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ORIGINAL ARTICLE

Evaluating trauma scoring systems for patients presenting with gunshot injuries to a district-level urban public hospital in Cape Town, South Africa

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ABSTRACT

Introduction: Trauma scoring systems are widely used in emergency settings to guide clinical decisions and to predict mortality. It remains unclear which system is most suitable to use for patients with gunshot injuries at district-level hospitals. This study compares the Triage Early Warning Score (TEWS), Injury Severity Score (ISS), Trauma and Injury Severity Score (TRISS), Kampala Trauma Score (KTS) and Revised Trauma Score (RTS) as predictors of mortality among patients with gunshot injuries at a district-level urban public hospital in Cape Town, South Africa.

Methods: Gunshot-related patients admitted to the resuscitation area of Khayelitsha Hospital between 1 January 2016 and 31 December 2017 were retrospectively analysed. Receiver Operating Characteristic (ROC) analysis were used to determine the accuracy of each score to predict all-cause in-hospital mortality. The odds ratio (with 95% confidence intervals) was used as a measure of association.

Results: In total, 331 patients were included in analysing the different scores (abstracted from database n = 431, excluded: missing files n = 16, non gunshot injury n = 10, < 14 years n = 1, information incomplete to calculate scores n = 73). The mortality rate was 6% (n = 20). The TRISS and KTS had the highest area under the ROC curve (AUC), 0.90 (95% CI 0.83-0.96) and 0.86 (95% CI 0.79–0.94), respectively. The KTS had the highest sensitivity (90%, 95% CI 68-99%), while the TEWS and RTS had the highest specificity (91%, 95% CI 87–94% each).

Conclusions: None of the different scoring systems performed better in predicting mortality in this high-trauma burden area. The results are limited by the low number of recorded deaths and further studies are needed.

Introduction

Traumatic injuries constitute a substantial component of patient presentations at public hospital emergency centres in South Africa [1,2]. Many of these are firearm related, despite South Africa's firearm-control laws and regulations [3]. In 2012, the number of firearm related injuries in South Africa was estimated to be almost 55,000 [4]. These injuries can be devastating and require a vast array of medical resources; accumulating into a significant burden on the public health-care system [4–6].

The district health system is the backbone for the provision of healthcare in South Africa and is expected to provide effective, efficient and high quality care [7,8]. Many of these emergency centres are served by junior doctors [1]. The immense burden of trauma includes critically injured patients, who often require transfer to facilities which can provide a higher level of care [1,2]. Decisions on which patients to be prioritized for transfer can be difficult and, at times, subjective. Trauma scoring systems have been used to aid clinicians' decision making and to allow for a more objective approach [9].

Trauma scoring systems convert injury severity, or the subsequent prognosis of the patient, into a single numerical value and can simplify communication between clinicians. Trauma scoring systems are divided into anatomical, physiological, or a combined anatomical and physiological scoring system [10]. The Abbreviated Injury Scale (AIS) and the AIS-based Injury Severity Score (ISS) are two examples of anatomical scoring systems that are widely used [10]. The Revised Trauma Score

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(RTS) and Kampala Trauma Score (KTS) are physiological scores [10,11]. The Trauma and Injury Severity Score (TRISS) is a combination of anatomical and physiological trauma scores [10]. Scoring systems are useful in predicting the need for referral to a higher level of care as well as mortality in trauma patients. A comparative study in India showed that physiological scores outperformed the anatomical scoring systems when measured at admission [12]. However, trauma scoring systems may disregard details and very different injuries can receive the same score [9]. Furthermore, trauma scoring systems are frequently validated within the setting they are developed in and perhaps, therefore, more context appropriate.

The Triage and Early Warning Score (TEWS) is a component in the South African Triage Scale (SATS); it includes documentation of mobility, respiratory rate, heart rate, systolic blood pressure, temperature, level of consciousness, and presence of injury [13]. The two other components of the SATS include, a list of clinical discriminators and the final opinion of a senior health professional [13]. Accordingly, the SATS is based on physiological measures and symptoms, in combination with the presence of injury and level of mobility. The triage scale has been implemented outside of South Africa, for example, in Ghana as well as other sites by Médecins Sans Frontières (MSF) [14,15]. The SATS has been found useful specifically in trauma settings [16], but has not yet been compared with trauma scoring systems for fire-arm injuries.

The TEWS, ISS, RTS, KTS and TRISS have been studied in trauma but there are few studies that have examined the efficacy of these scores in subgroups of trauma such as gunshot injuries [17]. Accordingly, there is a need for further comparisons between the different scoring systems and studies on the pattern and characteristics of gunshot injuries. This study compared the TEWS to four trauma scoring systems, the ISS, KTS, RTS, and TRISS, as predictors of mortality in patients with gunshot injuries presenting to the resuscitation area of Khayelitsha Hospital in South Africa. A secondary objective was to describe the overall burden of gunshot-related injuries presenting to this hospital.

Methods

A retrospective analysis of a prospectively collected database was done. This was supplemented by a retrospective chart review to include additional variables and to limit missing variables.

Khayelitsha Hospital, located on the outskirts of the City of Cape Town, serves a health district of a population of more than 400,000. The residents of the township are mainly Black African and the area suffers from a high unemployment rate (38%) [18]. Khayelitsha Hospital, a 300-bed district-level hospital, provides inpatient services including surgery, medicine, paediatrics, and obstetrics [19,20]. The 5-bed resuscitation area is part of a large emergency centre and is the only area with continuous patient monitoring outside the operating theatre complex. Patients with high acuity scores according to the SATS are mainly treated within the resuscitation area [13].

The electronic Khayelitsha Hospital Emergency Centre database was initiated on 1 January 2014, and has been registered with the Stellenbosch University Health Research Ethics Committee. It is an observational database capturing all patients managed within the hospital's resuscitation area. Captured data are immediately coded upon data entry into a password-controlled Excel spreadsheet. Each patient is assigned a unique study identification (ID) number linked to the patient folder number; a decoding sheet is then separately stored.

All patients, regardless of age, with a gunshot injury that were treated within the resuscitation area of Khayelitsha Hospital within a two-year period (1 January 2016 – 31 December 2017) were extracted from the above mentioned database. Exclusion criteria were incorrect clinical record number, missing clinical record, and absence of documented gunshot wound.

Data were collected using a decoded clean extract of the database. This was copied into a spreadsheet with all non-gunshot cases removed. Missing data and additional variables not initially captured in the database were retrospectively populated using electronic clinical records. Collected variables included patient demographics, transport method, day of injury, body area(s) injured, patient disposition and components needed to calculate the various scoring systems. The primary outcome of interest was all-cause in-hospital mortality, including those who died at referral hospitals. A detailed description of each score is available as online material (Appendix A).

Summary statistics were used to describe all variables. We summarised categorical data by using frequency counts or percentages. Median or mean was the measures of central tendency for ordinal and continuous responses and standard deviation (SD) or inter-quartile range (IQR) were indicators of spread. Patients younger than 14 years were excluded from the diagnostic test accuracy analysis as the trauma scores have not been validated in this population. We determined empirical diagnostic cut-off points for each trauma score using Receiver Operating Characteristic (ROC) curves to maximize the product of sensitivity and specificity. Where appropriate, univariate logistic regression was used to determine significant associations and predictive value of triage scores on the stipulated outcomes. The odds ratio, with 95% confidence intervals (CI), was used as a measure of association of individual variables with mortality. Analyses were performed using SPPS statistical software. Complete-case analysis was used for analysing the different scores. Cases with missing data points for analysis relating to burden of disease were not excluded, but were indicated where applicable.

Results

A total of 431 patients with gunshot injuries were abstracted from the Khayelitsha Hospital Emergency Centre database. Twenty-six patients were initially excluded and a further 74 patients were excluded from the primary analysis. The final study sample therefore consisted of 331 patients; 78% of the total number of patients derived from the database (Fig. 1).

The main characteristics of participants and their injuries are presented in Table 1. A total of 32 (7.9%) participants died. The mean age ± SD of all participants (dead and alive) was 30.1 ± 9.2 years (range 11–71 years), and is similar to those who died, 31.1 ± 9.1 years (range 17–61 years). Comorbidities most frequently recorded were a positive HIV status (n = 21, 5.2%) and Diabetes Mellitus (n = 7, 1.7%). Most patients presented on Sundays (n = 105; 25.9%) and most also died on a Sunday (n = 11; 35.4%). The extremities were most often affected (n = 235, 58%), while the highest number of deaths (n = 17, 53.1%) occurred in participants where the primary injury involved the abdominal region. However, gunshot injuries to the head and neck region had the highest mortality proportion per specific region (12/59, 20.3%). The median length of stay in the resuscitation area was 600 minutes (IQR 240-1170 minutes; missing data n = 31). The median length of hospital stay, including hospitalisation at referral hospital, was three days (IQR 1–9 days).

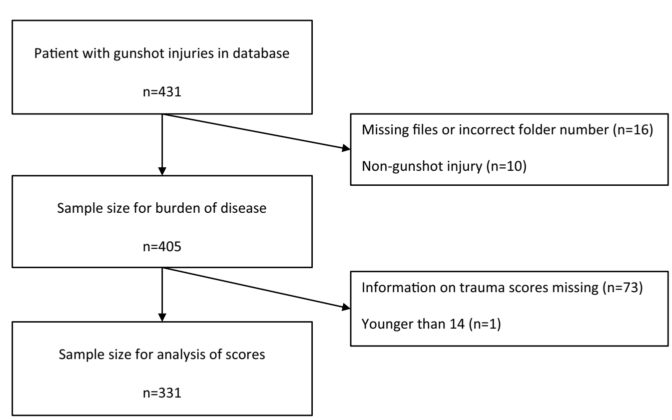

Fig. 1. Flow diagram of study sample

Table 1
Characteristics of patients presenting with gunshot injuries to the resuscitation area of Khayelitsha Hospital.

	All patients (%)	Patients that died (%)
Gender		
Male	369 (91.1)	31 (96.9)
Female	36 (8.9)	1 (3.1)
Age (years)		
< 18	15 (3.7)	1 (3.1)
18–29	221 (54.6)	15 (46.9)
30–39	116 (28.6)	12 (37.5)
≥40	53 (13.1)	4 (12.5)
Transport to Khayelitsha Hospital		
Emergency medical services	159 (39.3)	12 (37.5)
Self-transported	159 (39.3)	15 (46.9)
Other	27 (6.7)	1 (3.1)
Unknown	60 (14.8)	4 (12.5)
Day of injury		
Monday to Friday	220 (54.3)	13 (40.6)
Saturday or Sunday	185 (45.7)	19 (59.4)
Body area injured[a]		
Head and neck	59 (14.6)	12 (37.5)
Chest	93 (23)	12 (37.5)
Abdomen	128 (31.6)	17 (53.1)
Extremities	235 (58)	11 (34.4)
Unknown	2 (0.5)	0 (0)
Single area injured	317 (78.3)	21 (65.5)
Multiple areas injured	86 (21.2)	11 (34.4)
Unknown	2 (0.5)	0 (0)
Disposition from resuscitation area		
Transfer to referral hospital	244 (60.3)	10 (31.3)
Discharged home from Emergency Centre	65 (16.0)	0 (0)
Surgical referral within Khayelitsha Hospital	63 (15.6)	1 (3.1)
Died while in resuscitation unit	21 (5.2)	21 (65.6)
Patient refusing hospital treatment	7 (1.7)	0 (0)
Transfer to private hospitals	5 (1.2)	Unknown

[a] Area injured per entrance wound, multiple gunshots per area counted as one area.

The TRISS and KTS were overall the best predictors of mortality with the highest area under the ROC curve (AUC), 0.9 and 0.86, respectively. This difference was not substantial as is evident by the overlapping confidence intervals. The KTS had the highest sensitivity (90%) of the scores, while the TEWS and RTS had the highest specificity (91% each). The diagnostic accuracy of the various scores is detailed in Table 2.

Discussion

The study highlights the high burden of gunshot injuries managed at a district-level hospital in South Africa. None of the scoring systems were significantly better at predicting mortality. One can thus argue that the least complex scoring system should be used to identify patients of high mortality risk in order to expedite transfer to appropriate level of care for definitive management.

The TRISS and KTS had the best diagnostic performance, measured as AUC, to predict mortality, however not significantly. This resembles the described inconsistency of injury severity scores in predicting mortality [21]. The KTS was specifically developed for low-resource countries and proved to be useful in predicting mortality in trauma patients [11,22]; however, KTS was not superior to TEWS [22]. The limitations and underperformance of TRISS has been previously documented [23]. TRISS favours poor prognostic outcome in head and neck injuries and fails to distinguish between different types of penetrating injuries [24]. The reasonable performance of TRISS was possible due to our homogenous study population, specifically limited only to gunshot injuries, and that most mortalities occurred in the head and neck region. The TEWS alone and the TEWS as part of the SATS is not traditionally seen as an injury severity score as it encompasses all Emergency Centre presentations, which have also not been validated to be used as such. However, TEWS has been shown as a good predictor of 29-day trauma-related mortality [25], whereas the SATS performed similarly to the KTS in a Ghanaian cohort [22]. The ISS is an anatomical scoring system that requires an intricate knowledge of anatomical and radiological findings to determine the severity of the injury [12,26]. Our determined cut-off of 15 is similar to the international standard, however, these data points are not available on admission, which essentially excludes the ISS as a usable discriminator on patient admission. Lastly, RTS seems to be an effective predictor of mortality in traumatic brain injuries, but performed poorly in the setting of penetrating injuries [27]. This could explain the non-superiority in our gunshot-only study population.

The overlapping of confidence intervals indicates that no score is superior to another. In resource limited settings, perhaps the least complex scoring system with the fewest number of factors and diagnostic studies should be used to identify patients at risk of dying. The advantage of physiological-based scoring systems is that they are calculated based on the patients' vital parameters upon arrival to hospital and do not require deeper understanding of the medical condition. Thus, it can be calculated by any health professional, including junior levels. However, physiological parameters can be influenced by the level of prehospital care, if any, and the time from injury to hospital arrival [23]. The use of physiological-based scoring systems seems more appropriate for the acute care setting to be used as a triage tool. However, the implementation of different triage systems for different presentations will create confusion and should be avoided. This is especially important for facilities where the case mix of patients includes non-trauma patients of all ages. It would thus make sense to preferentially use a single triage system for all presentations than different triage systems for different presentations, especially if the triage systems perform equally [28].

Table 2
Diagnostic accuracy of trauma scores in predicting mortality of patients presenting with gunshot injuries to the resuscitation area of Khayelitsha Hospital.

Score	Range	Empirical cut-point	AUC (95% CI)	Odds ratio (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	LR (+) (95% CI)	LR (−) (95% CI)
TRISS	0 – 1	0.98	0.90 (0.83–0.96)	9 (3–25)	80 (56–94)	69 (63–74)	2.5 (1.9–3.3)	0.3 (0.1–0.7)
KTS	5 – 16	13.5	0.86 (0.79–0.94)	9 (2–40)	90 (68–99)	51 (45–56)	1.8 (1.5–2.2)	0.2 (0.1–0.7)
TEWS	0 – 17	6.5	0.82 (0.70–0.93)	17 (7–45)	65 (41–85)	91 (87–94)	6.7 (4.2–10.8)	0.4 (0.2–0.7)
ISS	1 – 75	15	0.81 (0.70–0.91)	7 (3–18)	70 (46–88)	75 (70–80)	2.8 (2.0–3.9)	0.4 (0.2–0.8)
RTS	0 – 7.84	7.7	0.80 (0.67–0.94)	17 (7–46)	65 (41–85)	91 (87–94)	6.7 (4.2–10.8)	0.4 (0.2–0.7)

AUC, area under the curve; CI, confidence interval; LR, likelihood ratio; TRISS, Trauma and Injury Severity Score; KTS, Kampala Trauma Score; TEWS, Triage Early Warning Score; ISS, Injury Severity Score; RTS, Revised Trauma Score.

The study had a number of limitations. Firstly, the retrospective nature of this study incorporates an inherent bias due to risk of missing values. An additional review of clinical notes was conducted to limit patients with missing data, however 18% of eligible patients were still excluded due to missing values for comparing the different scoring systems. Nevertheless, we were able to retain a decent sample size in comparison to the literature. The convenience sample included two years of patients and possible fluctuations due to seasonal variation, public holidays, etc. would have been eliminated. Sampling bias was further minimised since all gunshot injured patients are admitted via the resuscitation area irrespective of clinical stability. Secondly, the low number of deaths, the primary outcome, made it difficult to draw any reliable conclusions on which scoring system is the most suitable for the management of patients with gunshot injuries; large prospective studies are thus needed. Lastly, care should be taken to not generalise the results since this was a single centre study in a setting with unique health care related challenges.

Khayelitsha Hospital experiences a high burden of gunshot injuries. None of the different trauma scores were superior in predicting mortality. The results are limited by the low number of recorded deaths and further studies are needed.

Dissemination of results

Results from this study were shared with the management team of Khayelitsha Hospital's emergency centre via email.

Authors' contributions

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: ALA contributed 35%; MQP contributed 25%; DJH contributed 20%; and LK and MM contributed 10% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of Competing Interest

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.afjem.2019.07.004.

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