Comparing traditional and novel injury scoring systems in a US level-I trauma center: an opportunity for improved injury surveillance in low- and middle-income countries

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ABSTRACT

Background: In most low- and middle-income countries (LMICs), the resources to accurately quantify injury severity using traditional injury scoring systems are limited. Novel injury scoring systems appear to have adequate discrimination for mortality in LMIC contexts, but they have not been rigorously compared where traditional injury scores can be accurately calculated. To determine whether novel injury scoring systems perform as well as traditional ones in a HIC with complete and comprehensive data collection.

Methods: Data from an American level-I trauma registry collected 2008-2013 were used to compare three traditional injury scoring systems: Injury Severity Score (ISS); Revised Trauma Score (RTS); and Trauma Injury Severity Score (TRISS); and three novel injury scoring systems: Kampala Trauma Score (KTS); Mechanism, GCS, Age and Pressure (MGAP) score; and GCS, Age and Pressure (GAP) score. Logistic regression was used to assess the association between each scoring system and mortality. Standardized regression coefficients ($\sqrt{\beta^2}$), Akaike information criteria, area under the receiver operating characteristics curve, and the calibration line intercept and slope were used to evaluate the discrimination and calibration of each model.

Results: Among 18,746 patients, all six scores were associated with hospital mortality. GAP had the highest effect size, and KTS had the lowest median Akaike information criteria. Although TRISS discriminated best, the discrimination of KTS approached that of TRISS and outperformed GAP, MGAP, RTS, and ISS. MGAP was best calibrated, and KTS was better calibrated than RTS, GAP, ISS, or TRISS.

Conclusions: The novel injury scoring systems (KTS, MGAP, and GAP), which are more feasible to calculate in low-resource settings, discriminated hospital mortality as well as traditional injury scoring systems (ISS and RTS) and approached the discrimination of a sophisticated, data-intensive injury scoring system (TRISS) in a high-resource setting. Two novel injury scoring systems (KTS and MGAP) surpassed the calibration of TRISS. These novel injury scoring systems should be considered when clinicians and researchers wish to accurately account for injury severity. Implementation of these resource-appropriate tools in LMICs can improve injury surveillance, guiding quality improvement efforts, and supporting advocacy for resource allocation commensurate with the volume and severity of trauma.

Introduction

Trauma accounts for at least 10% of the global burden of disease, and over 90% of trauma deaths occur in low- and middle-income countries (LMICs).[1] Accurate surveillance is the cornerstone for trauma prevention and systems' strengthening. Injury scoring systems compose an important aspect of trauma surveillance, trauma systems assessment, and quality improvement programs, allowing clinicians and researchers to quantify injury severity and adjust for case mix in the prognosis of trauma patients.[2,3] Two key measures of model performance are their discrimination, that is, the ability to distinguish between subjects with and without an outcome of interest, and calibration, that is, agreement between observed and predicted outcomes.[4]

Traditional injury scoring systems include the Injury Severity Score (ISS), which quantifies injury severity based on specific anatomic injuries to different body regions and the Revised Trauma Score (RTS), which uses physiologic data collected on presentation to describe injury severity.[5,6] However, the use of these scores has been debated. Critics suggest that ISS cannot differentiate between severe injuries and poor care[7] and that it lacks relevance when cross-sectional imaging is unavailable. Critics note that even in high-resource settings, RTS has been plagued by missing data[8] and that it is unreliable in intubated, sedated, and intoxicated patients.[9]

More complex injury scoring systems, such as the Trauma Injury Severity Score (TRISS), have been developed in Europe and the United States in an attempt to improve discrimination and correlation with outcomes such as hospital mortality compared to traditional scores. These scores have become broadly used in high-income countries (HIC) to adjust for trauma case mix.[10] All of these complex scores require extensive data about anatomic injuries, making them difficult to implement in low-resource settings where complete and accurate information on anatomic injuries are often unobtainable due to the rarity of cross-sectional imaging and autopsy.

In an effort to create a feasible, context-appropriate means of quantifying injury severity in low-resource settings, the Kampala Trauma Score (KTS) was derived in Uganda and has been used in other LMIC settings.[11,12] The "Mechanism, GCS, Age, Pressure Score" (MGAP) and the "GCS, Age, Pressure Score" (GAP) are two other injury scoring systems that were developed to balance discrimination with simplicity and ease of calculation.[13,14] A recent analysis showed that MGAP and GAP were easy to calculate and discriminate well using data from a trauma registry in India where incomplete and inaccurate data were a major threat to accurate injury scoring.[15] Similarly, KTS has been evaluated in several settings and was also found to demonstrate good discrimination.[12,15]

One limitation in these analyses was the reliability of data used to calculate traditional scores, such as ISS, which are used as the gold standard for comparison of novel scoring systems in these reports. Limited record keeping and constrained access to complete anatomic information through imaging or operative reports may influence the accuracy of ISS scoring in these contexts, therefore potentially causing traditional scores to underperform in these settings. To date, the performance of these novel injury scoring systems has not been directly compared to each other and to traditional injury scoring systems in a high-resource setting, where accurate imaging and operative reports are more readily available.

Comparing novel and traditional injury scoring systems in a context where the traditional scores can be optimally calculated allows us to more reliably determine the performance of novel scores. This analysis also helps to determine the appropriateness of using novel injury scoring systems in comparing the burden of injury and clinical outcomes between diverse settings. To assess model performance, we calculated their discrimination and calibration. We hypothesized that more feasible injury scoring systems (KTS, MGAP, and GAP) discriminate hospital mortality as well as traditional injury scoring systems (ISS and RTS) and approach the discrimination and calibration of a gold-standard injury scoring system (TRISS) in a high-resource setting.

Methods

Design

We conducted a registry-based study using data from the institutional trauma registry of San Francisco General Hospital (SFGH) in San Francisco, CA.

Setting

SFGH is an academic medical center that serves 100,000 patients each year and provides 20% of the city's inpatient care. As the only level I trauma center in the city, it provides care to the 1.5 million inhabitants of San Francisco and northern San Mateo