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Diagnostic accuracy of the Kampala Trauma Score using estimated Abbreviated Injury Scale scores and physician opinion

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ABSTRACT

Background: The Kampala Trauma Score (KTS) has been proposed as a triage tool for use in low- and middle-income countries (LMICs). This study aimed to examine the diagnostic accuracy of KTS in predicting emergency department outcomes using timely injury estimation with Abbreviated Injury Scale (AIS) score and physician opinion to calculate KTS scores.

Methods: This was a diagnostic accuracy study of KTS among injured patients presenting to Komfo Anokye Teaching Hospital A&E, Ghana. South African Triage Scale (SATS); KTS component variables, including AIS scores and physician opinion for serious injury quantification; and ED disposition were collected. Agreement between estimated AIS score and physician opinion were analyzed with normal, linear weighted, and maximum kappa. Receiver operating characteristic (ROC) analysis of KTS-AIS and KTS-physician opinion was performed to evaluate each measure's ability to predict A&E mortality and need for hospital admission to the ward or theatre.

Results: A total of 1053 patients were sampled. There was moderate agreement between AIS criteria and physician opinion by normal ($\kappa = 0.41$), weighted ($\kappa_{lin} = 0.47$), and maximum ($\kappa_{max} = 0.53$) kappa. A&E mortality ROC area for KTS-AIS was 0.93, KTS-physician opinion 0.89, and SATS 0.88 with overlapping 95% confidence intervals (95%CI). Hospital admission ROC area for KTS-AIS was 0.73, KTS-physician opinion 0.79, and SATS 0.71 with statistical similarity. When evaluating only patients with serious injuries, KTS-AIS (ROC 0.88) and KTS-physician opinion (ROC 0.88) performed similarly to SATS (ROC 0.78) in predicting A&E mortality. The ROC area for KTS-AIS (ROC 0.71; 95%CI 0.66–0.75) and KTS-physician opinion (ROC 0.74; 95%CI 0.69–0.79) was significantly greater than SATS (ROC 0.57; 0.53–0.60) with regard to need for admission.

Conclusions: KTS predicted mortality and need for admission from the ED well when early estimation of the number of serious injuries was used, regardless of method (i.e. AIS criteria or physician opinion). This study provides evidence for KTS to be used as a practical and valid triage tool to predict patient prognosis, ED outcomes and inform referral decision-making from first- or second-level hospitals in LMICs.

Introduction

Trauma accounts for 11% of all disability-adjusted life years incurred annually, and disproportionately affects low- and middle-income countries (LMICs) [1,2]. Significant reductions in avertable death and disability can be won with improvements to the quality and processes of care for the injured [3]. Process improvements may be particularly important during emergency care, which is underdeveloped in many LMICs [4,5].

Strategies to rapidly and effectively triage the injured are vital to care for patients with appropriate resources in a timely manner [6]. The Kampala Trauma Score (KTS) has been proposed as a potentially useful triage tool for LMICs [7–9]. KTS may be more practical than other triage tools, such as the South African Triage Scale (SATS), since it requires fewer variables for calculation, and a single algorithm can be applied to all age groups [10,11]. KTS was

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originally developed as an injury severity score in settings without advanced diagnostics; it has comparable sensitivity and specificity with the Revised Trauma Score (RTS), Injury Severity Score (ISS), and Trauma and ISS (TRISS) for predicting outcomes retrospectively [10,12]. KTS is calculated using the patient's age, systolic blood pressure, respiratory rate, AVPU neurologic status (i.e., A – Alert, V – responds to Voice, P – responds to Pain, U – Unresponsive), and number of serious injuries [10].

Studies that attempted to validate KTS prospectively have used a variety of methods for determining number of serious injuries [7–9]. Further, these reports have not described data collection under the pressure of time, which is inherent to emergency care [7–9]. For the KTS to be a useful triage tool, emergency care teams would have to estimate the number of serious injuries early in the care process. Abbreviated Injury Scale (AIS) scores, and resultant ISS scores, have been successfully used to estimate injury severity, but have not been validated in settings with limited diagnostics [13]. Until now, prospective KTS scoring has been coupled to AIS criteria for determining number of serious injuries [8,9]. A simpler method to quantify serious injuries would potentially make KTS a useful triage tool.

To address these challenges, we sought to evaluate the use of KTS as a triage tool by collecting all component variables upon completion of the secondary survey in a Ghanaian emergency department. In addition, early estimated AIS scores were compared to physician opinion as a more practical method for estimating the number of serious injuries. Lastly, the diagnostic accuracy of KTS performance was compared to the South African Triage Scale (SATS). By doing so, the utility of KTS as a prospective triage tool in the absence of well-resourced diagnostic capacity could be determined.

Methods

Setting

This study was conducted at the Accident and Emergency Unit (A&E) of Komfo Anokye Teaching Hospital (KATH), a tertiary facility, in Kumasi, Ghana. KATH A&E admits around 14,000 injured children and adults each year, and these patients arrive from the scene of injury as well as lower-level hospitals [5]. All patients are triaged by nurses using SATS. SATS is a validated, reliable, sensitive, and specific 5-level triage acuity scale that assigns each patient to a color-coded acuity tier: i) red – emergency; ii) orange – very urgent; iii) yellow – urgent; iv) green – not urgent; and v) blue – dead on arrival [11,14,15]. SATS triages patients based on age, basic physiologic data, neurologic status, and predefined clinical discriminators (such as uncontrolled bleeding). This triage system was designed for lower resourced settings, and as such, has been utilized in various LMICs [16–18]. Patients triaged green are cared for in a separate unit given their low acuity. KATH A&E diagnostic capacity is limited due to high-demand, long periods of breakage of equipment, and prohibitively expensive user-fees for some items and services [19]. However, physician physical examination, hemoglobin determination, X-ray, and focused assessment with sonography for trauma (FAST) are routinely available for most injured patients.

Study design and patient selection

A nested diagnostic accuracy study of KTS among consecutive patients admitted to the KATH A&E from November 2014 through April 2015 was performed. The subjects in this study were the same as the parent cohort study, which examined the frequency of alcohol-related trauma. Thus, the inclusion and exclusion criteria were based on breathalyzer and saliva strip alcohol testing limitations. As such, patients aged 18 years and older with kinetic or thermal injuries defined by ICD-10 were included. Patients admitted eight hours or more after they sustained the injury were excluded given concern for complete alcohol metabolism and inappropriate classification of alcohol-injured patients. The current study included patients regardless of the alcohol test result. Lastly, patients triaged green were excluded since they were not managed by the A&E.

Data collection

Full-time, trained research assistants collected data using Epi Info 7 (Centers for Disease Control, USA) on computer tablets. Research assistants were fluent in both English and Twi, the local language. Data were uploaded to a central computer weekly and checked at random by one of the study investigators to assess completeness of data collection.

Care providers recorded patient data on triage sheets and physician sheets. These sheets were standardized, and prompted providers to consistently record information in the medical records. The following variables were collected by research assistants from chart review: date and time of admission; age, sex; SATS color; systolic blood pressure; respiratory rate; AVPU neurologic status; cause of injury; intent of injury (i.e. unintentional, assault, self-inflicted, undetermined) type of injury; and disposition of the patient from the A&E (i.e. discharged, admitted to ward, admitted to theatre, died in the A&E).

Triage nurses determined systolic blood pressure, respiratory rate, and AVPU status. Cause and intent of injury were defined by an ICD-10 injury matrix [20]. Type(s) of injury was collected for nine body regions using abridged AIS-based drop-down menus in the data capture software. These menus were designed to calculate estimated AIS scores in a triage setting. AIS-based menus were developed by condensing the AIS 2005 Update 2008 Manual into non-serious (i.e. AIS 1–2) and serious (i.e. AIS $\geq$ 3) injuries (Appendix 1) [21]. This version of the manual developed the ability to condense types of injuries through use of a 'not further specified' category [21]. Menu creation was also guided by the limited availability of diagnostics and the types of injuries that commonly present to KATH.

Research assistants completed data collection at the time of the secondary survey. Efforts were made by the care providers to perform the secondary survey immediately after the primary survey, start of resuscitation and results of initial diagnostic tests (e.g. FAST, radiographs, and hemoglobin). Since timely data collection was vital for prospective assessment of KTS, a study investigator was always available to field questions from research assistants (i.e., 24 h per day, 7 days per week, including holidays).

Physician opinion

The research assistants then asked the patient's emergency physician to estimate the number of serious injuries. The research assistants provided a standardized definition of serious injury: an injury that is potentially life threatening or may significantly impact the patient's life. This simple definition was used to obtain a response based on physician judgment alone (i.e. not guided by any standardized physiologic or anatomic criteria). Clinicians estimating serious injuries were blinded to AIS and resultant KTS.

Data collection for sensitivity analysis of excluded patients

To assess the potential for selection bias with regard to the current study, we retrospectively collected data on patients who were excluded from the parent study. Specifically, data from all adult injury patients who were excluded by category (i.e. patients

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