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Research Article

The Correlation between Shock Index, TRISS, MGAP, NTS, MESS, and MEWS for Prediction of Outcome in Patients with Multiple Trauma

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Abstract

Introduction: In trauma patients, various severity scoring indices have been developed to predict the severity of injury and mortality. This study aimed to investigate the relationship between severity scoring indices for predicting survival in moderate and severe trauma patients.

Methods: This cross-sectional study was conducted among 100 trauma patients. Information on each of the Shock Index, Glasgow Coma Scale/Age/Pressure (GAP), RGAP, New Trauma Score (NTS), Mechanism/Glasgow Coma Scale/Age/Pressure (MGAP), Modified Early Warning Score (MEWS), and Trauma and Injury Severity Score (TRISS) indices was separately completed for moderate and severe trauma patients. Statistical analyses were performed using SPSS version 21.

Results: In this study, no significant differences were observed between surviving and deceased patients in terms of the Shock Index, GAP, RGAP, NTS, MGAP, MEWS, and TRISS indices. However, in all these indices, significant differences were observed between multi-trauma patients with and without morbidity. According to the ROC curve, a value less than 92.5% for the SPO2 variable was the best cutoff point for predicting the probability of death in multi-trauma patients. Also, ROC curves showed that a value higher than 95.5% for SPO2, a GCS score less than 7.5, an RR value less than 19.5, a GAP score less than 14.5, an RGAP score less than 13.5, an MGAP score less than 18, a TRISS score less than 54.2, an MEWS score higher than 3.5, and an NTS score less than 14.5 were the best ways to tell if a patient with multiple injuries was likely to be hospitalized.

Conclusion: The GAP, RGAP, MGAP, NTS, and TRISS scoring systems performed well in predicting morbidity in multi-trauma patients. However, according to the ROC curve, the GAP and RGAP indices performed slightly better than other indices. The findings of this study can be useful in better assessing survival rates, mortality, and timely treatment and intervention in trauma patients.

Keywords: Trauma Patients, Severity of the Injury, Survival Prediction, Scoring Indices, GAP, RGAP, NTS, MGAP, MEWS, TRISS.

Introduction

Trauma remains a significant public health concern worldwide, with a substantial impact on morbidity, mortality, and healthcare resource utilization.[1] Predicting outcomes in trauma patients is crucial for optimizing care delivery and improving patient outcomes.[2] Various clinical scoring systems and predictive variables have been developed to assess the severity of injury, predict survival, and guide treatment decisions in trauma patients.[3] Among these predictive variables, the Shock Index[4,5], RISS[6–9], Glasgow Coma Scale[10, 11], MGAP[12], NTS[13], MEWS[14–16], and MESS[17–19] have been widely studied for their prognostic value in trauma patients. [20] These scoring systems incorporate a combination of vital signs, laboratory values, injury severity scores, and clinical parameters to predict outcomes such as survival, function, and health status following trauma. While these scoring systems have shown promise in predicting outcomes in trauma patients, there is a need to further evaluate their performance in specific patient populations and healthcare settings. Moderate and major trauma patients represent a distinct subgroup with unique injury patterns, comorbidities, and treatment requirements that may influence the predictive value of these scoring systems.

Severity scoring indices play a crucial role in trauma management by providing healthcare professionals with a standardized method to assess and categorize the severity of traumatic injuries.[3] These indices help prioritize treatment, predict outcomes, and guide decision-making in the acute care setting. By quantifying the extent of injury and physiological derangement, severity scoring indices enable clinicians to allocate resources efficiently and improve patient outcomes. This systematic approach to trauma assessment is essential in ensuring timely and appropriate interventions for critically injured individuals. In this context, the review aims to explore the effectiveness of interventions targeting individuals with traumatic brain injuries, considering the impact on various outcomes such as social engagement, behavior changes, and cognitive functions. [21] This study aims to investigate the correlation between the Shock Index, TRISS, MGAP, NTS, MESS, and MEWS for the prediction of survival, function, and health status outcomes in moderate and major trauma patients. By analyzing data from trauma patients at our institution, we seek to identify the optimal cutoff points for these scoring systems and evaluate their performance in predicting outcomes in this specific patient population. Through this study, we aim to contribute valuable insights into the predictive value of these scoring systems in moderate and major trauma patients and provide evidence-based recommendations for their clinical application. Understanding the correlation between these scoring systems and outcomes in trauma patients can inform treatment decisions, improve risk stratification, and ultimately enhance patient care in this vulnerable population.

Methods

This is a cross-sectional prospective study conducted in Tabriz in 2022. The study population included all trauma patients who were referred to the emergency department of Imam Reza Hospital from July to December 2022. The regional ethics committee of Tabriz University of Medical Sciences approved the study proposal (IR.TBZMED.REC.1401.805). Prior to data collection in this study, all participants or their companions provided informed consent.

Table 1: The eligibility criteria for the study.

Inclusion Criteria	Exclusion Criteria
Over 18 years old	Patients who died or required cardiopulmonary resuscitation at the time of admission
Having clear medical and drug histories	Multiple referrals due to inadequate treatment
Being able to assess all parameters related to scoring indices	Unclear medical and drug histories
willingness to participate in the study	being pregnant
	Discharged from the hospital before completing treatment in the emergency department

The sampling method was a census that was conducted from October to June 2023, and all patients who met the inclusion criteria during this period were included in the study.

To collect data, the research team designed a data collection form. This form consisted of three main sections: 1) background information; 2) vital signs of trauma patients and trauma outcomes; and 3) severity scoring indices for trauma. To calculate the severity scoring indices, Youden’s index was used. The Youden index, also known as Youden's J statistic, has the following definition: J =sensitivity+specificity−1 In the second section, the patient's vital signs at admission and trauma outcomes in terms of transfer to the ICU or emergency department were recorded live, or as deaths. The type of morbidity (temporary or permanent) was also recorded in this section. In the third section, severity scoring indices such as the Shock Index, GAP, RGAP, NTS, MGAP, MEWS, and TRISS were calculated and recorded. The data collection process involved obtaining informed consent from moderate and severe trauma patients or their companions and completing each of the Shock Index, GAP, RGAP, NTS, MGAP, MEWS, and TRISS checklists separately.

The data for this study were collected by both residents and experts in the field. The data collection process involved training sessions and standardization procedures to ensure consistency among data collectors. Before the commencement of data collection, all residents and experts underwent training sessions to familiarize themselves with the study protocol, data collection instruments, and procedures. During these training sessions, detailed instructions were provided on how to accurately assess trauma severity scoring indices and record patient outcomes. Additionally, standardization procedures were implemented to ensure uniformity in data collection practices among all data collectors. This included regular meetings to discuss any issues or discrepancies that arose during data collection and address any potential sources of bias. By incorporating training and standardization procedures, we aimed to minimize variability in data collection practices and enhance the reliability and validity of the study findings. This approach helped to ensure that data were collected consistently across all participants, regardless of whether they were collected by residents or experts, thereby strengthening the overall quality of the study results.

The data were analyzed using SPSS version 21. The results were reported as frequency (percentage), mean (standard deviation), and median (interquartile range). The Kolmogorov-Smirnov test was used to test the normality of the data. The T-student test, Mann-Whitney U test, and ROC curve were used to investigate the relationship and comparison of indices in predicting survival and health outcomes. In this study, the level of statistical significance was less than 5%.

Results

In this study, 100 trauma patients admitted to Imam Reza Hospital were examined, with an age range of 18 to 82 years (mean age of 41.65 years). 16% of the patients had a driving profession, and the rest were active in other occupations. 75% of them lived in urban areas, and 25% lived in rural areas. More than half of the trauma patients had education levels below a high school diploma (72%). The main complaint of 69% of the patients was car accidents, followed by falls (18%). Approximately 35.4% of the studied multi-trauma patients were pedestrians, 34.2% were car drivers, 17.7% were passengers, 11.4% were motorcycle riders, and 1.3% were bicyclists.

In terms of mortality, 10 patients (10%) died, with 7 in the emergency department and 3 in the mortuary. 64 multi-trauma patients were transferred alive to the hospital ward, 13 to the ICU, and 13 to the operating room. In terms of morbidity, 22 patients (24.7%) had no morbidity, while 75.3% had morbidity. The details of patient classification based on AVPU, GAP, RGAP, and NTS are shown in Table 1.

Variable		Frequency (Percent)
Final status of the patient	Live - Admission to the ward	64
	Live - Admission to the ICU	13
	Live - transfer to the operating room	13
	Dead - Emergency	7
	Dead - Ward	3
Hospital Outcome	Live	90
	Dead	10
Condition of the patient if alive (n = 89)	Without morbidity	22 (24.7)
	With morbidity	67 (75.3)
AVPU	A	1
	P	19
	V	12
	U	68
Category of GAP	Mild	10
	Moderate	26
	Sever	64
Category of RGAP	Mild	2
	Moderate	26
	Sever	59
	Very sever	13
Category of NTS	Low	15
	Moderate	20
	Sever	63
	Very sever	2

Comparison of clinical symptoms and injury severity between two groups of Multi trauma patients (died and survived)

The mean systolic and diastolic blood pressure of all patients was 135.7 ± 7.125 and 76.99 ± 9.76 mmHg, respectively. The mean blood pressure of surviving patients was slightly higher than that of deceased patients, but no statistically significant difference was observed between the two groups. There was no statistically significant difference between surviving and deceased patients in terms of age, HR, RR, GCS, Pain score, Pulse rate, and BT ($P < 0.05$). In all patients, the median SPO2 was 97%, and in deceased and surviving patients, it was 87% and 97%, respectively. There was a statistically significant difference in SPO2 between the two groups ($P = 0.008$). No statistically significant difference was observed between surviving and deceased patients in terms of Shock Index, GAP, RGAP, NTS, M.GAP, MEWS, and TRISS ($P < 0.05$) (Table 2).

Comparison of clinical symptoms and injury severity between two groups of patients with and without morbidity

The mean systolic and diastolic blood pressure of patients with morbidity was slightly higher than those without morbidity, but no statistically significant difference was observed between the two groups. There was no statistically significant difference between patients with and without morbidity in terms of age, HR, Pain score, Pulse rate, BT, and Shock Index ($P < 0.05$). In comparing clinical indices, RR, SPO2, and GSC showed a statistically significant difference between patients with and without morbidity ($P > 0.05$). Thus, the median RR and GCS were significantly lower in patients with morbidity than those without morbidity. The median SPO2 was also higher in patients with morbidity than those without. There was a statistically significant difference in all GAP, RGAP, NTS, M.GAP, MEWS, and TRISS indices between patients with and without morbidity ($P > 0.05$) (Table 3).

The SPO2 cut-off point is used to predict the patient's outcome (mortality).

In examining the results of the ROC curve based on the area under the curve (AUC), SPO2 played a significant role in predicting mortality in multi-trauma patients with an AUC of 0.75. Accordingly, a value lower than 92.5 for SPO2 was calculated as the best cutoff point for predicting the probability of death in multi-trauma patients (Table 4). The ROC curve for this factor is shown in Figure 1.

To predict morbidity in multi-trauma patients, the cut-off points of SPO2, GCS, and RR factors are used.

In examining the results of the ROC curve based on the AUC, SPO2 played a significant role in predicting morbidity in multi-trauma patients with an AUC of 0.797. So, an SPO2 value higher than 95.5 was found to be the best cutoff point for predicting the likelihood of morbidity in multi-trauma patients with a 70% success rate. This makes sense since a lot of patients with morbidity need to be intubated.

The GCS index, with an AUC of 0.91, played a significant role in predicting morbidity in multi-trauma patients. Accordingly, a score lower than 7.5 for the GCS index with a sensitivity of 89% was calculated as the best cutoff point for predicting the probability of morbidity in multi-trauma patients.

The RR variable, with an AUC of 0.778, played a significant role in predicting morbidity in multi-trauma patients. As a result, a value less than 19.5 for the RR variable was found to be the best way to predict the chance of morbidity in patients who have had more than one injury (Table 5). The ROC curves for these factors are shown in Figure 2.

The cut point of GAP, RGAP, MGAP, TRISS, MEWS, and NTS injury severity scoring indices is used to predict morbidity in multi-trauma patients.

These cut-off points for severity scoring indices, such as GAP, RGAP, MGAP, TRISS, MEWS, and NTS, were used to predict morbidity in multi-trauma patients based on the ROC curves. They were found to be very good at doing this based on their AUC. So, the best cutoff points for figuring out the chance of morbidity in multi-trauma patients were found to be a score lower than 14.5 for GAP, a score lower than 13.5 for RGAP, a score lower than 18 for MGAP, a score lower than 2.54 for TRISS, and a score lower than 14.5 for NTS. These cutoff points were based on tests that were 91% sensitive. For the MEWS index, a score higher than 3.5 with a sensitivity of 54% and specificity of 72% was calculated as the best cutoff point for predicting the probability of morbidity in multi-trauma patients (Table 6). The ROC curves for these factors are shown in Figure 3.

Table 2 :Comparison of clinical features and severity of injury between two groups (dead and alive).

Variables	Total Patients	Dead	Alive	P value
SBP (mmHg)	125.7 ± 35.38	111.8 ± 50.34	127.24 ± 33.35	0.192
DBP (mmHg)	76.99 ± 21.96	68.5 ± 26.88	77.93 ± 21.32	0.199
HR (/minute)	101 (120 – 81.25)	92.5 (131.5 – 58.7)	102 (120 – 84.25)	0.285
RR (/minute)	16 (20.75 * 16)	16 (23 – 15)	16 (20.25 – 16)	0.771
SPO2 (percent)	97 (99 – 92)	87 (95.75 - 73.5)	97 (99 – 93)	0.008
GCS	3 (8.75 – 3)	4.5 (9.25 – 3)	3 (8.5 – 3)	0.373
Pain score	7 (9 – 7)	7 (7 – 7)	7 (10 – 7)	0.350
Age (year)	41.65 ± 18.90	40.7 ± 21.25	41.75 ± 18.74	0.868
Pulse rate (/minute)	101.5 (120 – 81.25)	95 (131.5 – 58.7)	102 (120 – 84.25)	0.352
BT (Centigrade)	2 (2 – 2)	2 (2 – 2)	2 (2 – 2)	1
Shock Index	0.76 (1.04 – 0.61)	0.75 (1.33 – 0.46)	0.76 (1.03 – 0.62)	0.761
GAP	10 (15 – 10)	11 (15.25 – 9.25)	10 (15.25 – 10)	0.887
RGAP	11 (14 – 9)	12 (14.25 – 7)	11 (14 – 9)	0.796
NTS	11 (15 – 9.25)	11.5 (14.5 – 6.5)	11 (15.25 – 10)	0.484
MGAP	17 (20 – 15)	19 (20.5 – 15)	17 (20 – 15)	0.575
MEWS	5 (7 – 4)	5.5 (9 – 3)	5 (7 – 4)	0.659
TRISS	43.75 (72.1 – 14.1)	9.75 (71.9 – 5.2)	48.06 (72.5 – 17.7)	0.131

SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate; RR: Respiratory rate; SPO2: Saturation pressure of oxygen; GCS: Glascow coma scale; BT: Body temperature; GAP: GCS, Age, Pressure; RGAP: Revise GAP; NTS: New trauma score; MGAP: Mechanism, GAP; MEWS: Modified Early Warning Score; TRISS: Trauma related injury severity scale

Table 3: Comparison of clinical features and severity of injury between two groups (with and without morbidity).

Variables	With morbidity	Without morbidity	P value
SBP (mmHg)	128.01 ± 34.23	124.77 ± 31.97	0.696
DBP (mmHg)	78.79 ± 21.61	74.77 ± 20.96	0.448
HR	102 (126 – 78)	101.5 (110 – 91.5)	0.879
RR	16 (18 – 16)	23 (27.75 – 19)	<0.0001
SPO2	98 (100 – 95)	93 (96.25 – 83.75)	<0.0001
GCS	3 (3 – 3)	12 (12 – 11)	<0.0001
Pain.score	7.5 (10 – 7)	7 (9.5 – 7)	0.533
Age	41.18 ± 19.05	42.54 ± 18.02	0.768
Puls.rate	102 (126 – 78)	101.5 (110 – 91.5)	0.879
BT	2 (2 – 2)	2 (2 – 2)	1
Shok.index	0.76 (1.11 – 0.63)	0.75 (0.97 – 0.61)	0.996
GAP	10 (10 – 10)	18 (19 – 16)	<0.0001
RGAP	11 (11 – 9)	17 (19 - 14.75)	<0.0001
NTS	11 (11 – 9)	18 (19 – 16)	<0.0001
M.GAP	15 (17 – 15)	23 (25 – 20.75)	<0.0001
MEWS	5 (7 – 4)	4 (6 – 3)	0.019
TRISS	35.9 (52.8 – 14.1)	73.3 (87.25 – 63.35)	<0.0001

Table 4 :Rock curve results of SPO2 for outcome of patients.

Factor	Area under curve	95% Confidence Interval	P-value	sensitivity	Specificity	Cutoff point
SPO2	0.753	0.576 - 0.931	0.009	0.78	0.70	<92.5

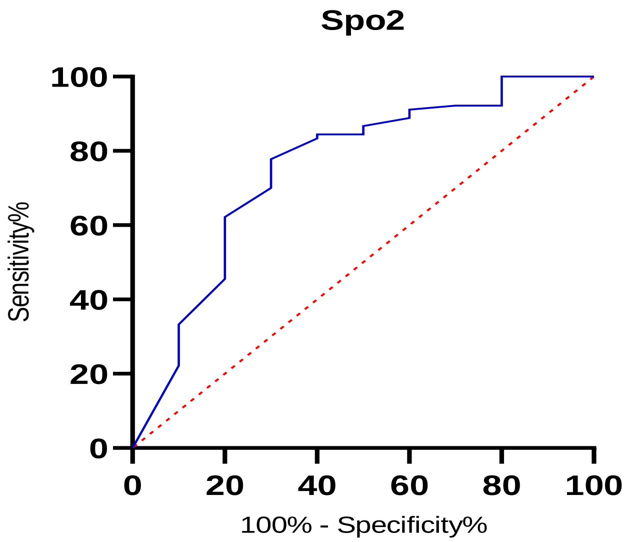

Figure1: SPO2 in predicting the mortality of multi-trauma patients.

Table 5 :Rock curve results of SPO2, GCS, and RR for the morbidity of patients

Factor	Area under curve	95% Confidence Interval	P-value	sensitivity	Specificity	Cutoff point
SPO2	0.797	0.706 – 0.887	<0.0001	0.70	0.75	> 95.5
GCS	0.910	0.830 – 0.991	<0.0001	0.89	0.95	< 7.5
RR	0.778	0.664 – 0.893	<0.0001	0.74	0.81	<19.5

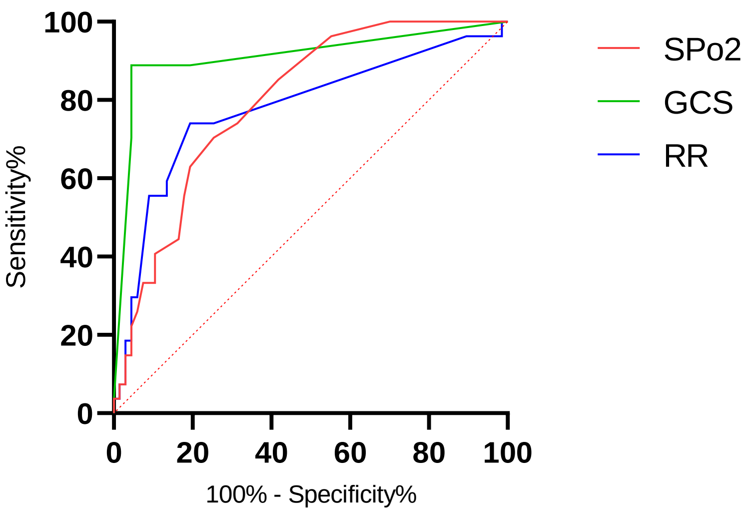

Figure 2: Comparison of SpO2, GCS, and RR in predicting morbidity in multi-trauma patients

Table 6: Rock curve results of GAP, RGAP, MGAP, TRISS, MEWS, and NTS for morbidity in patients

Factor	Area under curve	95% Confidence Interval	P-value	sensitivity	Specificity	Cutoff point
GAP	0.935	0.865 - 1	<0.0001	0.91	0.95	< 14.5
RGAP	0.931	0.859 - 1	<0.0001	0.91	0.94	< 13.5
MGAP	0.914	0.832 – 0.996	<0.0001	0.91	0.88	< 18
TRISS	0.852	0.752 – 0.952	<0.0001	0.91	0.78	< 54.2
MEWS	0.664	0.525 – 0.804	0.021	0.54	0.72	> 3.5
NTS	0.914	0.826 - 1	<0.0001	0.91	0.94	<14.5

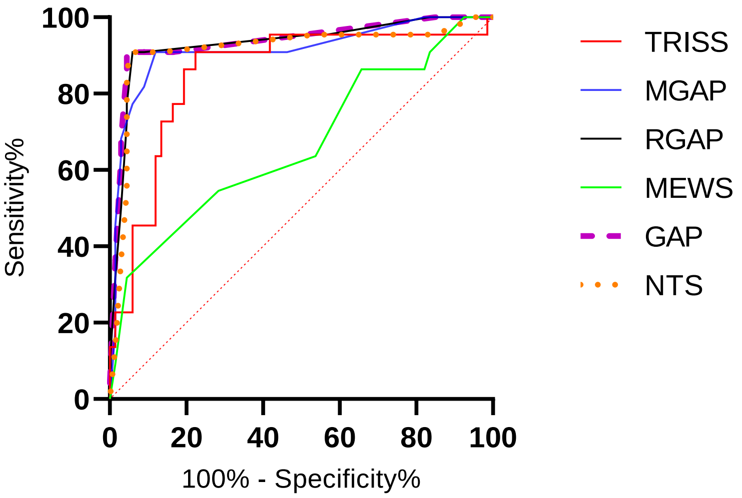

Figure 3: Comparison of GAP, RGAP, MGAP, TRISS, MEWS, and NTS factors in predicting the morbidity of multi-trauma patients

Discussion

In this study, we investigated the predictive value of severity scoring indices for survival in trauma patients admitted to Imam Reza Hospital in Tabriz in 2023. The ROC curve results showed that all severity scoring indices (GAP, RGAP, NTS, M.GAP, MEWS, and TRISS) were very good at predicting morbidity in patients who had more than one injury. In terms of predictive value, GAP and RGAP had the highest AUC of 0.93, followed by MGAP and NTS with AUCs of 0.91, and TRISS with an AUC of 0.85. MEWS had the lowest predictive value with an AUC of 0.66. For each index, the best cutoff points for predicting morbidity in multi-trauma patients were calculated.

According to Yedollahi et al.'s study, both GAP and MGAP methods are capable of predicting mortality rates in trauma patients, and both can be used for proper patient triage and predicting injury severity and mortality.[22] According to Jin Hee Jeong et al., NTS predicts hospital mortality significantly better than RTS, and no less than MGAP and GAP. Therefore, NTS can be a useful tool for triage and management of trauma patients.[13] Spencer Kuo et al.'s study, which aimed to identify high-risk trauma patients using the Reverse Shock Index (RSI), showed that trauma patients with an RSI score of less than 1 had a potentially worse condition and required more attention and aggressive care in the emergency department.[23] Zhejun Yu et al. showed that MEWS and RTS can independently predict short-term outcomes in trauma patients in the emergency department, and better prediction by MEWS can assist in quick decision-making.[16]

In Hung and Ahun's study, GAP and MGAP indices were better than RTS in predicting the death of patients, but there was no significant difference between GAP and MGAP.[12,13] In line with the results of the present study, Yadollahi et al. showed that considering the AUC, the GAP index performed slightly better than the MGAP in predicting the death of patients.[22] In Amini and Jeong's study, the NTS index was better than RTS in predicting death but similar to GAP and MGAP, which is also consistent with the results of our study.[13,]

[24] According to the Sartorius study, comparing TRISS with ISS and RTS, the TRISS index performed better, but its predictive power was lower than GAP and MGAP.[12] Yu et al also showed a better performance of MEWS in predicting death than RTS[6], but the RTS index was not investigated in our study.[16]
The study found that for multi-trauma patients, the best cut-off point for predicting morbidity for the GAP, RGAP, MGAP, and NTS index was less than 14.5, 13.5, 18, and 14.5, in that order, with a sensitivity of 91%. The best cut point for the MEWS index was a score higher than 3.5 with a sensitivity of 91% and for the TRISS index, a score lower than 54.2 with a sensitivity of 54% was estimated. The results related to the cut points in this study are contrary to previous studies. Amini's study found the optimal GAP cutoff point to be less than 15.5 [24], Soltani's study found it to be less than 16 [25] and Yadollahi's study found it to be less than 18.[22] The best MGAP index cutoff points in Yadollahi's study were below 23 [22], in Soltani's study below 21 [25], and in the remaining study below 22.[26] This difference in cut-off points can be caused by minor differences in the values of the scoring systems' parameters, such as GCS, age, blood pressure, etc.[27]. The best cut point of the NTS index for predicting the death of patients in Amini et al.'s study was 5.59 [24]. Patients with an NTS score of less than 5.59 are more likely to die. Based on the results of rock curves in this study, GCS, SPO2, and RR factors also played a significant role in predicting the morbidity of trauma patients. In comparison, GCS with a level under the curve of 0.91, SPO2 with a level under the curve of 0.79, and RR with a level under the curve of 0.77 had the highest predictive power, respectively. In Yadolahi's study, comparing indicators in terms of predicting trauma patients' deaths, GCS with a level under the curve of 0.79 had lower predictive power than TRISS, ISS, and RTS indicators.[22] In Rahmani et al.'s study, GCS had a lower predictive power compared to GAP and MGAP index.[28] Contrary to the results of the present study, Amini et al showed that the SPO2 index with a level under the curve of 0.99 has a better performance than GCS in predicting the death of patients.[24] In the present study, the best cut-off points for predicting morbidity in multi-trauma patients for GCS, SPO2, and RR were scores below 7.5, scores above 95.5, and scores below 19.5, respectively (in almost equal sensitivities). In Amini's study, the best GCS cut point was less than 8.5[24]; in Soltani and Yadollahi's study, it was less than 14. Patients with a consciousness level below 14 are at high risk of death. The present study in this field is contrary to the results of the aforementioned studies because the average GCS in the present study was 3; While the average GCS in Amini's study was about 10 and in Soltani and Yadollahi's study it was about 14. [22, 25] Also, the results of this study showed that the SPO2 factor with a level under the curve of 0.75 had a significant role in predicting death in trauma patients. The best SPO2 cut-off point for predicting the probability of death in multi-trauma patients. In Amini et al.'s study, the best SPO2 cutoff point for predicting death in patients was 77.5% (with sensitivity and specificity of 94%).[24] In the present study, there was a significant difference between patients with and without morbidity in terms of all scoring indicators. So the score of GAP, RGAP, MGAP, NTS, and TRISS indicators in patients with morbidity was significantly lower than in patients without morbidity. While there was no significant difference between the living and deceased patients in terms of these indicators. Also, in this study, there was a significant difference between patients with and without morbidity in terms of GCS, SPO2, and RR indices. Thus, in patients with morbidity, GCS and RR were lower than patients without morbidity. SPO2 was also higher in patients with morbidity than in patients without, because a large number of these patients were intubated. In terms of age indicators, HR, Pain score, Pulse rate, BT, and Shock. The index did not show any difference between patients with and without morbidity. The results of this study showed that the SPO2 factor was significantly higher in living patients than in deceased patients. However, in terms of age, HR, RR, GCS, Pain score, Pulse rate, and BT, there was no significant difference between living and deceased patients. In this study, there was no significant difference between blood pressure in living and deceased patients, as well as patients with and without morbidity. While in Soltani et al.'s study and Satorious' study, there was a strong relationship between death and low blood pressure. Thus, 90% of patients with blood pressure below 60 experienced deaths.[12, 25] Consistent with the findings of Javali et al.'s study, the current study found that traffic accidents and falls were the most common mechanisms leading to trauma.[29] In Aydin's study, traffic accidents were reported as the most common mechanism leading to trauma.[30] In Farzan et

al.'s study, many of the victims were under 60 years of age, which indicates the importance of age in multi-trauma patients.[31] In line with the studies of Soltani, Amini, and Rahmani [24, 25, 28], in our study, the average age of trauma patients was 41 years, which can be said that trauma is high in people of this age because these people are more involved in high-risk activities, including high-risk driving.

In a study conducted at Imam Reza hospital in Tabriz, Iran, a Trust in Trauma Care in an Emergency Department (TTC-ED) tool was developed and validated among 498 trauma patients. Patient-focused interviews, expert opinions, and literature reviews were used to create a 22-item tool. The TTC-ED demonstrated high content validity (k* = 0.97), good internal consistency (Cronbach's α = 0.93), and strong test-retest reliability (ICC = 0.96). Exploratory Factor Analysis revealed a two-component structure, with Factor 1 comprising 13 items and Factor 2 containing nine items. The TTC-ED was deemed a valid and reliable instrument for assessing patients' trust in emergency room settings providing trauma care.[32] Another study evaluated the overcrowding in the ED of Tabriz Imam Reza hospital in 2015 using the National Emergency Overcrowding Scale (NEDOCS) and Emergency Department Work Index (EDWIN). Over the course of one year, the researchers conducted a cross-sectional descriptive study, collecting data four times a day on 10 days each month. A total of 488 samples were gathered and analyzed using both scales. NEDOCS indicated varying levels of overcrowding, while EDWIN showed that the ED was mostly extremely busy throughout the year. The EDWIN scale highlighted certain months as the most overcrowded, suggesting its effectiveness in providing a comprehensive assessment of ED overcrowding for policy-making and management purposes. [33] In a cross-sectional study that conducted in Tabriz, Iran, aimed to assess the awareness and knowledge of emergency medical services (EMS) among older adults aged 60 years and above, sample of 1071 participants was selected using probability proportional to size sampling, with 1062 completing the questionnaire. Results showed that 47% of older adults were not familiar with the EMS system. Males, urban residents, and those with higher education levels had a higher awareness of EMS. The study highlights the need to improve awareness among older adults to ensure they can access essential EMS services effectively.[34] Other study aimed to assess the predictive value of two novel scoring systems, the modified rapid emergency medicine score (mREMS) and new trauma score (NTS), in hospitalized elderly patients with traffic injuries in Tabriz, Iran. A total of 243 elderly patients were included and divided into three groups for analysis. Logistic regression analysis revealed that mREMS and NTS scores were significant predictors of outcomes in male patients, with mREMS showing a higher odds ratio in this group. The NTS, which includes parameters like blood oxygen saturation and GCS code, demonstrated similar predictive ability to mREMS in determining the severity of trauma in elderly patients. The study suggests that both mREMS and NTS have moderate predictive utility for elderly patients with multiple traumas, emphasizing the need for further investigation and assessment of these scoring systems.[35]

In previous studies, GAP scoring systems were mostly compared with MGAP, ISS, TRISS, and RTS [22-25] and the predictive power of new scoring indices such as NTS, MEWS, and RGAP was less considered. Variations in cutoff points can be influenced by a variety of factors, including patient demographics, trauma mechanisms, and hospital protocols. In our study, the cutoff points for certain variables may differ from previous research due to differences in the patient population we studied. For example, our study may have included a higher proportion of older adults or individuals with comorbidities compared to previous studies, which could impact the cutoff points for certain outcomes. Additionally, variations in trauma mechanisms (e.g., blunt trauma vs. penetrating trauma) or injury severity patterns in our study population may have contributed to different cutoff points for predicting outcomes. Hospital protocols and practices can also play a role in determining cutoff points for certain variables. Differences in triage protocols, resuscitation strategies, or surgical interventions at different hospitals can influence the predictive value of certain variables in our study compared to previous research. It is important to consider these factors when interpreting and comparing cutoff points across studies. While differences in cutoff points may exist, they can provide valuable insights into the unique characteristics of specific patient populations and healthcare settings. We appreciate your consideration of these factors, and we will continue to explore potential explanations for variations in cutoff points in future research.

This study comprehensively compared the aforementioned indicators in terms of morbidity prediction power in trauma patients. One of the limitations of the present study was that sampling was done in only one hospital. Also, the relatively small sample size was another limitation of the study that could affect the results, and further studies with a larger sample size are recommended.

Conclusion

In the present study, GAP, RGAP, MGAP, NTS, and TRISS scoring systems performed well in predicting morbidity in multi-trauma patients. The sensitivity, specificity, and AUC of these systems were nearly identical. However, according to the level under the curve, the scores of GAP and RGAP performed slightly better compared to other indicators. The findings of the present study can be useful in a better evaluation of survival rate, mortality rate, and timely treatment and intervention in trauma patients. Also, the results of this study can be fruitful in developing guidelines for trauma patients, both in pre-hospital care and in-hospital care and interventions.

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Conflict of Interest Disclosures

The authors declare no conflict of interest.

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Ethical Statement

The regional ethics committee of Tabriz University of Medical Sciences approved this study (IR.TBZMED.REC.1401.805).

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