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An evaluation of trauma scores (RTS, GAP, EMTRAS) on mortality in multiple trauma patients

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Abstract

Background: Emergency Trauma Score (EMTRAS), Revised Trauma Score (RTS) and Glasgow Age Pressure (GAP) are used to determine the patient status, and to predict the intervention and prognosis.

Objectives: The aim of the present study was to evaluate the association between mortality and trauma severity scores (EMTRAS, RTS, and GAP) in multiple trauma patients.

Methods: In this study, patients who had referred to the Emergency Department of Mustafa Kemal University Hospital due to multiple trauma within a one-year period were evaluated retrospectively. The hospital is located in the central district of Hatay, Antakya in the Republic of Turkey, 680 km from the capital, on the Syrian border. Its population is 1,5 million. Antakya is located as the central district of Hatay with population of 400,000. Demographic data, trauma type, nationality, vital parameters [pulse, peripheral oxygen saturation (SO_2), respiratory count, systolic blood pressure (SBP), diastolic blood pressure (DBP)], physiological scoring systems (GCS, RTS, GAP and EMTRAS), and mortality states of the patients were reviewed. Data were analysed by SPSS 21, and the effect of current parameters on short-term (in the emergency service) and long-term (30 days) mortality was examined.

Results: Three hundred and thirty-three multi-trauma patients were enrolled into the study. The median age of the patients was 31 (IQR: 22) years; 88.3% (294) of the patients were male. The exitus rate was detected as 7.8% in the emergency service and 26.4% within one month. GCS, RTS and GAP values of the patients who have died in the emergency service and within one month were significantly lower; however, the EMTRAS level was significantly higher in these patients ($p<0.05$). RTS and EMTRAS were detected as short- and long-term independent variables for mortality ($p<0.05$). After Receiver Operating Characteristic (ROC) analysis, the areas under the curve (AUC) of GCS, GAP, RTS and EMTRAS for short-term mortality were 0.861cm^2, 0.876 cm^2, 0.901cm^2 and 0,917cm^2, respectively; the AUC of such parameters for long-term mortality was detected 0.896cm^2, 0.904 cm^2, 0.914cm^{2}and 0.899cm2, respectively.

Conclusion: EMTRAS values were detected more significant parameters for short-term mortality whereas RTS was more significant for long-term mortality in multiple trauma patients. Such two scores may be useful to predict the patient prognosis along with GCS or solely.

Keywords: Multiple trauma, RTS, GAP, EMTRAS, Mortality.

Introduction

Trauma is the name of structural damage on tissues caused by kinetic effect, chemical and/or heat energy. Multiple trauma is an injury of multiple body spaces or body regions.[1] The rate of trauma-associated injuries among all causes of death has been 9.1% according to death data of World Health Organization (WHO) in 2013; however, such rate increases to 27.7% for the individuals between 15 and 49 years of age.[2] Statistical analyses indicate that physical and mental problems appear in the long period along with higher death rates.[3]

Progress of trauma patients is dependent to trauma severity, timely and adequate intervention. Therefore, trauma severity should be determined before hospital and patients should be transferred to adequate centers for their condition. Different trauma scoring systems were created in order to understand the trauma severity, to perform the triage as soon as possible, and to decide to transfer the patient to an accurate trauma center.[4]

Trauma scoring systems are used to determine the patient status, and to predict the intervention and prognosis. Although many trauma scores were defined, some may reflect the actual condition only. Therefore, development of new scoring systems is needed. [5,6]

Glasgow Coma Scale (GCS), Emergency Trauma Score (EMTRAS), Revised Trauma Score (RTS) and Glasgow Age Pressure (GAP) are physiological scoring systems used in trauma patients. Glasgow Coma Scale is a physiological scale which is most commonly used for prediction or triage and mortality in emergency services.[5] RTS was created by adding SBP and respiration count to CGS; GAP was created by adding SBP and age to GCS; and EMTRAS score was created by adding the prothrombin time (PTT) or international normalized ratio (INR) and base deficit (BD) into GCS. [5-7]

Objectives

The aim of the present study was to reveal clinical significance of trauma scores (RTS, GAP, EMTRAS) in multiple trauma patients referred to the red zone of the emergency department ambulatory or taken by ambulance for mortality prediction.

Methods

This study was designed retrospectively after approval of the local ethical committee in the Medical Faculty of Hatay Mustafa Kemal University (Ethics Decision number: 18 in 2nd meeting on 17.01.2019). The hospital is located in the central district of Hatay, Antakya in the Republic of Turkey, 680 km from the capital, on the Syrian border. Its population is 1,5 million. Antakya is located as the central district of Hatay with a population of 400,000. The distance between Antakya and Ankara is 680 km. Transportation location is available at this link: https://goo.gl/maps/YEfKG8m75ndEVe9V9. The study was conducted on 333 of 375 multiple trauma patients referred to the Emergency Service of Hatay Mustafa Kemal University Research Hospital between January, 1, 2018 and December, 31, 2018. Forty patients whose data/file could be accessed were excluded.

Data of the patients who had referred between the dates specified were obtained retrospectively through electronic records and files filled in the emergency service. Demographic data, trauma type, nationality, vital parameters [pulse, peripheral oxygen saturation (SO_2), respiratory count, systolic blood pressure (SBP), diastolic blood pressure (DBP)], physiological scoring systems (GCS, RTS, GAP and EMTRAS), and mortality states of the patients were reviewed.

Inclusion criteria included patients at and over 16 years of age, patients with trauma on two systems at least (multiple trauma), patients whose vital signs were taken, parameters that form the trauma scores were calculated, and blood samples were collected for blood gas analysis; and patients who had referred the red zone of the emergency room by an ambulance or by their own.

Exclusion criteria of the study included patients with isolated trauma (single region), patients below 16 years of age, patients who had died on the scene and taken to the emergency room by an emergency ambulance, and multiple trauma patients whose files/information could be accessed.

Statistical analysis

All data obtained in the study were analyzed in version 21 of SPSS IBM statistics (SPSS Inc, Chicago, IL, USA). The distribution of the data was evaluated by the Kolmogorov Smirnov test. Since the data were not continuous, the median, interquartile range (IQR) and minimum-maximum values were used for presentation; categorical variables were expressed in case number (n) and frequency (%). The Mann-Whitney U test was used for data analysis. The association between categorical variables was analyzed through Pearson's chi-square and Fisher's exact chi-square tests. The logistic regression analysis was used for evaluation of factors relating the mortality. The ROC analysis was utilized for calculation of sensitivity, specificity, the area under the curve (AUC) and and cut-off value. A "P-value" less than 0.05 was considered significant.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki. Institutional Review Board approval (Ethics Decision number: 18 in 2nd meeting on 17.01.2019) was obtained. The present study did not interfere with the process of diagnosis and treatment of patients and all participants signed an informed consent form.

Results

The median age of the present study was 31 (IQR:22); 294 (88.3%) males and 39 (11.7%) females were enrolled. The short-term mortality rate of the patients was detected 7.8%. The age and gender were not detected to be related on short-term mortality ($p<0.05$). The short-term mortality rate was significantly higher in Syrian citizens ($p<0.05$). The most common cause of trauma was penetrating injury (54.1%), and the death rate was detected higher with a penetrating injury ($p<0.05$). The most common trauma location was on head and neck

(63.9%) in our study; patients with facial injury showed less mortality whereas cases with abdominal trauma showed more mortality (p<0.05). GCS, RTS and GAP values of the patients who had died were significantly lower; however, the EMTRAS level was significantly higher in these patients (p<0.05). Statistical methods used are added to Table 1.

Table 1. Analysis of factors related to the short-term mortality

Variable		**Total (n:333)**	**Death (n:26)**	**Alive (n=307)**	**P value**
Age (years), Median (IQR)		31 (22)	30.5 (8.5)	31 (23)	0.491*
Gender	Male, n (%)	294 (88.3)	24 (92.3)	270 (87.9)	0.507$^{\beta}$
	Female, n (%)	39 (11.7)	2 (7.7)	37 (12.1)	
Nationality	Syrian, n (%)	210 (63.1)	23 (88.5)	187 (60.9)	0.005$^{\beta}$
	Turkish, n (%)	123 (36.9)	3 (11.5)	120 (39.1)	
Trauma mechanism	Penetrating, n (%)	180 (54.1)	20 (76.9)	160 (52.1)	0.015$^{\alpha}$
	Motor vehicle Traffic Accident, n (%)	73 (21.9)	6 (23.1)	67 (21.8)	
	Falling, n (%)	69 (20.7)	0	69 (22.5)	
	Beating, n (%)	6 (1.8)	0	6 (2)	
	Blunt, n (%)	2 (0.6)	0	2 (0.7)	
	Other, n (%)	3 (0.9)	0	3 (1)	
Trauma location	Head & neck, n (%)	213 (63.9)	21 (80.8)	192 (62.5)	0.063$^{\beta}$
	Face, n (%)	98 (29.4)	3 (11.5)	95 (30.9)	0.037$^{\beta}$
	Chest, n (%)	197(59.1)	20 (76.9)	177 (57.7)	0.055$^{\beta}$
	Abdomen, n (%)	148/44.4	20 (76.9)	128 (41.7)	0.001$^{\beta}$
	Extremity, n (%)	179 (53.7)	10 (38.5)	169 (55)	0.103$^{\beta}$
Vital signs	Pulse (beat/min), Median (IQR)	92 (28)	138 (63.3)	92 (26)	<0.001*
	Respiration count (breath/min, Median (IQR)	16 (14)	37.4 (2.3)	17 (12)	<0.001*
	O2 saturation (%), Median (IQR)	97 (5)	95 (12)	97 (4)	0.036*
	SBP (mmHg), Median (IQR)	100 (35)	60 (32.5)	100 (30)	<0.001*
	DBP (mmHg), Median (IQR)	70 (20)	40 (30)	70 (20)	<0.001*
Scores	GCS, Median (IQR)	12 (11)	3 (0.5)	15 (10)	<0.001*
	GAP, Median (IQR)	19 (11)	10 (4)	19 (10)	<0.001*
	RTS, Median (IQR)	11 (6)	4 (2.3)	11 (5)	<0.001*
	EMTRAS, Median (IQR)	4 (4)	7 (2)	3 (4)	<0.001*

IQR: Interquartile range; GCS: Glasgow Coma Scale; GAP: Glasgow Age Pressure; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score, *Mann-Whitney U test, β: Pearson's chi-square, α Fisher's exact chi-square tests

It was detected that 7.8% of the patients had died. The age was not detected to be related with a long-term mortality (p<0.05). Male patients were determined to have more long-term mortality (p<0.05). The long-term mortality rate was significantly higher in Syrian citizens (p<0.05). The long-term mortality prevalence was higher in patients with penetrating injuries. The results showed that long-term mortality was lower in patients admitted due to motor vehicle traffic accident and falling (p <0.05). The death rate of the patients with head trauma was higher in the long-term; however, the cases with abdominal trauma showed less mortality (p<0.05). GCS, RTS and GAP values of the patients who had died were significantly lower; however, the EMTRAS score was significantly higher in these patients (p<0.05). Statistical methods used are added to Table 2.

There was a negative linear relationship between short- and long-term mortality rates with GAP, RTS and GCS, and a positive linear relationship with EMTRAS (p<0.05) [Table 3].

The AUC values for GCS, GAP, RTS, and EMTRAS in the short-term mortality were detected as 0.861cm2, 0.876 cm2, 0.901cm2, and 0.917cm2, respectively [Figure 1]. The AUC values for GCS, GAP, RTS, and EMTRAS in the long-term mortality were detected as 0.896cm2, 0.904 cm2, 0.914cm2, and 0.899cm2, respectively [Figure 2]. The cut-off values, specificity, sensitivity, and safety ranges of the scores were presented in Table 4.

Table 2. Analysis of factors related to the long-term (30 days) mortality

Variable		Exitus (n:88)	No (X (n:245)	P value
Age (years), Median (IQR)		31(19.8)	30 (23)	0.654*
Gender	Male, n (%)	83 (94.3)	211 (86.1)	0.040 β
	Female, n (%)	5 (5.7)	34 (13.9)	
Nationality	Syrian, n (%)	79 (89.8)	131 (53.5)	<0.001 β
	Turkish, n (%)	9 (10.2)	114 (46.5)	
Trauma mechanism	Penetrating, n (%)	68 (77.3)	112 (45.7)	<0.001α
	Motor Vehicle Traffic Accident, n (%)	11 (12.5)	62 (25.3)	
	Falling, n (%)	9 (10.2)	60 (25.3)	
	Beating, n (%)	0	6 (2.4)	
	Blunt, n (%)	0	2 (0.8)	
	Other, n (%)	0	3 (1.2)	
Trauma location	Head & neck, n (%)	73 (83)	140 (57.1)	<0.001 β
	Face, n (%)	23 (26.1)	75 (30.6)	0.429 β
	Chest, n (%)	57 (64.8)	140 (57.1)	0.212 β
	Abdomen, n (%)	47 (53.4)	101 (41.2)	0.048 β
	Extremity, n (%)	45 (51.1)	134 (54.7)	0.566 β
Vital signs	Pulse (beat/min), Median (IQR)	110 (55)	90 (21.5)	0.001*
	Respiration count (breath/min, Median (IQR)	5 (4)	18 (6)	<0.001*
	O2 saturation (%), Median (IQR)	94 (9)	97 (3)	<0.001*
	SBP (mmHg), Median (IQR)	75 (30)	110 (20)	<0.001*
	DBP (mmHg), Median (IQR)	50 (20)	70 (20)	<0.001*
Scores	GCS, Median (IQR)	3 (2)	15 (7.5)	<0.001*
	GAP, Median (IQR)	10 (4)	22 (7.5)	<0.001*
	RTS, Median (IQR)	4 (4)	12 (2)	<0.001*
	EMTRAS, Median (IQR)	6 (2)	2 (3)	<0.001*

IQR: Interquartile range; GCS: Glasgow Coma Scale; GAP: Glasgow Age Pressure; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score,
* Mann-Whitney U test, β: Pearson's chi-square, α Fisher's exact chi-square tests

Table 3. Regression analysis of mortality status to scores

		R^2	Unstandardized Coefficients		Standardized	P value
			B	Beta	Coefficients	
Short-term	**GCS**	0.113	-0,017	0,003	-0,337	<0,001
	GAP	0,135	-0,017	0,002	-0,368	<0,001
	RTS	0,185	-0,034	0,004	-0,430	<0,001
	EMTRAS	0.166	0,046	0,006	0,408	<0,001
Long-term	**GCS**	0.397	-0,053	0,004	-0,630	<0,001
	GAP	0,418	-0,049	0,003	-,647	<0,001
	RTS	0,473	-0,090	0,005	-,688	<0,001
	EMTRAS	0,395	0,116	0,008	,628	<0,001

GCS: Glasgow Coma Scale; GAP: Glasgow Age Pressure; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score,

Table 4. AUC, cut-off value, specificity, sensitivity and safety ranges of short- and long-term scores

		Area (%95Cl)	Cut-off	Sensitivity	Specificity
Short-term	GCS	0,861 (0,809-0,913)	3.5	83.4	76.9
	GAP	0,876 (0,808-0,945)	10.5	81.8	80.8
	RTS	0,901 (0,854-0,948)	4.5	88.9	69.2
	EMTRAS	0,917 (0,882-0,953)	6.5	89.6	73.1
Long-term	GCS	0,896 (0,859-0,933)	4.5	89.8	71.6
	GAP	0,904 (0,869-0,94)	11.5	89.0	73.9
	RTS	0,914 (0,881-0,947)	5.5	93.1	62.5
	EMTRAS	0,899 (0,866-0,932)	5.5	86.9	71.6

GCS: Glasgow Coma Scale; GAP: Glasgow Age Pressure; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score

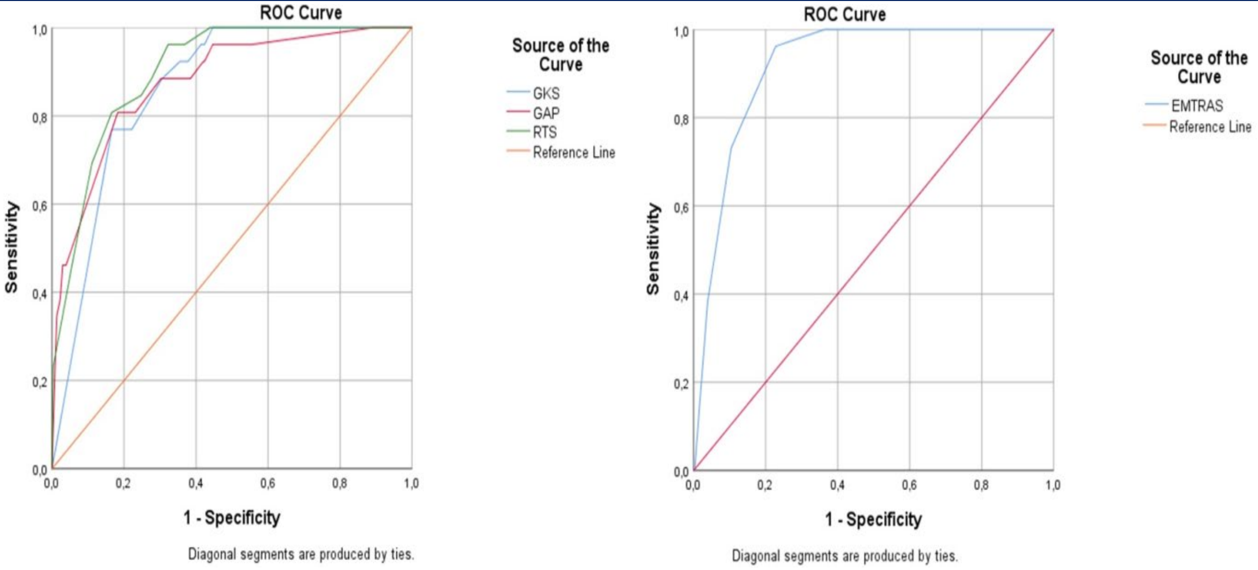

Figure 1. ROC analysis of GCS, RTS, GAP and EMTRAS for the short-term mortality

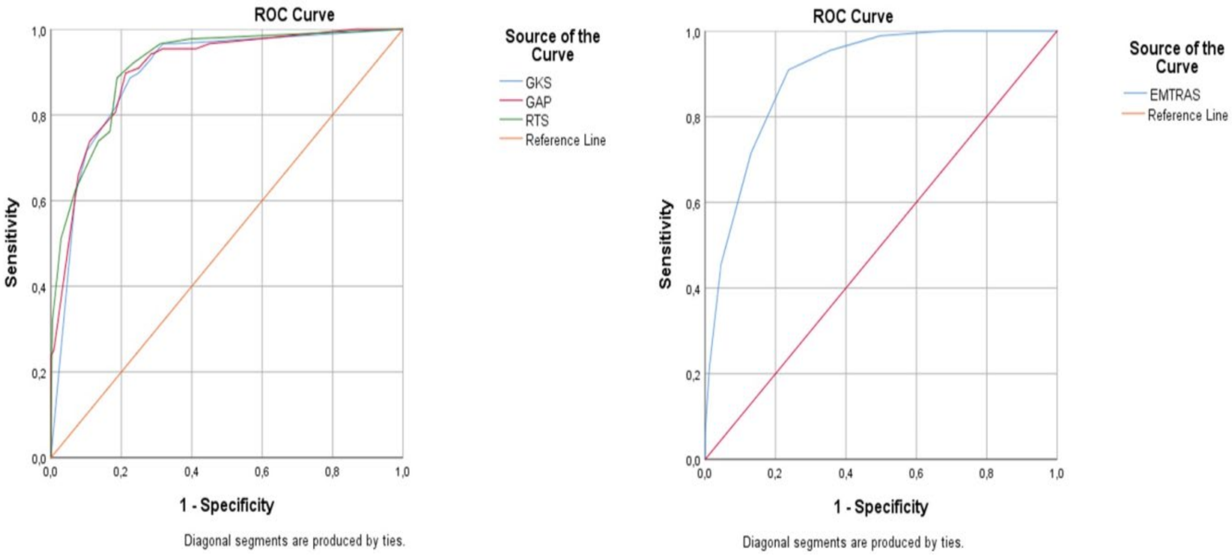

Figure 2. ROC analysis of GCS, RTS, GAP and EMTRAS for the long-term mortality

Discussion

Trauma is a serious public health problem relating especially the young population in our country and in the world. It has been shown that the morbidity and mortality of life-threatening traumatic patients in the emergency service and at discharge are significantly lower when treated in advanced trauma centers. The mortality rate within the emergency department was 5.4% to 21.9%; and the long-term mortality rate (30 days) was detected as 15% to 21%.[4,6,8-13] In line with the literature, the mortality rate in the emergency department was 7.8%; and the short-term mortality was detected 26.4%. Although our hospital is not a trauma center, we believe that the serious increase in the experience of both our emergency clinic and other surgical branches regarding trauma due to the war in the region makes the hospital similar to trauma centers.

It was stated that the patients presenting with trauma were usually young, adult and male; however, the association of mortality with age and gender has not been clearly reported.[11,14,15] In line with the literature, the results of the present study showed that younger men were exposed to trauma at a higher rate. No association between the age and mortality was detected. While no association was found between the mortality and gender in the short-term, it was found that male patients had a more prognosis of death in the long-term compared to the short-term mortality. Since adult males are involved in the social life more, drive more, perform more dangerous works, and they are involved in violence more, we believe that they are more exposed to trauma. Furthermore, we believe that younger males were exposed to severe traumas since the ongoing war events in our region mostly related to young men; and these patients are more likely to die due to additional factors (infection, embolism, crush syndromes, etc.).

In previous studies conducted on wounds due to war and deaths due to firearm injuries, the damage caused by firearm injuries were reported to cause a serious increase in mortality rate.[16,17] It was detected in our study that Syrian patients had more mortally. It was concluded that this situation could cause the death of individuals in the short-term due to traumatic organ damage caused by firearms, and haemorrhage in abdominal/thoracic injuries.

Different results were reported in previous studies on traumas due to mechanism of formation. According to the 2015 data of American College of Surgeons National Trauma Database, falls were the most common cause by 43.41%, whereas the motor vehicle accidents were the second by 25.95%.[18] It was stated that motor vehicle accidents are responsible for the majority of deaths among young adults. [19,20] A previous study conducted stated that mortality rates due to falling from the height and traffic accidents are higher in trauma patients admitted to the intensive care unit.[21] Kara et al., emphasized that mortality is not associated with the type of trauma.[22] Unlike the literature, penetrating injuries took the first place by 54.1%, and the rate of death due to penetrating injury was found to be significantly higher in our study. The most important possible cause may be consistent admission of the patients with a severe brain injury due to the war in Syria.

Morbidity and mortality rates vary depending on the area related by the trauma. The order of the region related by the trauma is the soft tissue, limbs, head and thorax traumas in general.[11,14] Unlu et al., stated in their study that the most frequently injured areas in patients exposed to severe trauma and requiring intensive care were head and neck (55.3%), limbs (41%), and thorax (37.8%).[14] Kara et al. stated in their study that although mortality was not associated with head and neck, thorax and abdomen injuries, the prevalence of extremity trauma was not higher in survived patients.[22] Another study stated that the most important factor in trauma patients leading to mortality is head trauma, followed by pelvis and spine injuries.[23] Although the most common injuries in our study were head and chest injuries, it was found that patients with abdominal and head injuries had more mortality in the short-term and abdominal and head injuries in the long-term. In both motor vehicle accidents and falls, the moving structure of the head, hitting the steering wheel/glass, falling from heights due to bending forward may have caused head trauma. Furthermore, snipers in warfare in Syria chose to shoot to the head in order to kill; and while the majority of the body was protected by equipment, the rare protection of the head area may explain the higher prevalence of head injuries. The most common causes of mortality due to abdominal injuries include the physician's inability to detect solid organ injuries in blunt traumas; and the international referral procedure in penetrating injuries may be related to delay due to distance, procedures and lack of security.

Vital parameters of trauma patients play a determinant role on the mortality. Blood pressure and oxygen saturation of the patients progressing mortally were lower; however, their pulse rate was higher.[24,25] In line with the literature, mortality cases were more hypotensive, tachycardic, tachypnoeic and had lower oxygen saturation. We believe that the blood pressure of the patients decreases due to bleeding, saturation decreases due to the hypoxia that develops in the tissues, and tachypnea and tachycardia develop with compensatory mechanisms.

Scoring systems are used for evaluation of the prognosis of the trauma patients. GAP and RTS are superior to GCS due to inclusion of physiological parameters (SBP, respiration count etc.[6,26] It was shown in some studies that coagulation factors and base deficit (BD) are the parameters that best predict in-hospital deaths. It was stated in these studies that as the BD increases or coagulation factors deteriorate, mortality increases. [27-29] In line with the literature, patients with both short-term and long-term mortality had lower GCS [30,31], RTS [5,26] and GAP [4,6] scores and higher EMTRAS [12,26] scores. We believe that GCS, RTS and GAP decreased, and EMTRAS increased due to the impairment of consciousness and hemodynamics caused by the trauma.

Mortality evaluations may appear by different results due to different parameters used in scoring systems. Raum et al., reported in their study that the AUC of EMTRAS (0.828) and RTS (0.762) were higher than the AUC (0.735) of GCS; and EMTRAS and RTS are superior to GCS to predict the mortality.[26] In the study conducted by Kondo et al., the AUC values of EMTRAS for mortality and short-term mortality in the emergency department were 0.965 and 0.933, respectively. EMTRAS was superior to RTS (AUC: 0.919) in predicting short-term mortality; however, it was poor for prediction of the long-term mortality than the short-term one (AUC: 0.966).[6,9] Mangini et al. stated in their study that the AUC (0.818) value of RTS in trauma patients was higher than the AUC (0.809) value of EMTRAS.[32] In our study, the best scoring system to predict the short-term mortality was EMTRAS, which was followed by RTS; the worst result was detected with GCS. RTS was superior to EMTRAS for the long-term mortality. Furthermore, EMTRAS and RTS were detected to relate the mortality independently in the short- and long-term mortality. We believe that this situation is superior to predict the mortality in addition to GCS, because it evaluates other physiological parameters in RTS and GAP, and indicates the damage caused by coagulation and BD in EMTRAS.

In traumatic cases, GAP may not be an independent variable on both short-term and long-term mortality, if the losses to the third spaces that lead to the decrease in GAP are prevented and if the current loss is replaced. The lower RTS due to the relation of the respiratory center located in the brainstem of trauma patients, the presence of tachypnea as a poor prognostic factor in trauma cases with both cranial and other organ damage, foreign body aspiration and respiratory distress in patients with chest trauma may have related to the long- and short-term mortality independently. Since organ damage and bleeding that will disrupt the coagulation that develops in the patient or causes severe BD would increase the mortality significantly, it may have caused EMTRAS to be superior to other scores and to be an independent variable for prediction of the short-term mortality.

The limitations of our study are that the majority (%60) of the patients included in the study had wounds due to war and their general condition was poor. Also, the patients who died in the field were not included in the study. It can be listed as insufficient hospital archive records and incomplete scoring, inadequate intervention and follow-up due to insufficient material and physical conditions in the hospital. One of the shortcomings of our study is inability to use reference values by which emergency room outcome table 1 and hospital outcome table 2 mortalities are compared.

Conclusions

It should be kept in mind that EMTRAS in trauma patients is more valuable than other scoring systems for prediction of short-term mortality and RTS is more valuable than other scoring systems. We believe that detailed and large-scale studies to be carried out in this context will contribute to the literature.

Acknowledgment

None.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

World Health Organization: WHO; Emergency Trauma Score: EMTRAS; Revised Trauma Score: RTS; Glasgow Age Pressure: GAP; Oxygen saturation: SO2; Systolic blood pressure: SBP; diastolic blood pressure: DBP; Receiver Operating Characteristic: ROC; Areas under the curve: AUC; Glasgow Coma Scale: GCS; Prothrombin time: PTT; International normalized ratio: INR; Base deficit: BD.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. Institutional Review Board approval (Ethics Decision number: 18 in 2nd meeting on 17.01.2019) was obtained. All participants signed an informed consent form.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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