

Value of the Glasgow coma scale, age, and arterial blood pressure score for predicting the mortality of major trauma patients presenting to the emergency department

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ABSTRACT

BACKGROUND: The purpose of this study is to detect the mortality predictive power of new Glasgow coma scale, age, and arterial pressure (GAP) scoring system in major trauma patients admitted to the emergency department (ED).

METHODS: A total of 100 major trauma patients admitted to Uludağ University Faculty of Medicine ED who were 18 years of age or more were included in the study. In this prospective study, revised trauma score (RTS), injury severity score (ISS), trauma-related ISS (TRISS), Mechanism, GAP (MGAP) and GAP scores of the patients were calculated.

RESULTS: A significant positive correlation was established between ISS, TRISS, MGAP, and GAP in predicting in-hospital mortality ($p < 0.0001$). Short-term (24 hours) and long-term (4-week) mortality prediction rates and area under the curve in receiver operating characteristics analysis were 0.727-0.680 for RTS, 0.863-0.816 for ISS, 0.945-0.911 for TRISS, 0.970-0.938 for MGAP, and 0.910-0.904 for GAP. All calculated trauma scoring systems revealed a significant mortality prediction power ($p < 0.001$). GAP score was found statistically and significantly selective and sensitive in predicting both in-ED and in-hospital mortality ($p = 0.0001$).

CONCLUSION: In major trauma patients, GAP score is an easily calculable system both in the field and at the time of admission in the EDs by providing emergency physicians with future decision-making schemes by means of mortality prediction of the patients.

Key words: Major trauma; mortality; trauma scoring systems.

INTRODUCTION

Trauma is a serious problem worldwide, particularly affecting the young. Accordingly, trauma results in production loss in addition to being a health problem. It is also the leading cause of death in people from 1 to 44 years of age, while it is in the third leading cause for all age groups, following cancer and

cardiovascular diseases.^[1] Previous studies have demonstrated that 25-50% of deaths due to trauma are preventable.^[2] Trauma scoring systems (TSSs) have been used for nearly four decades to determine the type and severity of trauma and predict the prognosis of trauma patients with an increased mortality rate.^[3]

The practical use of some current TSSs is somewhat restricted in terms of calculation difficulty and the requirement of laboratory data for scoring. The Glasgow coma scale (GCS)-age-systolic blood pressure (SBP) (GAP) score is a physiological trauma scoring system defined in a study by Kondo et al.^[4] It is remarkable due to the requirement of fewer parameters, its applicability in the field, and mortality predictive power very similar to the trauma-related injury severity score (TRISS).^[4] The GAP score is easily calculable both in the field and at the time of admission to the emergency department (ED).

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The purpose of this study was to detect the mortality predictive power of a new GAP scoring system for major trauma patients admitted to the ED. We therefore compared the revised trauma score (RTS), the ISS, TRISS, and the mechanism, GAP (MGAP) scores.

MATERIALS AND METHODS

Following a physical examination, a total of 100 major trauma patients admitted to the Uludag University Faculty of Medicine ED who were 18 years of age or older were included in the study (Ethic Board number: 2012-13/9). Pregnant patients and those with psychiatric illnesses were excluded. Demographic data (age, gender), type of arrival, GCS, blood pressure, oxygen saturation, respiration rate, injury mechanism, vital signs, anatomic sites of injury, alcohol intake, prescribed treatments, required consultations, final outcome (hospitalization, transfer, discharge, treatment rejection, and exitus), and unit of hospitalization (clinic, intensive care unit [ICU]) were recorded.

Using the phone numbers and addresses recorded at the time of admission, the patients were contacted and followed up during a 4-week period to calculate the short-term (24 hours) and long-term (4-week) mortality prediction rates. The RTS, ISS, TRISS, MGAP, and GAP scores were calculated by evaluating the patient data, laboratory data, and radiologic imaging and consultation results recorded in the data processing system. The prediction of mortality by TSS was classified as low risk (<5%), intermediate risk (5-50%) and high risk (>50%). The patient RTS, ISS, and TRISS were obtained using a score calculator available at www.trauma.org. For the MGAP and GAP scores, the point scoring systems reported by Sartorius et al.^[5] and Kondo et al. were used, respectively^[4] (Table 1).

Statistical analyses were performed with IBM SPSS Statistics 21.0 and MedCalc 12.2.1.0. Normality of the variables was tested with the Shapiro–Wilk test. For normally distributed

variables mean±standard deviation were given as descriptive statistics; otherwise median (minimum-maximum) values were given. Mann–Whitney U-test was used to compare two independent groups. Fisher's exact test was used to compare categorical variables and n and percentage values were given as descriptive statistics. Receiver operating characteristics

Table 2. Characteristics of the trauma patients

	n	%	Mean±SD
Age (years)			40.35±16.11
Gender			
Male	77	77	
Female	23	23	
Arrival			
From scene	80	80	
By transfer	20	20	
Type of transport			
Ambulance	99	99	
Private vehicle	1	1	
Type of injury			
Blunt	98	98	
Penetrating	2	2	
Mechanism			
In-vehicle traffic accident	68	68	
Extravehicular traffic accident	6	6	
Falling from a height	13	13	
Motorbike accident	11	11	
Injury by firearms	1	1	
Sharp object injuries	1	1	
Injured area			
Head-neck	55	55	
Face	19	19	
Chest	57	57	
Abdomen	18	18	
Extremity	70	70	
Other	2	2	
Vital signs			
Pulse (per min)			90.99±17.57
SBP (mmHg)			119.60±18.58
DBP (mmHg)			75.50±10.09
Respiratory rate (per minute)			17.19±3.22
Temperature (°C)			36.25±0.36
SpO ₂			95.57±4.78
Glasgow coma score*			15 (3-15)
Alcohol intoxication	14	14	

SBP: Systolic blood pressure; DBP: Diastolic blood pressure; *Data were given as median (minimum-maximum).

Table 1. GAP scoring system

GCS	
3-15	3-15 points
Age	
<60	3 points
>60	0 point
Systolic blood pressure (mmHg)	
>120	6 points
60-120	4 points
<60	0 point

GAP: Glasgow coma scale, age, and arterial pressure; GCS: Glasgow coma scale.

(ROC) curve analysis was performed to evaluate and compare the performances of the scores. The statistical significance level was $\alpha=0.05$.

RESULTS

The mean patient age was 40.35 ± 16.11 (min: 18 - max: 90) years and 77% were male. Blunt injury accounted for 98% of the injuries. The most frequent causes of presentation were in-vehicle traffic accident (68%) and falling from a height (13%). The most common injured body parts were the extremities (70%), followed by the chest (57%). Other characteristics of the trauma patients are shown in Table 2.

Of the major trauma patients, 36% were hospitalized in the ICU, and 36% were hospitalized in the clinic. The mortality rate in the ED was 3%, and it was similar in the ICU and operating room (OR) within 24 hours, at 3%, while the mortality rate within 4-week was 6%. The mortality rate of all patients included in the study was 12%.

Trauma scoring systems (RTS, ISS, TRISS, and MGAP) were used to classify patients as having a low risk (<5%), intermediate risk, or high risk (>50%) of death. Two patients who were evaluated as intermediate risk by the RTS were classified as low risk by the GAP score, while 1 patient evaluated as low risk by the RTS was classified as intermediate risk by the GAP. In addition, 1 of 2 patients classified as high risk by the MGAP was classified as intermediate risk by the GAP, and 2 patients classified as low risk by the MGAP were classified as intermediate risk by the GAP. Five patients classified as intermediate risk by the GAP were reclassified as low risk by the MGAP. Five of 14 patients classified as high risk by the ISS were classified as intermediate risk by the GAP, while the GAP considered 8 of them low-risk. In addition, 20 of 24 patients classified as intermediate risk were evaluated as low risk, and 2 patients evaluated as low risk by the ISS were classified as intermediate risk. Four of 15 patients classified as intermediate risk by the TRISS were classified as low risk by the GAP. In the study by Kondo et al., patient classifications by the scoring systems were similarly reclassified by the GAP

Table 3. The comparison of GAP scores with the RTS, ISS, TRISS and MGAP score for mortality prediction groups

Score	Severity	Revised trauma score			Total	
		Severe (<3.4 points)	Moderate (3.4 to 7.2 points)	Mild (>7.2 points)		
GAP	Severe (3-10 points)	1	0	0	1	
	Moderate (11-18 points)	0	10	1	11	
	Mild (19-24 points)	0	2	86	88	
	Total	1	12	87	100	
Score MGAP	Severity	Severe (3-14 points)	Moderate (15-22 points)	Mild (23-29 points)	Total	
	GAP	Severe (3-10 points)	1	0	0	1
	Moderate (11-18 points)	1	8	2	11	
	Mild (19-24 points)	0	5	83	88	
Total	2	13	85	100		
Score ISS	Severity	Severe (>25 points)	Moderate (16-25 points)	Mild (<16 points)	Total	
	GAP	Severe (3-10 points)	1	0	0	1
	Moderate (11-18 points)	5	4	2	11	
	Mild (19-24 points)	8	20	60	88	
Total	14	24	62	100		
Score TRISS	Severity	Severe (>25 points)	Moderate (16-25 points)	Mild (<16 points)	Total	
	GAP	Severe (3-10 points)	1	0	0	1
	Moderate (11-18 points)	0	11	0	11	
	Mild (19-24 points)	0	4	84	88	
Total	1	15	84	100		

ISS: Injury severity score; GAP: Glasgow coma scale, age, and arterial pressure; TRISS: Trauma-related injury severity score; MGAP: Mechanism, Glasgow coma scale, age, and arterial pressure.

Table 4. Characteristics of survivors versus non-survivors for 4-week mortality

Characteristics	Survivors (n=88)	Non-survivors (n=12)	p
Gender n (%)			0.286
Male	66 (85.71)	11 (14.29)	
Female	22 (95.65)	1 (4.35)	
Age (years)	35 (18-90)	52.50 (18-78)	0.023
Systolic pressure	120 (90-160)	115 (70-160)	0.414
Diastolic pressure	80 (60-100)	70 (40-90)	0.176
Pulse rate	88 (56-132)	105 (52-140)	0.019
Respiratory rate	16 (12-25)	19 (9-30)	0.097
Temperature	36.0 (36-38.2)	36 (36-36.7)	0.722
O ₂ saturation	97.5 (83-99)	92 (70-99)	0.008
Glasgow coma scale	15 (6-15)	13 (3-15)	<0.001
Revised trauma score*	7.84 (5.97-7.84)	7.84 (3.36-7.84)	0.001
Injury severity score	10 (1-43)	24 (9-48)	<0.001
Trauma-related injury severity score	99.2 (68.7-99.7)	90 (14.9-98.8)	<0.001
Mechanism, Glasgow coma scale, age, and arterial pressure	27 (18-29)	22 (15-25)	<0.001
Glasgow coma scale, age, and arterial pressure	22 (13-24)	18 (9-22)	<0.001

Data are presented as n (%) or median (minimum-maximum). *Mean±standard deviation for survivors are 7.71±0.43 and for non-survivors are 6.49±1.82.

score.^[4] The distribution of patients by the TSSs and their reclassification by the GAP are displayed in Table 3.

While RTS, TRISS, MGAP, and GAP values were significantly higher among 4-week survivors than among non-survivors; ISS values were significantly lower among 4-week survivors than among non-survivors. Furthermore, there was a significant difference between the survivals and non-survivals in terms of age, pulse rate, oxygen saturation, and GCS (Table 4).

ROC analyses were performed to examine the performances of RTS, ISS, TRISS, MGAP, and GAP in predicting 24-hour and 4-week mortality. The area under the curves (AUCs) were found to be 0.727 (p=0.012) for RTS, 0.863 (p<0.001) for ISS, 0.945 (p<0.001) for TRISS, 0.970 (p<0.001) for MGAP and

0.910 (p<0.001) for GAP respectively, in predicting 24-hour mortality (Table 5, Fig. 1).

Furthermore, AUCs were found to be 0.680 (p=0.026) for RTS, 0.816 (p<0.001) for ISS, 0.911 (p<0.001) for TRISS, 0.938 (p<0.001) for MGAP and 0.904 (p<0.001) for GAP respectively, in predicting 4-week mortality (Table 6, Fig. 2).

The performance of MGAP in predicting 4-week mortality was significantly higher than RTS (p<0.001) and ISS (p=0.039); but there was no significant difference between the performance of MGAP was not significantly from the GAP (p=0.177) and from the TRISS (p=0.293). The performance of GAP and TRISS were significantly higher from the RTS (p<0.001 and p=0.001).

Table 5. Predictive values of the scores in the prediction of the 24 hours mortality

	Cut-off value	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	AUC	p
Revised trauma score	5.68	50.00 (12.4-87.6)	100.00 (95.9-100.0)	0.727	0.012
Injury severity score	17	83.33 (36.1-97.2)	73.86 (63.4-82.7)	0.863	<0.001
Glasgow coma scale, age, and arterial pressure	19	83.33 (36.1-97.2)	87.50 (78.7-93.6)	0.910	<0.001
Trauma-related injury severity score	95.4	100.00 (54.1-100.0)	87.50 (78.7-93.6)	0.945	<0.001
Mechanism, Glasgow coma scale, age, and arterial pressure	23	100.00 (54.1-100.0)	89.77 (81.5-95.2)	0.970	<0.001

CI: Confidence interval; AUC: Area under the curve.

Table 6. Predictive values of the scores in the prediction of the 4-week mortality

	Cut-off value	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	AUC	p
Revised trauma score	5.97	41.67 (15.2-72.3)	95.45 (88.8-98.7)	0.680	0.026
Injury severity score	16	83.33 (51.6-97.9)	67.05 (56.2-76.7)	0.816	<0.001
Glasgow coma scale, age, and arterial pressure	21	91.67 (61.5-99.8)	78.41 (68.4-86.5)	0.904	<0.001
Trauma-related injury severity score	96.8	91.67 (61.5-99.8)	80.68 (70.9-88.3)	0.911	<0.001
Mechanism, Glasgow coma scale, age, and arterial pressure	25	100.00 (73.5-100.0)	80.68 (70.9-88.3)	0.938	<0.001

CI: Confidence interval; AUC: Area under the curve.

DISCUSSION

Trauma scoring systems are commonly used for prognosis and determining the severity of a patient's condition in the early stage of treatment. The TRISS is one of the most widely used TSSs, and it strongly predicts the probability of survival.^[6,7] The GAP, which is one of the physiological scoring systems, is easy to use and fast to calculate and provides efficient treatment by determining the trauma severity in the early stages. This study aimed to evaluate the predictive prognostic power of the GAP scoring system for major trauma patients and its applicability in the ED by comparing it with the RTS, ISS, TRISS, and the MGAP scores.

TSSs are valuable for facilitating communication between healthcare professionals and allowing a consistent common

language in investigations. Studies performed using similar measurements can be reliably compared.^[8-10] The literature indicates that trauma-related deaths are usually divided into three groups. Group 1 (50%) includes those who die at the scene, and they are usually patients with major head trauma or severe vascular injury. Group 2 (30%) includes those who are admitted to the hospital and die within the first several hours, a period termed the "golden hour." These injuries often include major head, thorax, and abdominal trauma. Group 3 (20%) consists of patients who die at a later time, for example in an ICU. The deaths in this group are typically due to sepsis or multi-organ failure.^[11] The mortality of patients in Groups 2 and 3 can be prevented through fast and accurate treatment methods. Accordingly, a TSS that is easy and efficient to use may help prevent mortality. Scoring systems are bedside methods for identifying patients with catastrophic

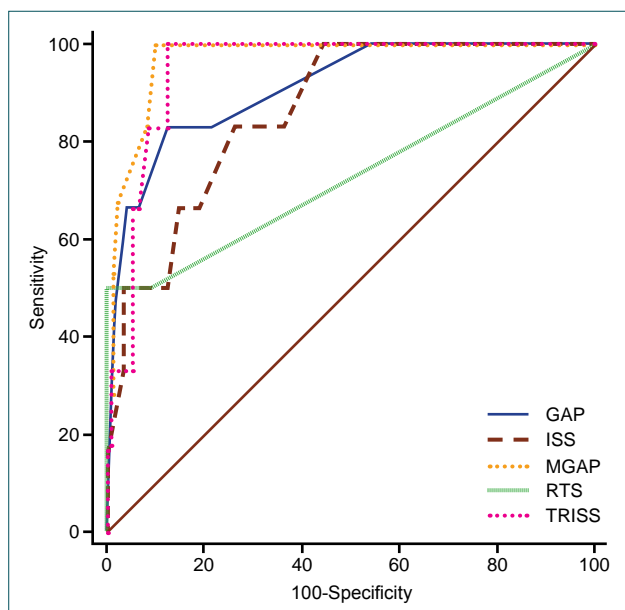


Figure 1. Receiver operating characteristics curves for the Glasgow coma scale, age, and arterial pressure (GAP), mechanism GAP, injury severity score, trauma-related injury severity score, and revised trauma score for short-term mortality prediction.

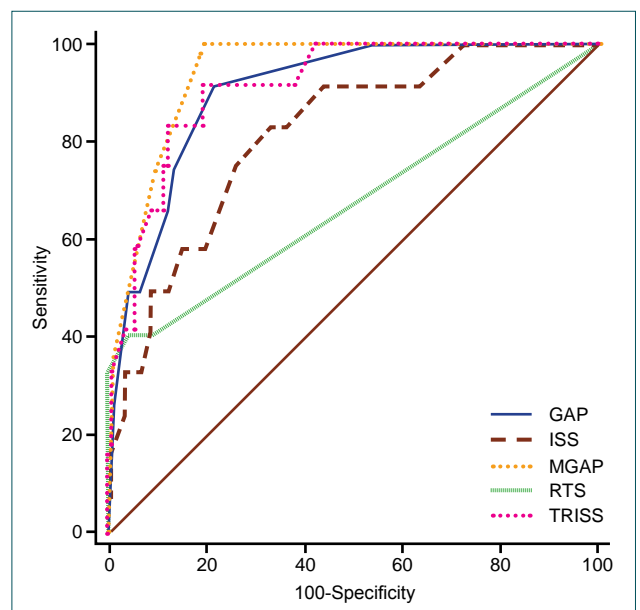


Figure 2. Receiver operating characteristics curves for the Glasgow coma scale, age, and arterial pressure (GAP), mechanism GAP, injury severity score, trauma-related injury severity score, and revised trauma score for long-term mortality prediction.

deterioration risk by identifying abnormalities.^[12] The ISS and the TRISS are widely accepted TSSs, and their calculation requires that all examinations and workups are performed and that injuries in anatomic locations are noted in a detailed manner. The accurate determination of the seriousness of the condition on the part of patient is only possible through accurate identification of the injury. Both methods require time. It is suggested that the ISS and the TRISS should be calculated 24 hours following patient admission.^[13] Within the first several hours, termed the “golden hour,” for a majority of patients presenting with major trauma, the ISS and the TRISS cannot be calculated, which handicaps their roles in guiding treatment. The prediction of prognosis is impossible at the time of ED admission using these TSSs. As the ISS and the TRISS require information not readily available at the time of presentation to the ED, they cannot provide early warning information on trauma severity for ED physicians.

Guenther et al.^[14] reported a mean in-hospital mortality rate of 26.2%. The mortality rates in other studies available in the literature vary from 9% to 18.3%.^[4,5,8,15] Similarly, the mortality rate in our study was 12%.

In the majority of trauma patients, serious injuries and mortality risk might be identified by considering physiological parameters at the scene.^[7] With this purpose, various TSSs have been developed. One of the best known is the RTS, but its adoption is limited due to the difficulty in its calculation.^[8,9,13] Sartorius et al.^[5] developed the MGAP score as an improvement over the previous simple trauma scores in a large-scale study in France, and the predicted mortality rates were similar between the RTS and the TRISS.

We found a significant difference between the RTS and the MGAP in favor of the MGAP and between the ISS and the MGAP in favor of the MGAP; however, no significant difference was found between the GAP and the MGAP. The GAP is a physiological trauma scoring system defined by Kondo et al. in a multicenter study carried out in Japan. Patient age, GCS, and SBP are sufficient for calculating the score. Kondo et al. reported correlations in the abilities of the GAP and the RTS as well as the TRISS and the MGAP to predict mortality. While the TRISS showed better predictive results, the GAP score provided the closest predictive results to those of the TRISS.^[4] In our study, the GAP score results were similar to the results of the TRISS, and no statistically significant difference was observed between them. However, a statistically significant difference was observed between the GAP and the RTS in favor of the GAP.

Conclusion

Because the GAP score is easier to calculate and has few parameters, it is advantageous for providing fast results, al-

lowing quick decision making. In major trauma patients, we believe that the GAP score is an easily calculable system both in the field and at the time of admission to the ED that can suggest future decision-making schemes to ED physicians by predicting patient mortality. In addition, it is a simple scoring system that can guide healthcare staff at the scene and enable the transfer of trauma patients to trauma centers, which may reduce the loss of time.

Conflict of interest: None declared.

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KLİNİK ÇALIŞMA - ÖZET

Acil servise başvuran majör travma hastalarının mortalite tahmininde Glasgow koma skalası, yaş ve arteriyel kan basıncı skorunun değeri

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AMAÇ: Bu çalışmanın amacı yeni bir travma skorlama sistemi olan GAP skorunun Acil Servis'e (AS) başvuran majör travma hastalarında mortalite tahmin gücünü değerlendirmektir.

GEREÇ VE YÖNTEM: Uludağ Üniversitesi Tıp Fakültesi Hastanesi AS'ye başvuran ≥ 18 yaş majör travmalı 100 hasta çalışmaya alındı. Hasta verileri ileriye yönelik olarak değerlendirilerek hastaların RTS, ISS, TRISS, MGAP ve GAP skorları hesaplandı.

BULGULAR: Hastane içi mortaliteyi öngörmede, ISS, TRISS, MGAP ve GAP arasında pozitif yönde anlamlı bir korelasyon saptandı ($p < 0.0001$). Travma skorlama sistemlerinin sırasıyla kısa dönem (24 saat) ve uzun dönem (4 hafta) mortalite tahmin oranları ROC analizinde Eğri Altındaki Alan (EAA)- Area Under Curve (AUC); RTS için 0.727- 0.680, ISS için 0.863-0.816, TRISS için 0.945-0.911 MGAP için 0.970-0.938, GAP için 0.910-0.904 olarak bulundu. Hesaplanan travma skorlarının hepsinin mortalite tahmin gücü anlamlı olarak bulundu ($p < 0.001$). GAP'ın hem AS'de, hem de hastane içi mortaliteyi öngörmede istatistiksel olarak anlamlı bir şekilde ($p = 0.0001$) seçici ve duyarlı olduğu belirlendi.

TARTIŞMA: Bu sonuçlarla GAP skorunun travma hastalarında, hem sahada ve hem de başvuru anında AS'de kolayca hesaplanabilecek ve hastanın mortalitesini öngörerek AS doktoruna fikir verebilecek bir skorlama sistemi olduğunu düşünmekteyiz.

Anahtar sözcükler: Majör travma; mortalite; travma skorlama sistemleri.

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