Evaluation of a modified South African Triage Score as a predictor of patient disposition at a tertiary hospital in Rwanda

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ABSTRACT

Background: Triage is essential for efficient and effective delivery of care in emergency centers (ECs) where numerous patients present simultaneously with varying acuity of conditions. Implementing EC triage systems provides a method of recognizing which patients may require admission and are at higher risks for poor health outcomes. Rwanda is experiencing increased demand for emergency care; however, triage has not been well-studied. The University Teaching Hospital of Kigali (UTH-K) is an urban tertiary care health center utilizing a locally modified South African Triage Score (mSATS) that classifies patients into five color categories. Our study evaluated the utility of the mSATS tool at UTH-K.

Methods: UTH-K implemented mSATS in April 2013. All patients aged 15 years or older from August 2015 to July 2016 were eligible for inclusion in the database. Variables of interest included demographic information, mSATS category, patient case type (trauma or medical), disposition from the ED and mortality.

Results: 1438 cases were randomly sampled; the majority were male (61.9%) and median age was 35 years. Injuries accounted for 56.7% of the cases while medical conditions affected 43.3%. Admission likelihood significantly increased with higher triage color category for medical patients (OR: Yellow = 3.61, p < .001 to Red (with alarm) = 7.80, p < .01). Likelihood for trauma patients, however, was not significantly increased (OR: Yellow = .84, p = .75 to Red (with alarm) = 1.50, p = .65). Mortality rates increased with increasing triage category with the red with alarm category having the highest mortality (7.7%, OR 18.91).

Conclusion: The mSATS tool accurately predicted patient disposition and mortality for the overall ED population. The mSATS tool provided useful clinical guidance on the need for hospital admission for medical patients but did not accurately predict patient disposition for injured patients. Further trauma-specific triage studies are needed to improve emergency care in Rwanda.

African relevance

• This is the first study of triage systems in Rwanda.
• The findings may guide future research on triage systems in Rwanda and other African settings.
• It may also provide valuable feedback to Rwandan medical leaders about triage and disposition at their referral hospital.

Introduction

Triage is essential for efficient and effective delivery of care in emergency centers (ECs) where numerous patients present simultaneously with varying acuity of conditions [1,2]. Implementing EC triage systems provides a method of recognizing which patients may require admission and are at higher risks for poor health outcomes [3,4]. Triage systems categorize patients by level of acuity ranging from non-urgent to life-threatening and guide how rapidly patients should be evaluated and treated based on specific criteria of clinical urgency [5–7]. The
The absence of triage systems is associated with longer times to provider evaluation, poorer assessments of clinical risk and increased morbidity and mortality [8].

Many triage systems exist, however no single system is universal or clinically superior [9–11]. High income countries (HICs) have implemented triage systems such as the Australian Triage Scale (ATS), Canadian Triage and Acuity Scale (CTAS), Manchester Triage System (MTS), Emergency Severity Index (ESI), and the Early Warning Score (EWS) [12,13]. HIC-developed triage systems are of lower utility in low- and middle-income countries (LMICs) for reasons such as resource limitations, culture barriers and region specific pathophysiologies [14–16]. LMICs have created variations and unique triage scores to fit their healthcare needs including local disease burdens and resource availability [17,18].

The South African Triage Scale (SATS) was created as a triage system contextually appropriate for Africa [5,19]. The SATS has been shown to have validity and reliability as a triage tool in resource-limited settings [20,21], and multiple countries in Africa have adapted the SATS to fit their setting specific needs [22–24]. Rwandan emergency providers working in conjunction with international physician partners (within the sidHARTe and Human Resources for Health Program) developed a locally modified South African Triage Scale (mSATS) which was implemented at the University Teaching Hospital-Kigali (UTH-K) in 2013.

Triage systems have not been well-studied in Rwanda, a country which is experiencing rapid development and increased demand for emergency care [25–28]. To test the reliability of an emergency triage system, it is important to apply the tool in the clinical environment where it will be utilized [14,20]. The current study aimed to evaluate the utility of the mSATS tool implemented at a tertiary hospital in Rwanda.
Methods

The study was carried out at UTH-K, the primary public referral hospital in Kigali, Rwanda. The facility is an urban, tertiary-care institution with approximately 40 EC and 500 inpatient beds with access to specialty services, laboratory medicine and radiologic capabilities. The study site serves approximately 11 million Rwandans as the primary public referral center for all seriously ill patients. UTH-K has a dedicated EC with multiple medical and surgical specialists and subspecialists available for consultation and is home to the country’s sole emergency medicine (EM) training program. UTH-K implemented the mSATS as their triage assessment system in April 2013. This retrospective cohort study aims to evaluate whether the implemented triage system provides clinically relevant information on patient disposition and mortality in the Rwandan context. The study received approval from the University of Rwanda College of Medicine and Health Science Institutional Review Board (No. 282/CMHS IRB/2017) and the University Teaching Hospital of Kigali’s Ethics Committee (reference number EC/CHUK/378/2017). The data obtained was retrospective and de-identified.

All patients aged 15 years or older presenting to the UTH-K EC during the time periods August 2015–July 2016 were eligible for inclusion in the study. Cases less than 15 years of age are generally treated in a pediatric care area unless they are critically ill. Thus, patients under 15 years of age were not included so as not to introduce bias. Cases without an identifiable medical record or those lacking EC record documentation for the visit of interest were excluded.

mSATS triage tool and clinical procedures

The mSATS has three components. The Triage Early Warning Score (TEWS), which includes, trauma patients [4,5], was chosen as one component of the system with its physiologic assessment and symptom based numeric scale. The other two components to SATS include a discriminator list and a color category. Discriminators are core to the decision-making process and include: mechanism of injury, presentation, pain, and senior healthcare professional’s discretion [2,29–31]. The color categories are red, orange, yellow, green, and blue. Red patients require resuscitation and are physiologically unstable patients. Orange patients are those with potentially unstable physiology or life/limb threatening pathology. Yellow patients are physiologically stable with reasonably serious medical or trauma conditions. Green patients have minor injuries or illnesses. Blue patients are clearly dead [5]. As illustrated in Fig. 1, the mSATS includes 3 components, similar to SATS, including a TEWS score, discriminators (called “signs”) and a color category. The discriminators include “emergency signs” including airway and breathing, circulation, convulsions, coma, hypoglycemia, purpuric rash, facial burn or inhalation burn injury as well as “very urgent signs” and “urgent signs”. The UTH-K triage system is a 5-level instrument, but does not include the SATS blue color category and divides the red color category into two sections for a more rapid assessment point to initiate resuscitation prior to calculation of a more in depth risk assessment score that uses aspects of the presentation and vital signs. The red color categories are: red (with alarm) or emergency signs, red (without alarm), orange, yellow, and green. Red (with alarm) patients require immediate resuscitation with disorders of the airway, breathing, and circulation, or convulsions, coma, hypoglycemia, purpuric rash, and burn. Red (without alarm) patients require immediate resuscitation with disorders of the airway, breathing, and circulation, or convulsions, coma, hypoglycemia, purpuric rash, and burn. Red (with alarm) patients require immediate resuscitation and are categorized as having an oxygen saturation of less than 92% or a TEWS score of 7–14. Orange patients have a TEWS score of 5–6 or a “very urgent sign” that warrants care in less than 10 min. Yellow patients have a TEWS score of 3–4 or “urgent signs” that warrant care in less than 60 min. Green patients have a TEWS score of 0–2 with no “urgent signs” and require care within 4 h but with hourly assessments by triage personnel. A physician is immediately notified if a patient is triaged as red or orange. Nurses with triage training perform an evaluation for every patient entering the EC (Fig. 1).

For the overall population studied, the likelihood of admission significantly increased with increasing triage color category ranging from an OR of 2.24 (Yellow, p = .01) to 4.1 (red with alarms,
Emergency care disposition across mSATS categories

Table 2

| mSATS category          | Admitted n (%) | Discharged n (%) | Referred to district hospital n (%) | Died n (%) | Eloped n (%) | Unknown n (%) |
|-------------------------|----------------|------------------|------------------------------------|------------|-------------|---------------|
| Red (with alarms)       | 18 (69.2%)     | 3 (11.5%)        | 0 (0.0%)                           | 2 (7.7%)   | 0 (0.0%)    | 3 (11.5%)     |
| Red (no alarms)         | 81 (76.4%)     | 12 (11.3%)       | 3 (2.8%)                           | 7 (6.6%)   | 0 (0.0%)    | 3 (2.8%)      |
| Orange                  | 296 (67.3%)    | 95 (21.6%)       | 5 (1.1%)                           | 5 (1.1%)   | 0 (0.0%)    | 39 (8.9%)     |
| Yellow                  | 243 (51.6%)    | 111 (23.6%)      | 6 (1.3%)                           | 1 (0.2%)   | 4 (0.84%)   | 106 (22.5%)   |
| Green                   | 28 (27.2%)     | 31 (30.1%)       | 0 (0.0%)                           | 0 (0.0%)   | 1 (1.0%)    | 43 (41.7%)    |
| Total                   | 648 (58.1%)    | 252 (22.3%)      | 14 (1.2%)                          | 15 (1.3%)  | 5 (0.4%)    | 194 (17.2%)   |

p < .001). When stratified by medical versus trauma patients, the likelihood of admission for medical patients had statistically significant ORs ranging from 3.61 (Yellow, p < .001) to 7.80 (Red with alarms, p = .01). For trauma patients, the likelihood of admission based on triage category was not statistically significant with p values > .05 for all categories (excluding red with no alarms p < .028) (Table 3).

Overall mortality outcomes were known for 1215 cases of which there were 124 deaths (10.2%) with 16 (1.3%) occurring in the EC. Overall case mortality prevalence increased with triage illness severity with the red with alarm category having the highest mortality (7.7%, OR 18.91) and the green category having no deaths. When stratified by medical versus trauma patients, the mortality OR for medical patients increased with triage category except for red with alarm (yellow OR 5.55, orange OR 10.91, red no alarm OR 16.36, red with alarm OR 12.27). The mortality ORs for trauma patients were not significant (Table 4).

Discussion

This study assessed the utility of a locally-modified SATS system in an EC population in Rwanda. For the overall sample population, we found that a higher triage color category was significantly associated with the increased likelihood of admission to the hospital. UTH-K’s admission rate is high (62.0%), possibly related to its status as Rwanda’s main tertiary referral hospital.

For trauma patients, the mSATS scoring system did not provide useful clinical differentiation for admission, suggesting that an alternative trauma-specific triage tool may be superior if used in the setting studied. In ECs that concurrently attend to trauma and medical emergencies, critical patients need to be effectively identified. Trauma patients are often prioritized because of the physical appearance of their injuries, while medical patients may have to wait for long periods before being evaluated even though they may have similar or even greater burdens of illness and mortality risks. Trauma patients are generally healthy and as such may have greater physiologic reserve. For this reason, some ECs use a different scoring system for trauma versus medical patients. This strategy may be beneficial in the setting currently studied at the UTH-K, and in other similar LMIC EC settings in which there are large numbers of trauma patients presenting for emergency care. Future prospective research evaluating the mSATS versus other commonly used trauma triage tools such as the Revised Trauma Score are needed to address this question.

Our study illustrates how stratified mortality likelihoods can be ascertained from the mSATS triage score information as overall mortality increased with increasing triage color category. Early identification of EC cases with a high mortality can guide expeditious treatment. Overall mortality in this study was 10.2% with 1.3% of those patients dying in the EC. When the data is further evaluated for medical versus trauma patients, the odds of death increased with increasing triage level for medical patients, however the findings were not stable for trauma patients similar to the outcome of admission. This reiterates the importance and need for further studies to identify a triage system that discriminates trauma patients at high risk of death in LMICs similar to the one studied here.

Globally, injuries are the leading cause of death for individuals less than 44 years of age and result in a major cost burden for healthcare systems [1,3]. In LMICs, almost half of the injury related deaths and a third of the disability from injuries could be addressed by emergency systems [1,3]. Triage systems have been implemented in other countries in East Africa outside of Rwanda. Tanzania, Kenya and...
However, as the cases were selected at random it is unlikely that not documented in a number of cases across all triage categories, medical records and associated missing data. The EC disposition was likely result in important data to guide the implementation of a better population of trauma patients. A direct prospective comparison would overcome the breakdown of the mSATS tool observed in the sub-population of trauma patients. A direct prospective comparison would likely result in important data to guide the implementation of a better triage system to improve emergency care in Rwanda.

**Limitations**

A limitation of this study was lack of documentation in some of the medical records and associated missing data. The EC disposition was not documented in a number of cases across all triage categories, however as the cases were selected at random it is unlikely that systematic error existed which would bias the observed findings. Additionally, for some of the sub-categorizations of interest, there were limited numbers of cases and this impacted the precision around select likelihood estimates for the outcomes of admission and mortality. Although there were limited samples in sub-categorizations the large overall sample provides important information on triage utility in the study setting. We do not have information about the type of triage training that nurses at UTH-K have to enable them to effectively triage trauma patients using the mSATS tool. A study in Uganda reveals that barriers to effective triage include lack of training which can cause inaccurate triage decisions [38]. We did not assess the accuracy of the nursing mSATS triage evaluations of patients included in this study. Finally, our data was extracted from a single academic training site with a relatively high-level of resources and emergency care experience and as such the generalization to less well-resourced practice environments is not certain.

**Conclusions**

This is the first study in Rwanda analyzing an implemented EC-based triage system (mSATS). Among all patients presenting for care, the UTH-K mSATS system provided useful clinical guidance on the likelihood of need for hospital admission and mortality, however in a sub-group analysis of trauma patients this utility was not maintained. Further prospective study of triage systems, especially focused on trauma patients, will help guide improvements in the emergency care system in Rwanda and potentially other similar practice settings.

**Dissemination of results**

Results from this study were shared at the African Conference on Emergency Medicine, November 2018 in Kigali, Rwanda (poster presentation by the first author). Results from this study were also presented for “Research Day” for the Department of Anesthesia and Critical Care at the University Teaching Hospital, Kigali in April, 2018 (presented by the first author).

**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

### Table 3

| mSATS category | Admission outcome | Trauma cases | Medical cases |
|----------------|------------------|--------------|--------------|
|                | OR (95% CI)      | p            | OR (95% CI)  | p            | OR (95% CI)  | p            |
| Green          | Reference        | .01          | Reference    | .75          | Reference    | .01          |
| Yellow         | 2.24 (1.3–3.9)   | .01          | 0.84 (0.27–2.55) | .75          | 3.61 (1.88–6.92) | <.001        |
| Orange         | 3.22 (1.9–5.6)   | <.001        | 1.62 (0.54–4.87) | .39          | 4.90 (2.5–9.6)   | <.001        |
| Red (no alarm) | 4.20 (2.1–8.4)   | <.001        | 4.63 (1.18–18.11) | .01          | 3.58 (1.58–8.09) | <.001        |
| Red (with alarm)| 4.10 (1.4–3.9)  | <.001        | 1.50 (0.26–8.58) | .65          | 7.80 (1.56–38.88) | .01          |

| mSATS category | Mortality outcome |
|----------------|-------------------|
|                | OR (95% CI)       | p   | OR (95% CI) | p   | OR (95% CI) | p   |
| Green          | Reference         | .13 | Reference  | .555 | (0.73–41.92) | .10 |
| Yellow         | 4.71 (0.63–35.35) | .13 | 0.01 (0.01–1) | <.001 | 5.55 (0.73–41.92) | .10 |
| Orange         | 7.27 (0.98–53.79) | .05 | 0.03 (0.01–0.14) | <.001 | 10.91 (1.16–81.54) | .02 |
| Red (no alarm) | 18.91 (2.49–143.50) | <.01 | 0.33 (0.7–1.50) | .15 | 16.36 (2.08–128.70) | .01 |
| Red (with alarm)| 25.81 (2.96–225.30) | <.001 | No data | 12.27 (1.16–129.6) | .04 |

### Table 4

| Medical vs trauma category | Trauma n (%) | Medical n (%) | Total n (%) |
|---------------------------|--------------|---------------|-------------|
| Green                     | 14 (2%)      | 46 (5%)       | 60 (6%)     |
| Yellow                    | 128 (13%)    | 237 (25%)     | 365 (38%)   |
| Orange                    | 196 (21%)    | 405 (23%)     | 401 (42%)   |
| Red (no alarm)            | 43 (5%)      | 66 (6%)       | 103 (11%)   |
| Red (with alarm)          | 9 (1%)       | 14 (2%)       | 23 (2%)     |
| Total                     | 390 (41%)    | 562 (59%)     | 952         |

| Medical vs trauma mortality | Trauma n (%) | Medical n (%) | Total n (%) |
|-----------------------------|--------------|---------------|-------------|
| Green                       | 0 (0%)       | 1 (<1)        | 1 (<1%)     |
| Yellow                      | 1 (<1%)      | 26 (25%)      | 27 (26%)    |
| Orange                      | 4 (4%)       | 40 (38%)      | 44 (42%)    |
| Red (no alarm)              | 9 (9%)       | 16 (15%)      | 25 (24%)    |
| Red (with alarm)            | 4 (4%)       | 3 (3%)        | 7 (7%)      |
| Total                       | 18 (17%)     | 86 (83%)      | 104 (100%)  |

Ethiopia have implemented the SATS tool and Uganda has developed the Kampala Trauma Score (KTS). The KTS was developed as a simplified composite of Revised Trauma Score (RTS) and Trauma Injury Severity Score (TRISS) for use in low-resource settings as it requires minimal data collection and recording [30]. Studies done in Cameroon and Ghana compared KTS to multiple trauma scoring systems from the developed world, including the Injury Severity Score (ISS), RTS and the TRISS and revealed the KTS is an effective predictor of patient outcomes achieving statistical performance comparable to the other scoring systems [30,37]. Given this prior evidence, the KTS may be an appropriate tool to use in the Rwanda emergency care context to overcome the breakdown of the mSATS tool observed in the sub-population of trauma patients. A direct prospective comparison would likely result in important data to guide the implementation of a better triage system to improve emergency care in Rwanda.
content: CI and MG contributed 20% each; ABA and ER 15% each; EC, ZM, NK, JCB 5% each; and ACL 10%. 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 conflict of interest.

Acknowledgements

Funding was provided through grants from the University of California, Berkeley, CA, and the University of California, Davis, CA. The funders had no role in the study design, data collection, analysis, interpretation or reporting processes.

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