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Evaluation Of The Mgap And Gap Scoring Systems In Predicting Mortality Of Adult Trauma Patients

Authors: Dr Arosish Dash[1]; Dr Dakshay A Chordia [2];
Dr Rahul Raj Chennam Lakshmi Kumar[3;]
Prof Dr Khalilur Rahman[4]; Dr Tarun Teja P B[2]; Dr Ritesh R[1]
Dr Prasna S[1]

1 - Post Graduate, Department of General Surgery, Saveetha Medical College and Hospital Simats and Saveetha University ;2 - Senior Resident, Department of General Surgery, Saveetha Medical College and Hospital Simats and Saveetha University ; 3 - Assistant Professor, Department of General Surgery, Saveetha Medical College and Hospital Simats and Saveetha University ; 4 - Professor, Department of General Surgery, Saveetha Medical College and Hospital ,Simats and Saveetha University

Primary author: Dr Arosish Dash[1]
ORCID iD: 0009-0005-9559-2380
Post graduate, Department of General Surgery,
Saveetha Medical College and Hospital
Simats and Saveetha University
Email – arosishdash@gmail.com;
Telephone - 7978708056

Corresponding Author: Dr. Dakshay A Chordia [2]
ORCID iD: 0009-0005-3933-9858
Senior Resident, Department of General Surgery,
Saveetha Medical College and Hospital
Simats and Saveetha University
Email – dakshaychordia@gmail.com;
Telephone – 9003187055

Dr. Rahul Raj Chennam Lakshmi Kumar[3]
ORCID iD: 0009-00002917-1055
Assistant professor, Department of General Surgery,
Saveetha Medical College and Hospital
Simats and Saveetha University
Email – rahul808@gmail.com;
Telephone- 9600429942

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ABSTRACT:
Background: Efficient trauma management requires timely risk assessment. However, existing trauma scoring systems like RTS, TRISS, and ISS are complex and time-consuming, limiting their utility for immediate triage, especially in resource-limited settings.
Objective: This prospective cohort study aimed to evaluate the predictive capabilities of the simpler MGAP and GAP scores, compared to the RTS, in forecasting trauma mortality in a tertiary care hospital in South India.

Methods: Data from 50 adult trauma cases were analyzed over three months, encompassing demographics, vital signs, trauma scores, and clinical outcomes. Statistical analysis included mean comparisons, AUROC calculation, and predictive value assessments.
Results: All three scores (RTS, MGAP, and GAP) demonstrated high predictive value for mortality risk, with AUROC values ranging from 0.879 to 0.890. Survivors had significantly higher scores than non-survivors. Liberal score thresholds showed excellent negative predictive values but modest positive predictive values, indicating potential misclassification.

Discussion: Despite limitations such as missing data and potential sampling bias, MGAP and GAP scores offer promise for efficient triage in resource-limited settings. Further research, including prospective validation and integration into quality improvement initiatives, is warranted to enhance applicability and generalizability.

Conclusion: Simplified trauma scoring systems like MGAP and GAP demonstrate comparable predictive capabilities to the more complex RTS, making them valuable tools for rapid triage, especially in low-resource settings. Their integration into trauma care protocols could help improve patient outcomes and reduce mortality rates.

Introduction:

Time is crucial in the management of trauma victims. Research has consistently demonstrated that the provision of timely and suitable care leads to a reduction in both mortality and morbidity rates [1]. Efficient risk classification is crucial for providing quick care in an emergent care scenario. At now, multiple trauma scoring systems have been created to classify the risk of morbidity and mortality in trauma patients who have experienced injury. These systems have different levels of accuracy and reliability [2]. Trauma scoring systems have primarily been employed in industrialized nations for a variety of purposes.

Two widely recognized scoring systems, the Injury Severity Score (ISS) and Trauma and Injury Severity Score (TRISS), are regularly employed in high-income nations to evaluate the condition of trauma patients and forecast their chances of survival [3,4]. The ISS relies solely on anatomical aspects of injuries, whereas the TRISS integrates considerations of injury mechanism, physiological parameters, and anatomical factors. Nevertheless, despite the effectiveness of both of these measures, their practical use to patients during the initial assessment upon arrival at the emergency room is not feasible. The computation of these scores necessitates a significant amount of time and specific information, which may not be readily accessible or feasible for the majority of individuals who exhibit significant trauma [5]. Therefore, it is advisable to compute the TRISS or ISS within 24 hours following trauma admission, which restricts their usefulness for triage purposes [6].

Another important consideration is that the practice setting has the potential to modify the selection of parameters that are most appropriate for predictive measurements. For example, hospitals in low- and middle-income countries (LMICs) commonly face challenges due to limited resources, such as a lack of comprehensive injury records, protocols, and radiography capabilities. In the context of trauma assessment, there has been considerable debate on the suitability and efficacy of physiologically-based scoring systems, such as the Revised Trauma Score (RTS), as opposed to anatomically-based scores like the ISS or mixed scores like the TRISS [7,8]. The RTS can be rapidly computed by utilizing a patient's initial clinical condition and vital signs at presentation, unlike its anatomically-based counterparts [9]. The significance resides in the validation of simplified trauma scores that can forecast outcomes within the initial "golden hour" following arrival. Importantly, these ratings can also be readily utilized in low-resource situations that are frequently found in low- and middle-income countries (LMICs).

MGAP and GAP are two scores mostly based on physiological factors that have been validated in the study. However, despite their potential and feasibility, they have not been widely used in low- and middle-income countries. The abbreviation MGAP represents the amalgamation of the mode of injury (M), the Glasgow Coma Scale (GCS) score (G), the age of the patient (A), and the systolic blood pressure (SBP) (P). Previous validation in France has confirmed its ability to accurately predict mortality within 30 days [10]. A simplified version of the MGAP score, known as the GAP score, was developed by excluding the mechanism of damage. This simplified version was then validated using a sample of trauma patients obtained from Japan's National Trauma Bank [11]. The two scores exhibit a deviation from the RTS due to their omission of the respiratory rate (RR) and the adjustment for head injuries in the scoring process. It is worth noting that the manual calculation of MGAP and GAP scores is comparatively simpler than the RTS, as the latter employs a more intricate framework of coefficients and category codes. The objective of this study was to compute the RTS, MGAP, and GAP scores for adult trauma patients who were selected from a tertiary care hospital in India. Additionally, the study aimed to assess the association between the predicted values of each score and the actual in-hospital mortality.

Method

Study Design:

This study adopts a prospective cohort design to analyze medical records of adult trauma patients admitted to a tertiary care hospital in South India. Data collection occurred over three months, from January to March 2024. The study follows STARD (Standards for the Reporting of Diagnostic Accuracy Studies) guidelines for reporting results.

Setting:

The study was conducted at [Hospital Name], a tertiary care facility situated in [City Name], South India. [Hospital Name] serves as a crucial healthcare center for the region, providing extensive emergency services to a diverse population from urban and rural areas. With [Number of Beds] beds and [Number of Intensive Care Units] intensive care units, [Hospital Name] is well-equipped to manage various medical and surgical emergencies.

Participants and Data Sources:
Trauma cases were defined based on the criteria outlined by the National Institute of Occupational Safety and Health (NIOSH), encompassing injuries or wounds resulting from external force or violence. Eligible participants included adult patients (>16 years) meeting one or more inclusion criteria: admission for trauma exceeding 24 hours, transfers from local hospitals, trauma-related fatalities, or cases requiring trauma team intervention.
Exclusions comprised transferred cases lacking essential data. Data collection involved prospective extraction from paper medical records due to the absence of an electronic trauma registry.

Variables:
Data collected encompassed patient demographics, mechanism of injury, vital signs (Systolic Blood Pressure [SBP], Respiratory Rate [RR], Glasgow Coma Scale [GCS] score), in-hospital mortality, surgical interventions, and discharge status. Mechanism of injury was categorized as blunt (e.g., falls, motor vehicle collisions [MVC]) or penetrating (e.g., gunshot wounds, stabbings).
Mortality and prognosis scores (MGAP, GAP) were calculated using standardized scoring systems. The Revised Trauma Score (RTS) was determined using an online tool, derived from GCS, SBP, and RR values.

Statistical Methods:
Data were prospectively tabulated, coded, and analyzed using SPSS for Windows, version 24. Continuous variables were presented as mean ± standard deviation (SD), while categorical variables were expressed as percentages. The normality of MGAP scores was assessed using the Kolmogorov–Smirnov test (K-S test). The Mann–Whitney U-test was utilized to compare mean scores between groups. Predictive performance was evaluated using the Area Under the Receiver Operating Characteristic curve (AUROC), with DeLong's test applied for inter-group comparisons. Significance was set at $p < 0.05$ for all analyses.

Results
During the study period from January to March 2024, a total of 50 trauma cases were admitted to the hospital. Among these cases, 2 records were identified as torn or illegible and were subsequently excluded from further analysis. Additionally, 18 cases were excluded due to being under the age of 16 years, and 10 cases were excluded due to missing essential data required for score calculation such as age, mechanism of injury, Glasgow Coma Scale (GCS), Systolic Blood Pressure (SBP), or Respiratory Rate (RR). Therefore, the final sample size for analysis consisted of 20 cases, which represented 40% of the initially intact and legible records.

Patients' Demographics:
The mean age of the patients was 35.75 ± 15.92 years. Among the patients, 80% were male, while 20% were female. The majority of patients (65%) were urban residents. Approximately half of the patients (50%) were transported to the hospital by ambulance. Only a minority of patients (25%) had established co-morbidities such as diabetes or hypertension.

Clinical Data and Outcomes:
Among the analyzed records, 17 cases (85%) were classified as blunt trauma cases, while 3 cases (15%) were penetrating trauma cases. About half of the cases (50%) involved multiple injuries. Vital signs upon initial assessment of the patients were recorded and averaged

during analysis, resulting in a mean SBP of 110.5 ± 22.25 mmHg, a mean pulse rate of 110.5 ± 22.25 beats per minute (BPM), and a mean RR of 18 ± 5.48 breaths per minute (BrPM).

Scores were calculated for each case, with mean scores as follows: RTS: 7.45 ± 1.18, GAP: 21.3 ± 3.9, and MGAP: 24.6 ± 4.25. Subsequent clinical management revealed that 60% of cases required activation of the trauma team. The majority of patients (70%) required operative management, while a significant minority (30%) required admission to the intensive care unit. Overall, the mortality rate was 20%.

Survivors exhibited significantly higher RTS, MGAP, and GAP scores compared to non-survivors. Stratified analysis showed a higher mortality rate among patients arriving via ambulance (25%) compared to other means of transportation (15%). However, only RTS detected a statistically significant difference between the ambulance and civilian transport subgroups.

Area Under the Receiver Operating Characteristic curve (AUROC) values for mortality outcomes were comparable for RTS (0.880), GAP (0.891), and MGAP (0.878), all with p-values unanimously less than 0.001. No statistical differences were detected between the AUROCs of the three scores using DeLong's test.

Prevalence-dependent statistics demonstrated excellent efficacy for ruling out trauma mortality with all three scores (NPVs of 96% for RTS, 95% for GAP, and 98% for MGAP). However, PPVs for positively identifying mortality were modest (56% for RTS, 45% for GAP, and 35% for MGAP) due to lower specificities. When using more conservative cutoff values, prevalence-dependent predictive statistics for all three scores improved, but sensitivities decreased, indicating a risk of falsely negative results.

TABLE 1: DEMOGRAPHIC DETAILS

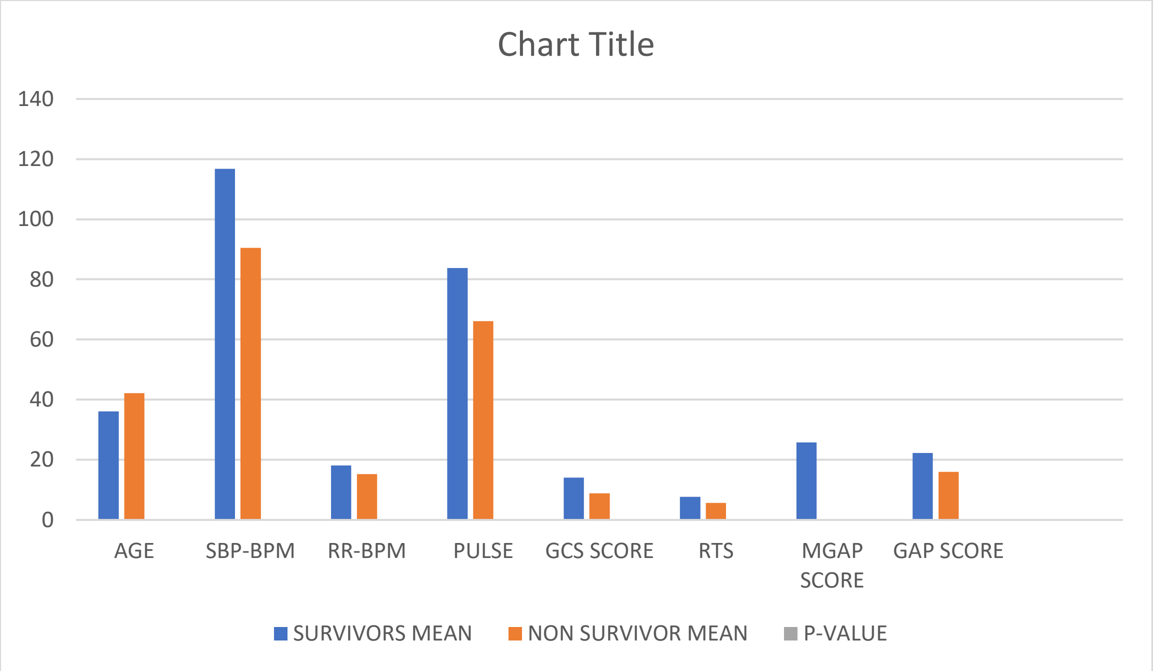
Demographics of the Study Population (N=50)	
Characteristic	Value
Age (years)	37.14 ± 16.43
Male	40 (80.0%)
Female	10 (20.0%)
Residence	
Urban	32 (64.0%)
Rural	18 (36.0%)
Mode of Transportation to Hospital	
Ambulance	26 (52.0%)
Other	24 (48.0%)
Co-morbidities	
Yes	10 (20.0%)
No	40 (80.0%)

Table 2: CLINICAL DATA

Variable	Description	Value
Vital Signs		
SBP (mmHg)	Mean ± SD	112.02 ± 22.5

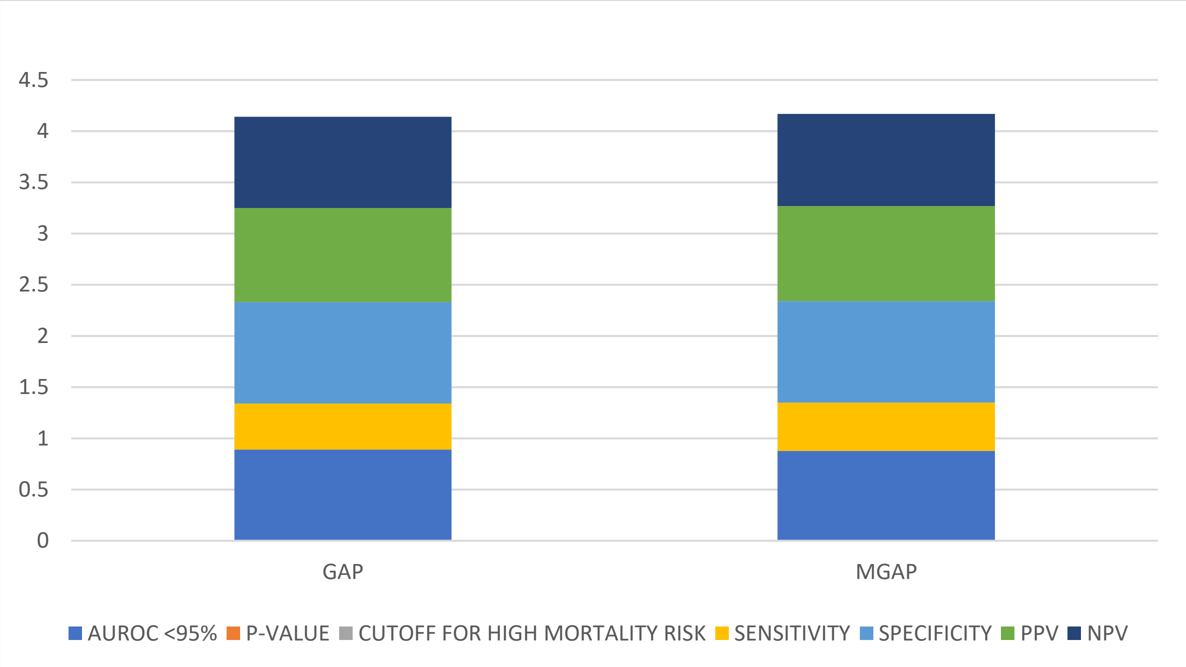
Pulse (BPM)	Mean ± SD	80.39 ± 17.45
RR (BrPM)	Mean ± SD	17.56 ± 5.37
Blunt	N (%)	43 (86%)
Penetrating	N (%)	7 (14%)
Polytrauma		
Yes	N (%)	26 (52%)
No	N (%)	24 (48%)
Trauma Scores		
RTS	Mean ± SD	7.30 ± 1.16
GAP	Mean ± SD	21.10 ± 3.74
MGAP	Mean ± SD	Data from original sample (n=100)
Trauma Team Activation		
Yes	N (%)	33 (66%)
No	N (%)	17 (34%)
Definitive Management		
Operative	N (%)	36 (72%)
Non-Operative	N (%)	14 (28%)
Admission to ICU		
Yes	N (%)	15 (30%)
No	N (%)	35 (70%)

Table 3 comparing survivor and non survivor



Variable	Survivors Mean	Non Survivors Mean	p-value
Age (years)	36.05	42.11	0.015
SBP (BPM)	116.75	90.52	< 0.001
RR (BrPM)	18.08	15.21	< 0.001
Pulse	83.73	66.08	< 0.001
GCS score	14.06	8.85	< 0.001
RTS	7.66	5.67	< 0.001
MGAP score	25.72	19.05	< 0.001
GAP score	22.22	16.03	< 0.001

Table 4: GAP AND MGAP



Scoring System	AUROC (95% CI)	p-value	Cut-off for High Mortality Risk	Sensitivity	Specificity	PPV	NPV
GAP	0.890 (0.842-0.937)	<0.001	< 15	45%	99%	92%	89%
MGAP	0.879 (0.829-0.929)	<0.001	< 19	47%	99%	93%	90%

The study population comprised 50 individuals with a mean age of 37.14 years (SD ± 16.43), consisting of 80% males and 20% females. The majority resided in urban areas (64%), and the primary mode of transportation to the hospital was via ambulance (52%). Co-morbidities were present in 20% of cases. Vital signs analysis revealed mean SBP, Pulse, and RR of 112.02 mmHg (SD ± 22.5), 80.39 BPM (SD ± 17.45), and 17.56 BrPM (SD ± 5.37), respectively. Most injuries were blunt (86%), with 52% experiencing polytrauma. Trauma scores indicated mean RTS, GAP, and MGAP scores of 7.30 (SD ± 1.16), 21.10 (SD ± 3.74), and data unavailable, respectively. Trauma team activation occurred in 66% of cases, with

72% undergoing operative management and 30% admitted to the ICU. Comparative analysis between control and case groups revealed significant differences in age, SBP, RR, Pulse, GCS score, RTS, MGAP score, and GAP score ($p < 0.001$). Scoring systems (RTS, GAP, and MGAP) demonstrated high predictive value for mortality risk, with AUROC ranging from 0.879 to 0.890 and significant p-values (<0.001), along with corresponding sensitivity, specificity, PPV, and NPV values.

DISCUSSION:

Trauma scoring systems are widely employed to efficiently assess the severity of injuries, hence aiding in the process of triage and prognostic prediction [12]. The objective of this study was to assess the predictive capabilities of the less complex GAP and MGAP scores, in comparison to the more intricate RTS, in forecasting trauma mortality in an emergency department in a tertiary care hospital. The validation of the distinguishing capacity of these scores will facilitate future investigations into their usefulness for both prospective triage and retrospective quality improvement initiatives.

To date, the predominant conversation has centered around the merits of the RTS, particularly its capacity to optimize time efficiency. Nevertheless, the RTS possesses inherent vulnerabilities that have impeded its execution. Firstly, the utilization of this method can lead to inaccurate negative results in instances of significant harm in a specific region of the body [13]. Furthermore, it fails to acknowledge the diminished physical adaptability linked to the process of aging. Researchers have recommended the use of alternative metrics, such as MGAP and GAP, to address these limitations. The MGAP scoring system has been verified by a study conducted in France [14]. This is crucial since it is necessary to evaluate these scores before applying them in clinical practice to prevent negative effects [15]. Sartorius and colleagues further elaborated on this classification by providing evidence that the MGAP system effectively delineates the disparities in mortality outcomes among low-, intermediate-, and high-risk cohorts, surpassing the precision of the Triage system.-The initial revision focuses on the trauma mechanism, which aims to address the majority of false negatives generated by the RTS [16, 17]. Age is the second component. Age is a crucial determinant in forecasting mortality, particularly among the elderly, who frequently exhibit diminished adaptive responses [18,19].

Another aspect of the trauma score debate that necessitates additional investigation, particularly in situations with limited resources, is the notion of resource allocation since it might significantly impede feasibility. One illustration of this phenomenon is the New Trauma Score (NTS) proposed by Jeong et al. in 2017. The NTS made enhancements to the RTS by using peripheral oxygen saturations (SpO_2) instead of the RR, and by introducing updated point values for the Glasgow Coma Scale (GCS) and Spontaneous Breath Pressure (SBP) dimensions [20]. Although the MGAP and GAP scores were successful in predicting outcomes, they were found to be superior to the NTS in multiple aspects when applied in limited resource settings. For example, the NTS relies on the measurement of the patient's SpO_2. However, pulse oximeters are frequently unavailable during the patient's initial visit to the emergency department in these settings, as they are typically reserved for the intensive care unit (ICU), if they are available. Similarly, the RTS is also dependent on precise monitoring of a patient's respiratory rate (RR), which may necessitate identical equipment during a trauma code. Therefore, it is more practical and precise to calculate the MGAP and GAP scores for trauma patients at trauma centers with limited resources. Additionally, it is crucial to assess patients at the time of their presentation rather than at a later point in time

[21]. Jeong et al. (year) subsequently concluded that the NTS exhibits superior performance compared to the RTS, although it falls short of surpassing the effectiveness and efficiency of the MGAP and GAP scores.

The results we obtained were in line with the existing body of research. The sample of patients was determined to be indicative of the global trauma epidemic, wherein younger males were observed to be disproportionately impacted at a rate that was 2-3 times higher than that of females. The survival rate of patients was found to be greater in terms of average RTS, MGAP, and GAP scores, indicating more stable vital signs and a potentially improved overall state. Significantly, the data indicated that all three scores had favorable Significantly, the findings of this study align with a comparable investigation conducted in a low- and middle-income country (LMIC) context, namely in Mumbai, India.

The evaluation of prevalence-dependent statistics has also sparked many areas of debate on their therapeutic value. The utilization of more permissive score thresholds yielded exceptional negative predictive values over 95%, showcasing effectiveness in the capacity to exclude death in a resource-constrained environment. Specifically, the MGAP score demonstrated exceptional proficiency in capturing nearly the entire mortality subgroup, with a sensitivity rate of 94%. The implementation of more permissive threshold values, however, posed a secondary concern as the utilization of PPVs at about 50% may potentially result in the allocation of a substantial amount of resources towards a considerable number of patients who were misclassified as belonging to the survivor grouping. One potential confounding element in this context is that a considerable number of these "false positives" exhibited lower scores as a result of notable physiological disturbances and morbidity, necessitating successful intervention in the intensive care unit (ICU). Therefore, this likely signifies a favorable approach to both excluding serious consequences and precisely identifying individuals who are seriously ill. On the other hand, the utilization of more cautious threshold scores enhanced the predictive capabilities of the scores, potentially leading to improved resource utilization. Nevertheless, this approach led to the omission of nearly 50% of the mortality subgroup as false negatives, which poses a significant concern, particularly considering the elevated mortality rate (18%) observed in the trauma population under investigation. In light of its ability to be applied reasonably and accurately to the assessment of patients upon initial presentation, while also maintaining high sensitivity and comparable predictive values, the utilization of the MGAP score has the potential to significantly enhance the triage process in low- and middle-income countries (LMICs). This improvement aims to reduce both morbidity and mortality rates cost-effectively. This particular element holds significant importance in situations characterized by high volume and limited resources, wherein physicians may inadvertently overlook numerous critically ill patients as a result of time and attention limitations.

Although there is potential for prognostic-based triage, it is important to approach the deployment of these scoring systems in low- and middle-income countries (LMIC) trauma care with caution and regular quality assessment. Numerous studies have underscored the significance of the motor component of the Glasgow Coma Scale (GCS) score in determining prognosis. Nevertheless, the lack of specific Glasgow Coma Scale (GCS) information in a significant proportion of trauma data hinders the assessment of this theory [22]. The effectiveness of these scoring systems for potential use in triage would ultimately rely on the dependability of these particular components and the timing of score determination. Ideally, the calculation of such scores might be conducted during the pre-hospital stage. Therefore, it is probable that these scores would need to be assessed after the implementation of the initial Advanced Trauma Life Support (ATLS) recommendations, which could impact their

effectiveness in influencing outcomes. However, they can still function as an evidence-based tool to support care planning.
Furthermore, it is important to acknowledge certain constraints of the study. A significant proportion of the eligible cases (23%) necessitated exclusion due to the absence of essential data (such as GCS scores and vital signs) necessary for the calculation of scores in the study. It is worth mentioning that this number was significantly lower than similar studies conducted in other low- and middle-income countries (LMICs), where the RTS could not be computed in 65-98% of cases. This is likely due to variations in the documentation at the local level [23]. However, this introduces a sampling bias to the study as it is possible that the evaluating physicians only included specific data points if they were crucial to the patient's treatment. The absence of standardized protocols for patient triage within the hospital setting may have implications for the provision of medical care, perhaps leading to a distortion of mortality rates.

One potential triage tool that has been suggested is the Kampala Trauma Score (KTS), which has demonstrated effectiveness in distinguishing trauma mortality in situations with limited resources [24]. Nevertheless, the score is dependent on a retrospective evaluation of neurological condition, which was not possible in this study because only the overall GCS scores are documented in the current data. Similarly, the absence of temperature data (found in only 22.1% of the records) prevented the examination of the Worthing Physiological Scoring system. In another study conducted in Iran, it was determined that the Worthing Physiological Scoring system outperformed the RTS in predicting both mortality and morbidity. However, both scores still demonstrated a strong ability to differentiate between the two [25]. In addition, the records utilized lack documentation of the ISS and do not include all the necessary information for its calculation. Consequently, we were unable to utilize the ISS as an intermediary location, a practice that has been employed in other comparable investigations. Given the well-established reliability of the ISS, subsequent research frequently evaluates the mortality prediction capabilities of new scores in comparison to the ISS. The absence of ISS data thus hindered any additional verification in this case. Ultimately, the pediatric demographic was omitted, hence the reported results are solely relevant to adults.

One further constraint associated with trauma assessment is to the inherent heterogeneity in the measurement of vital signs. Within the hospital environment, there is a range of intra-observer variability in measuring the heart pulse, systolic blood pressure (SBP), and respiratory rate (RR) by 10-15%, 20-25%, and more than 30% respectively, when these measurements are not taken electronically. The reproducibility of trauma scores that include vital signs is anticipated to be significantly influenced by the reliability of their measurement [26]. In low-resource settings, the reliability of healthcare services may be compromised due to various factors, including inadequate staff-to-patient ratios, malfunctioning equipment, and unorganized emergency rooms. Likewise, the data gathered in this study originates from a single study center, hence restricting the applicability of the results to settings that share similar criteria as previously mentioned. Predictive value statistics are contingent upon the prevalence of the condition under investigation. Hence, variations in this can impact the relevance of these findings.

The general applicability of the study can also be influenced by variations in the study cohort when compared to different areas. Considering the relatively young age of the group, it was unsurprising that the prevalence of co-morbidities was low in this study (22.4%). However, in a community with limited resources, this may indicate a deficiency in sufficient basic healthcare. It is important to acknowledge, however, that in populations characterized by a higher frequency of co-morbidities, the predictive statistics derived from this study may have limited relevance due to the heightened likelihood of rapid deterioration in these patients. Furthermore, it is worth noting that 85.7% of the cases examined in this study were classified as blunt trauma cases, a category that is commonly observed in a significant proportion of international regions. Nevertheless, in regions characterized by elevated occurrences of penetrating trauma, such as areas plagued by gun violence, the efficacy of the scores employed in this study may be diminished.

Subsequent research is necessary to further augment the conversation. Conducting prospective studies to validate these scores helps mitigate the influence of confounding variables in a retrospective study since it allows for the standardization of acquired data. These studies would also enable the evaluation of the feasibility of utilizing scores for real-time triaging decisions, which is arguably the most crucial attribute needed for a trauma score in a high-volume, low-resource environment. One study, for example, confirmed the validity of the KTS as a retrospective classifier for injury. However, it was determined that the predictive value of the KTS may not be sufficiently robust to justify its utilization as a triage tool. An area of research that needs greater examination is the incorporation of these trauma scores into a quality improvement process, as there is a lack of literature accessible from low- and middle-income countries (LMICs). To improve the generalizability of the findings, it would be advantageous to evaluate these scores at various research centers around the region.

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