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Which Scoring System is Better in Predicting Mortality in Multiple Trauma Patients: Revised Trauma Score or Glasgow Coma Scale

Az et al. Prognostic Value of RTS and GCS in Multi-Trauma Patients

Adem Az, Çiğdem Orhan
İstanbul Beylikdüzü State Hospital, Clinic of Emergency Medicine, İstanbul, Turkey

Corresponding Author Information
Adem Az, İstanbul Beylikdüzü State Hospital, Clinic of Emergency Medicine, İstanbul, Turkey
0000-0002-7204-6185
adem.aaz@gmail.com
5301007117

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Abstract
Objective: We investigated the prognostic value of the Revised trauma score (RTS) and Glasgow coma scale (GCS) in predicting mortality in multi-trauma patients.
Materials and Methods: This retrospective study included 537 consecutive trauma patients with a shock index ≥ 1.0. We evaluated the demographics, clinical characteristics, and trauma scores, including GCS and RTS, in both survivor and non-survivor groups.
Results: A total of 537 patients, comprising 58.29% males and 41.71% females, with a mean age of 44.46 ± 22.05 years, were included. Overall mortality was 13.04%. Age and sex differed significantly between survivors and non-survivors (p = 0.0001 and p = 0.001). Non-survivors had significantly lower mean GCS and RTS scores (p = 0.0001 for both comparisons). ROC analysis identified a GCS ≤ 10 for predicting mortality in multi-trauma patients, with 99.89% sensitivity and 99.79% specificity. Additionally, an RTS ≤ 8 had 98.57% sensitivity and 99.79% specificity for determining mortality.
Conclusion: Our results indicated that lower mean GCS and RTS scores were predictors of mortality in multi-trauma patients. A GCS of ≤ 10 and an RTS of ≤ 8 exhibited exceptional sensitivity and specificity for determining mortality in multi-trauma patients.
Keywords: trauma, trauma scores, Glasgow coma scale, Revised trauma score, mortality

Introduction

Traumatic injuries represent a significant global health concern. Each year, more than 45 million people worldwide suffer from moderate to severe disabilities due to trauma.

Furthermore, trauma-related injuries claim the lives of approximately 5.8 million individuals annually [1, 2]. Moreover, fifty to sixty percent of post-traumatic deaths occur within the initial hour [3]. Despite advances in healthcare and technology, fatalities at the scene or within the first hour persist as a significant public health issue. It is estimated that one-third of trauma-related deaths can be prevented with improved trauma systems [4].

In a study conducted in Türkiye, Höke et al. [5] investigated various trauma scores including Injury Severity Score (ISS), New Injury Severity Score (NISS), Revised Trauma Score (RTS), and Glasgow Coma Scale (GCS), and observed that all of these scores demonstrated statistical significance in predicting mortality. In another study involving 633 trauma patients, Orhon et al. [6] found that GCS and RTS were significant indicators of mortality. While numerous trauma scores are used to assess the severity of injuries and monitor clinical outcomes in trauma patients, the most accurate and reliable scoring system for determining morbidity and mortality remains unclear.

This study aimed to investigate the prognostic value of the RTS and GCS in predicting mortality in patients with a shock index (SI) ≥ 1.0 who presented to the emergency department (ED) with multi-trauma.

Materials and Methods

Ethics Committee Approval and Patient Consent

This study was conducted in accordance with the 1989 Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of XXXX, XXXX, XXXX (approval no. 2022-110). As neither the images nor the accompanying text contained potentially identifying markers or patient identifiers, IRB did not require patient consent for the review of their medical records.

Study Design and Setting

This retrospective, observational, and single-center study included 537 consecutive adult patients (≥18 years old) who were admitted to our ED with multi-trauma between April 2021 and April 2022. Our hospital is one of the high-volume EDs in Istanbul, handling about 1500 emergency patient admissions daily. Additionally, as a trauma center, our facility provides care for over 200 trauma patients daily, ranging from mild to severe cases. Only patients with a SI ≥ 1.0 were included in the study to exclude mild cases. The hospital's automation systems and archives were scanned for information on all patients presenting for evaluation and treatment of acute traumatic injuries.

We assessed patients' demographics (age and sex), vital signs on admission (systolic blood pressure [SBP], respiratory rate, and heart rate), complaints and symptoms at admission, anatomic region of injury, type of trauma (blunt or penetrating), mechanism of injury, alcohol consumption, trauma scoring systems (GCS and RTS), clinical outcomes (discharge, hospitalization, or death). In addition, SI was calculated for each patient. SI is defined as the ratio of HR to SBP.

Multi-trauma was defined as an injury to at least two body regions. Patients who experienced injuries, whether blunt or penetrating, in the same anatomical region were classified as having penetrating injuries. This study classified multiple injuries to the same anatomical region as a singular injury to that specific anatomical region.

The patients in the study cohort were categorized into survivors and non-survivors. Demographics, clinical characteristics, and trauma scores (GCS and RTS) were compared among the groups to determine the factors associated with mortality.

Study Population and Sampling

All cases meeting the eligibility criteria were included to prevent selection bias. We enrolled a total of 6978 patients admitted to the ED due to traumatic injuries between April 2021 and April 2022. Patients with non-traumatic injuries or those presenting to the ED for any other reasons were subsequently excluded. Additionally, 152 patients were excluded due to a lack of information. Moreover, 2348 patients under the age of 18 were excluded from the study. Further 1926 patients were excluded because they had mono-trauma. Moreover, 2015 patients with a SI < 1.0 were excluded due to determine severe injuries. The remaining 537 patients were included in the study (Figure 1).

Trauma Assessment Scores

GCS is a neurological assessment tool that measures a person's level of consciousness based on eye-opening, verbal, and motor responses, which are assigned 4, 5, and 6 points, respectively (for a total score of 15 points).

RTS is a tool used to assess the severity of a traumatic injury. It considers three key parameters: GCS, systolic blood pressure, and respiratory rate, with a total score of 12 points.

Statistical Analysis

All data analyses were conducted using SPSS statistical software (version 15.0 for Windows; SPSS Inc., Chicago, IL, USA). Categorical variables were expressed as numbers of patients (n) and percentages (%). Numerical data were expressed as mean, standard deviation (SD), minimum and maximum values. Intragroup analyses (survivors vs non-survivors) were conducted using the chi-square test for normally distributed data and the Mann–Whitney U-test for non-normally distributed data, as appropriate. **Independent variables predicting mortality (age, sex, GCS and RTS) were analyzed using multivariate logistic regression analysis.** The ROC curve was utilized to determine the cut-off point for GCS and RTS. The threshold for statistical significance was defined as $p < 0.05$.

Results

The demographic and clinical characteristics of the trauma patients were presented in Table 1. The study comprised a sample size of 537 patients, with 313 (58.29%) male and 224 (41.71%) female. The mean age was 44.46 ± 22.05 years, with a range of 18 to 96 years. The overall mortality rate was 13.04%. In addition, 26.82% of patients were discharged from the ED, and 61.64% of were hospitalized. Overall, 73.93% of patients presented with blunt injuries. Falls were the most commonly reported mechanism of trauma, accounting for 52.51%, followed by traffic accidents at 17.13%, and accidental injuries at 11.17%. A total of 64 individuals were transported to the ED via ambulance, while 473 arrived on foot. The analysis of anatomical regions affected by injuries revealed that the head and face were the most prevalent sites, comprising 43.58% of the cases.

A total of 142 patients were hospitalized and follow-up in the orthopedics department. Additionally, 64 individuals received treatment in the neurosurgery department, 54 were in the general surgery department, 30 were in the cardiovascular surgery department, 22 were in the thoracic surgery, and 8 were in ICU.

Table 2 demonstrates the comparative analysis of demographics, clinical characteristics, and trauma scores among patients who survived and those who did not. The age of non-survivors was found to be significantly lower compared to survivors ($p = 0.0001$). Furthermore, the prevalence of males was statistically significantly higher among non-survivors than among survivors ($p = 0.001$). Penetrating traumas occurred significantly more commonly in non-survivors than in survivors ($p = 0.024$). Moreover, statistically significant differences were observed among non-survivors and survivors, in terms of the mechanisms of trauma such as falls, traffic accident, assault, and gunshot wounds ($p = 0.0001$, $p = 0.014$, $p = 0.002$, and $p = 0.001$, respectively). Finally, non-survivor patients had significantly lower mean GCS and RTS scores compared to survivors ($p = 0.0001$ for both comparisons).

The multivariate logistic regression analysis demonstrated that increased age (odds ratio [OR]: 0.98, 95% confidence interval [CI]: 0.96–1.01; $p = 0.001$), female gender (OR: 1.96, 95% CI: 1.06–2.61; $p = 0.031$), and decreased GCS (OR: 0.64, 95% CI: 0.18–0.98; $p = 0.027$) and RTS scores (OR: 0.64, 95% CI: 0.22–1.97; $p = 0.049$) were identified as significant predictors of mortality among trauma patients (Table 3).

ROC analysis identified a GCS cutoff score of ≤ 10 to determine mortality in multi-trauma patients, with 99.89% sensitivity and 99.79% specificity (Area under the curve [AUC]: 0.999, 95% confidence interval [CI] 0.991–0.999; Table 4 and Fig. 2). In addition, ROC analysis revealed a cutoff RTS of ≤ 8, with 98.57% sensitivity and 99.79% specificity for determining mortality in multi-trauma patients (AUC: 0.99, 95% CI 0.990–1.000; Table 4 and Fig. 2).

Discussion

Trauma is one of the leading causes of mortality. Annually, trauma leads to the mortality of nearly 6 million individuals worldwide [1]. A substantial number of fatalities occur either at the scene of the incident or within the initial four-hour subsequent to the patient's arrival at an ED [2]. Hence, the main goal of this study was to predict and determine individuals who are at increased risk of mortality at an early stage. The key findings of our study are as follows. First, males and young adults exhibited a higher prevalence of trauma and trauma-related mortality. Second, falls, traffic accidents, and accidental injuries were the most commonly reported mechanism of trauma. Third, non-survivors had lower mean GCS and RTS scores than survivors. Fourth, in determining the mortality in multi-trauma patients, a GCS score of ≤ 10 was found to be the cutoff with 99.89% sensitivity and 99.79% specificity, and an RTS score of ≤ 8 was determined as the cutoff with 98.57% sensitivity and 99.79% specificity.

In studies analyzing the epidemiologic and demographic features of trauma patients, Mutasingwa et al. [7] and Aluisio et al. [8] have consistently noted that young males were more commonly presented to the ED with traumatic injuries. Additionally, in the United States, trauma is the leading cause of mortality among individuals under the age of 44 [9]. Similarly, in our study males and young adults exhibited a higher prevalence of trauma and trauma-related mortality.

According to our findings, the prevailing causes of trauma were falls and traffic accidents. Consistent with our study, Chokotho et al. [10] reported that falls and traffic accidents were the most common mechanisms of injury in their study involving 49241 trauma cases. In another study conducted in Türkiye, Çırak et al. [11] found that falls and traffic accidents were the leading causes of trauma among patients. In studies conducted in Low- or Middle-Income Countries, Rouhani et al., [12] Soundarrajan et al., [13] and Zuraik et al. [14] discovered that road traffic accidents were the most common trauma mechanism, followed by falls. Our findings are consistent with the main causes responsible for trauma worldwide. However, the prevalence and trends of trauma may vary across various cultural contexts, nations, and socioeconomic circumstances. The higher incidence of traffic accidents, particularly in low and middle-income countries, can be attributed to inadequate adherence to safety precautions and less compliance with traffic regulations [10, 14]. The research conducted within Türkiye reveals a higher prevalence of fall incidents compared to traffic accidents [11]. Moreover, based on our findings, penetrating injuries exhibited a higher fatality rate, even though the majority of trauma incidents involved blunt injuries.

In a study involving a sample of 633 trauma patients from Türkiye, Orhon et al. [6] found that GCS and RTS were significant indicators of mortality. In another study conducted in Türkiye, Güneytepe et al. [15] investigated various trauma scores including GCS, RTS, ISS, and Trauma and Injury Severity Score (TRISS), and observed that all these scores demonstrated statistical significance in predicting mortality. In a study of 1410 trauma patients, Yadolahi et al. [16] also observed that TRISS, RTS, GCS, and ISS were all highly effective in determining prognosis and mortality among trauma patients. Similarly, our study revealed that there were significant differences between survivors and non-survivors in terms of GCS and RTS.

In a study assessing post-traumatic deaths, Demetriades et al. [17] discovered that GCS < 8 emerged as the most important risk factor associated with mortality among trauma patients within the first hour after admission to the hospital. Another study, involving 740 trauma patients, also recognized a GCS < 8 as a reliable predictor of mortality [18]. Furthermore, Yadolahi et al. [16] identified increased age, GCS < 8, RTS < 7.6, and TRISS < 0.9 as the most significant predictors of in-hospital mortality. Our results demonstrated that GCS could predict mortality with 99.89% sensitivity and 99.79% specificity in the scores ≤ 10. Moreover, patients with a GCS of ≤10 have a 467-fold increased risk of mortality than those with a GCS of >10. Similar to our findings, a study conducted in Northern Iran reported that a GCS ≤ 8 predicts mortality with exceptionally high accuracy, showing a sensitivity of 98.4% and specificity of 92.3% [19].

Yadolahi et al. [16] demonstrated that the RTS exhibited the highest effectiveness in assessing the severity of traumatic injuries, following TRISS. Furthermore, they established a cut-off point for RTS at ≤ 7.69 with 95% sensitivity and 67% specificity in predicting mortality in trauma patients. In another study conducted by Yousefzadeh-Chabok et al. [20], an RTS score of ≤ 6 was identified as a predictor of mortality among trauma patients, exhibiting 99% sensitivity and 62% specificity. In our study, an RTS score of ≤ 8 was determined as a predictor of mortality with 98.57% sensitivity and 99.79% specificity. In our cohort, we exclusively included patients with SI ≥ 1.0. The higher specificity observed in our findings compared to other studies can be attributed to this selection criterion. Based on our findings, the combined utilization of the RTS with SI offers valuable insights for predicting mortality and prognosis among multi-trauma patients.

In our multivariate logistic regression analysis that examined the utility of the GCS and RTS for predicting mortality in multi-trauma patients, we found that both scoring systems had a comparable OR. However, the GCS showed a slightly higher level of statistical significance and more reliable CI, suggesting that it may be a more reliable predictor of mortality in our population.

A limitation of this study is its utilization of a retrospective and hospital-based study design, which offers a risk of selection and misclassification biases affecting the obtained results. Secondly, our observations are limited to the patient population that seeks medical attention at the hospital. Consequently, it is not possible to reach conclusions about the prevalence of trauma among the general population. Finally, we lack information about the post-discharge health status and care quality of trauma patients.

Conclusion

Our results indicated that lower mean GCS and RTS scores were predictors of mortality in multi-trauma patients. Specifically, a GCS of ≤ 10 had a sensitivity of 99.89% and a specificity of 99.79% for determining mortality in multi-trauma patients with an SI ≥ 1.0. Moreover, an RTS of ≤ 8 exhibited an exceptional sensitivity of 98.57% and a specificity of 99.79% in identifying mortality. We recommend the use of trauma scores, such as GCS and RTS, in conjunction with SI at ED admission to accurately assess disease severity and mortality risk in trauma patients.

Conflict of interest statement

The authors declare no competing interests.

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Table 1. Demographic and clinical characteristics of trauma patients			
Characteristics			
Age in years, Mean ± SD (min – max)		44.46 ± 22.05 (18 - 96)	
		n	**(%)**
Sex	Female	224	(41.71)
	Male	313	(58.29)
Types of trauma	Blunt	397	(73.93)
	Penetrating	140	(26.07)
Mechanism of trauma	Fall	282	(52.51)
	Traffic accident	92	(17.13)
	Assault	60	(11.17)
	Accidental injuries	51	(9.50)
	Stab wounds	34	(6.33)
	Gunshot wounds	18	(3.35)
Place of trauma	Street/road/highway	351	(65.36)
	Home	103	(19.18)
	Commercial/work	83	(15.46)
Alcohol consumed	No	420	(78.21)
	Yes	117	(21.79)
Forensic trauma	No	186	(34.64)
	Yes	351	(65.36)
Transport to Hospital	By foot	473	(88.08)
	Via ambulance	64	(11.92)
Anatomic region of injury			
	Head and Face	234	(43.58)
	Lower Extremities	222	(41.34)
	Upper Extremities	201	(37.43)
	Abdomen	191	(35.57)
	Chest	184	(34.26)
	Spine	151	(28.12)
Outcome	Discharge	144	(26.82)
	Hospitalization	331	(61.64)
	Death	70	(13.04)
Note: Data were given as numbers (n) and percentages (%), mean, standard deviation (SD), minimum and maximum values.			

Table 2. Comparison of demographic characteristics, and trauma scores between patients who survived and those who did not					
	Survivors		**Non-survivors**		**p**
Age in years, Mean ± SD	46.05 ± 22.34		33.83 ± 16.54		0.0001
	n	**(%)**	**n**	**(%)**	**P**
Sex					
Female	208	(44.54)	16	(22.86)	0.001
Male	259	(55.46)	54	(77.14)	
Mechanism of trauma					
Fall	264	(56.53)	19	(27.14)	0.0001
Traffic accident	73	(15.63)	18	(25.71)	0.014
Accidental injuries	47	(10.06)	4	(5.71)	0.348
Assault	44	(9.42)	16	(22.86)	0.002
Stab wounds	29	(6.21)	5	(7.14)	0.972
Gunshot wounds	10	(2.14)	8	(11.43)	0.001
Types of trauma					
Blunt	353	(75.59)	44	(62.86)	0.024
Penetrating	114	(24.41)	26	(37.14)	
	Mean ± SD		**Mean ± SD**		**p**
Glasgow coma scale	14.95 ± 0.24		5.04 ± 2.07		0.0001
Revised trauma score	11.94 ± 0.27		5.61 ± 1.83		0.0001
Note: Data were given as numbers (n) and percentages (%), mean, and standard deviation (SD). *Intragroup analyses (survivors vs non-survivors) were conducted using the chi-square test for normally distributed data and the Mann–Whitney U-test for non-normally distributed data, as appropriate.					

Table 3. Multivariate logistic regression analysis to determine mortality				
	p	**OR**	**95% CI**	
Age in years	0.001	0.98	0.96	1.01
Sex (Female)	0.031	1.96	1.06	2.61
Glasgow coma scale	0.027	0.64	0.18	0.98
Revised trauma scores	0.049	0.64	0.22	1.97

Abbreviations: OR, odds ratio; CI, confidence interval.

Table 4. Trauma scores for determining mortality in multi-trauma patients

Criterion	AUC	SE	95% CI	Sensitivity	Specificity	PPV	NPV	LR (+)	
GKS ≤ 10	0.999	0.001	0.991 – 0.999	99.89	99.79	98.6	100.0	467.00	
RTS ≤ 8	0.999	0.001	0.990 – 1.000	98.57	99.79	98.7	99.8	460.33	

AUC: Area under the curve; SE: Standard error; CI: Confidence interval; PPV: Positive predictive value; NPV: Negative predictive value; LR (+): Likelihood Ratio

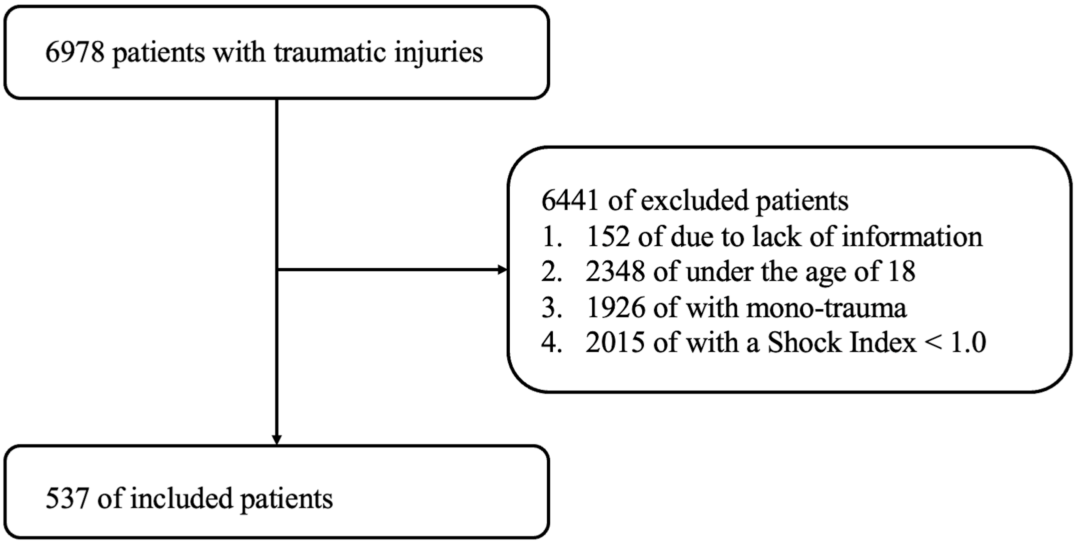

Figure 1. Flowchart

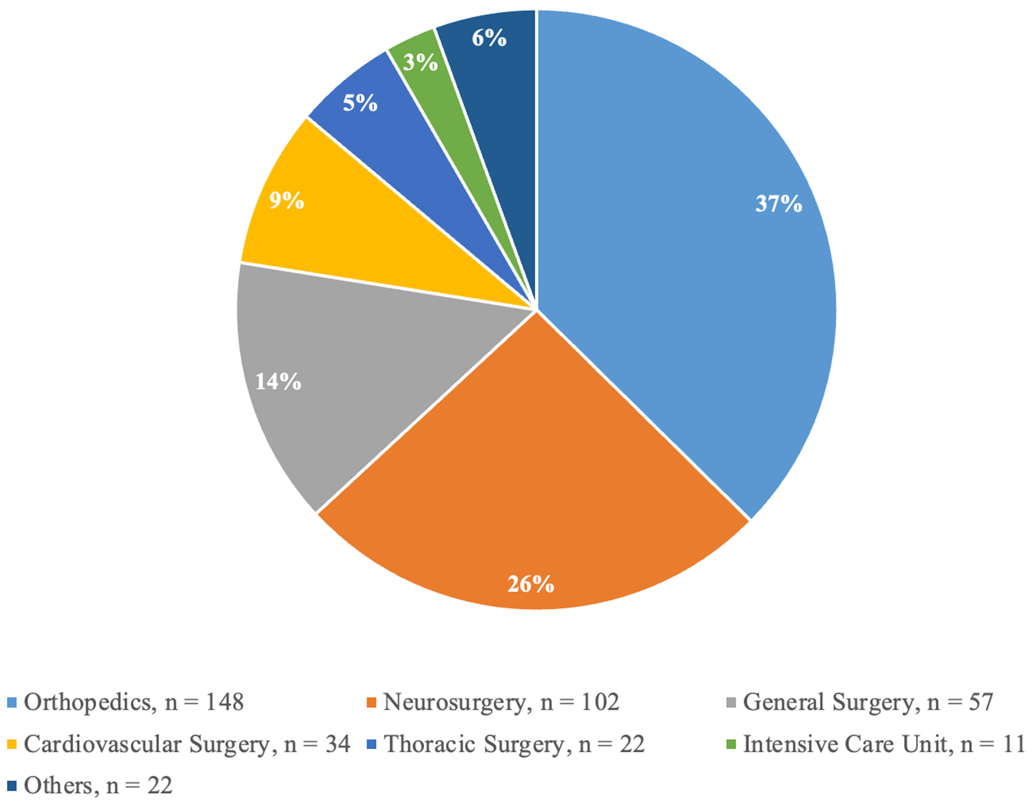

Figure 2. Specificity and sensitivity of GCS and RTS scores for determining mortality in multi-trauma patients using receiver operating characteristic curves (Area under the curve [AUC]: 0.999, 95% confidence interval [CI] 0.991–0.999 and AUC: 0.99, 95% CI 0.990–1.000; respectively)