU ("alert, voice, pain, unresponsive") score exists, an estimated AVPU score was assigned based on GCS using data from the original validation study of the KTS (GCS 14–15 = "alert", GCS 10–13 = "responds to voice", GCS 5–9 = "responds to pain", GCS 3–4 = "unresponsive") [14]. A note was made when insufficient data prevented calculation of any of the scores.

Pearson's chi-squared test was used to compare mortality rates among patients who did and did not have sufficient data to calculate each score recorded. Association between injury scoring systems and in-hospital mortality was evaluated with bivariate logistic regression. The goodness-of-fit of the injury scoring systems was quantified using the Akaike information criterion, a parametric likelihood-based model that assumes a linear relationship on the logistic scale. The discrimination of the scoring systems

Table 1
Comparison of injury scoring systems.

Injury Scoring System	Acronym	Type	Variables Included
Injury Severity Score	ISS	Anatomic	AIS values
Revised Trauma Score	RTS	Physiologic	GCS, SBP, RR
Kampala trauma score	KTS	Combined	Age, SBP, RR, AVPU score, number of serious injuries
Mechanism, GCS, age, pressure	MGAP	Physiologic	Penetrating mechanism of injury, GCS, age, SBP
GCS, age, pressure	GAP	Physiologic	GCS, age, SBP

AIS, abbreviated injury score; SBP, systolic blood pressure; RR, respiratory rate; GCS, Glasgow coma score; AVPU, "alert, voice, pain, unresponsive".