ORIGINAL ARTICLE

Prediction of massive transfusion and mortality in early trauma care: A retrospective analysis of scoring systems

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ABSTRACT

BACKGROUND: Hemorrhagic shock is a leading cause of preventable trauma deaths, particularly within the first hours following injury. Early identification of patients requiring massive transfusion or with high mortality risk is critical to optimizing trauma management. Early identification of massive transfusion needs supports timely blood product preparation. Likewise, predicting mortality risk early can influence therapeutic planning and clinical decisions. Numerous trauma and transfusion scoring systems have been developed to guide such early decisions; however, their comparative predictive performance remains unclear. This study aimed to evaluate the effectiveness of trauma and transfusion scoring systems in predicting massive transfusion requirements and in-hospital mortality within the first four hours of trauma.

METHODS: This retrospective study included 117 trauma patients who received at least one unit of red blood cell transfusion within the first four hours of admission to a tertiary care center between 2018 and 2022. Data on demographics, trauma mechanism, clinical and laboratory findings were collected. Each patient was evaluated using 16 trauma and transfusion scoring systems. Patients were categorized based on the need for massive transfusion, defined as receiving ≥5 units of blood products within four hours. Receiver Operating Characteristic (ROC) analysis was used to assess the performance of each scoring system, and optimal cut-off values were determined using the Youden Index.

RESULTS: Massive transfusion was required in 23 patients (19.7%), with firearm injuries being the most common mechanism among these cases. All 16 scoring systems significantly differentiated patients with and without massive transfusion. The Shock Index demonstrated the highest predictive accuracy for massive transfusion (area under the curve [AUC]=0.911). For in-hospital mortality, all scoring systems except the Schreiber Score showed significant predictive ability. The Trauma Related Injury Severity Score (TRISS) achieved the highest predictive value for mortality (AUC=0.975). Several scoring systems required revised threshold values for optimal performance in this cohort, highlighting the need for population-specific calibration.

CONCLUSION: Early-phase application of trauma and transfusion scoring systems provides valuable insights for predicting clinical outcomes in trauma patients. Among the systems analyzed, the Shock Index was the most reliable predictor of massive transfusion. Separately, TRISS demonstrated superior accuracy in forecasting in-hospital mortality. These findings emphasize the importance of rapid, score-based assessment in early trauma care and support further validation of scoring systems across diverse patient populations.

Keywords: Damage control resuscitation; hemorrhagic shock/therapy (MeSH ID: D012798); resuscitation (MeSH ID: D012137); massive transfusion (MeSH ID: D056278); trauma severity indices (MeSH ID: D049232).

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INTRODUCTION

According to data from the World Health Organization, trauma causes more than 4.5 million deaths worldwide each year.[1] Mortality due to trauma typically occurs within the first four hours and rarely after 24 hours.[2,3] To prevent and manage hemorrhagic shock, a major cause of mortality, an algorithm defined as damage control resuscitation (DCR) is implemented, starting at the scene of the injury and continuing in healthcare facilities.[4,5] Hemostatic resuscitation, a critical component of DCR, also involves early blood product replacement.[6,7]

The need to predict prognosis in patients presenting to the hospital following trauma is a critical concern; prompt assessment of the patient's condition and preparation for potential blood product transfusion are essential. This need for prediction has led to the development of numerous trauma and transfusion scoring systems (Table 1).[8-35] The massive transfusion protocol (MTP) refers to the administration of a blood transfusion equal to the patient's entire blood volume within 24 hours, or half of their blood volume within the first four hours. For practical purposes, it is often defined as the transfusion of ≥10 units of blood in 24 hours or ≥5 units in four hours (some sources define it as ≥4 units in one hour).[36-39] Predicting which patients will require MTP is important, and there is limited research on the early prediction of MTP necessity in trauma patients.[40]

Timely anticipation of massive transfusion facilitates early blood product allocation, whereas recognizing mortality risk in the early phase can shape therapeutic approaches and guide clinical decision-making. This study aimed to determine the success of scoring systems used in evaluating trauma and transfusion needs in predicting early massive transfusion requirements and mortality.

MATERIALS AND METHODS

Patients who presented to the Emergency Department (ED) of a tertiary care hospital due to trauma between January 1, 2018 and December 31, 2022, were retrospectively screened, and 1,097 patients followed up with a trauma diagnosis were identified. The inclusion criteria for the study were presentation to the ED due to trauma, administration of at least 1 unit of red blood cell suspension transfusion within the first four hours, and complete documentation of initial vital signs, descriptions of the trauma, and examination results. Patients with incomplete data, those under 18 years of age, those who received initial intervention at an external center and presented to the study hospital more than four hours later, those who did not receive blood transfusion in the ED, and those brought to the ED with cardiopulmonary arrest were excluded from the study. For the 117 patients included in the study, the date of admission, demographic information (gender, height, weight, blood group), trauma mechanism and injury locations, initial vital signs (systolic and diastolic blood pressure, pulse, respiratory rate, oxygen saturation), level of consciousness, blood tests (leukocyte count, hemoglobin, hematocrit, platelet count, lactate dehydrogenase, alanine aminotransferase, alkaline phosphatase, sodium, potassium, calcium, albumin, chloride, C-reactive protein, prothrombin time, International Normalized Ratio [INR], activated partial thromboplastin time, blood gas pH, lactate, bicarbonate, and base deficit), and imaging results (Focused Assessment with Sonography for Trauma [FAST], ultrasound, and computed tomography [CT]) were recorded, and various trauma and transfusion scores were calculated. Patients were divided into two groups based on whether they received ≥5 units of blood within the first four hours: massive transfusion and non-massive transfusion. It was also noted whether the transfusion continued after the initial four-hour period. Intensive care unit (ICU) and ward length of stay, as well as the occurrence of mortality, were recorded. This study received approval from the relevant local clinical research Ethics Committee with the document number 2020/20. The study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

Statistical analyses were performed using the SPSS software package (IBM Statistical Package for the Social Sciences, version 22.0, Armonk, New York). Descriptive statistics were presented as number (n), percentage (%), mean ± standard deviation, and median (minimum-maximum). The normality of continuous variables was assessed using histograms, probability plots, and statistical analytical methods (Kolmogorov-Smirnov and Shapiro-Wilk tests). Normally distributed numerical variables were compared between two groups using the Independent Samples t-test, while non-normally distributed variables were analyzed with the Mann-Whitney U test. The Chi-square test and Fisher's Exact test were used to compare categorical variables. The Kruskal-Wallis test was employed to examine the median values of non-parametric numerical variables across multiple groups. Where significant differences were observed with the Kruskal-Wallis test, post-hoc analysis was conducted to determine which specific groups differed significantly for the nominal variable. Factors potentially associated with in-hospital mortality and massive transfusion were evaluated using Receiver Operating Characteristic (ROC) curve analysis. The area under the ROC curve (AUC) and its 95% confidence interval were reported. Following the ROC analyses, the Youden Index was used to identify the optimal cut-off values for each trauma and transfusion scoring system. The diagnostic performance (sensitivity and specificity) for mortality and massive transfusion was then calculated for these identified cut-off values across all scoring systems. In the statistical analyses conducted in this study, a p-value of less than 0.05 was considered statistically significant.

RESULTS

Between 2018 and 2022, 1,097 patients who presented to the ED were followed up and treated with a trauma diagnosis were identified through screening. Among these, 117 patients

Table 1. Trauma and transfusion scoring systems

Scoring System	Year and Source	Parameters	Score Range	Score Interpretation
Glasgow Coma Scale (GCS) (8–10)	1974, Teasdale & Jennett	Eye, motor, verbal responses	3-15	Lower scores indicate higher mortality
Shock Index (SI) (11,12)	1967, Allgöwer et al.	Pulse/systolic blood pressure	Variable	≥0.9: High probability of transfusion
Abbreviated Injury Scale (AIS) (13)	1969, Association for the Advancement of Automotive Medicine (AAAM)	Injury severity by body region	1-6	Higher score indicates more severe injury
Injury Severity Score (ISS) (14–17)	1974, Baker et al.	Sum of squares of three most serious AIS scores	0-75	9-15: moderate; 16-24: severe; ≥25: very severe
Revised Trauma Score (RTS) (18,19)	1989, Champion et al.	GCS, systolic blood pressure (SBP), respiratory rate	0-7.8408	Lower scores indicate higher mortality
Trauma and Injury Severity Score (TRISS) (20,21)	1987, Boyd et al.	RTS, Injury Severity Score (ISS), age, mechanism of injury	0-100%	Probability of mortality (%)
Emergency Trauma Score (EMTRAS) (22,23)	2009, Raum et al.	Age, GCS, base excess, prothrombin time	0-12	Higher scores indicate increased risk
Assessment of Blood Consumption Score (ABCS) (24,25)	2010, Nunez et al.	SBP, pulse, penetrating mechanism, Focused Assessment with Sonography for Trauma (FAST)	0-4	≥2: 90% probability of massive transfusion
Massive Transfusion Score (MTS) (26)	2013, Holcomb et al.	Pulse, SBP, penetrating mechanism, FAST, International Normalized Ratio (INR), hemoglobin, base excess	0-7	≥3: massive transfusion
Vandromme Score (VS) (27)	2011, Vandromme et al.	Pulse, SBP, hemoglobin, INR, lactate	0-5	≥3: massive transfusion
Larson Score (LS) (28)	2010, Larson et al.	Pulse, SBP, hemoglobin, base excess	0-4	≥2: massive transfusion
Schreiber Score (SS) (29)	2007, Schreiber et al.	Hemoglobin, INR, penetrating mechanism	0-3	≥1: massive transfusion
Trauma Associated Severe Hemorrhage (TASH) Score (30)	2006, German Trauma Society	Gender, pulse, SBP, fracture, FAST, hemoglobin, base excess	0-28	≥16: >50% probability of massive transfusion
Prince of Wales Hospital Risk Score (PWHRS) (31)	2011, Rainer et al.	Pulse, SBP, disrupted pelvic fracture, GCS, free abdominal fluid in ultrasonography (USG), base excess, hemoglobin	0-10	>6: elevated risk of massive transfusion
Emergency Transfusion Score (ETS) (32,33)	2006, Ruchholtz et al.	SBP, free abdominal fluid (USG), pelvic instability, age, resuscitation center type, trauma mechanism	0-9.5	<3: massive transfusion unlikely
Traumatic Bleeding Severity Score (TBSS) (34)	2014, Ogura et al.	Age, SBP, USG, pelvic fracture, lactate	0-57	>15: elevated risk of massive transfusion
Trauma-Induced Coagulopathy Clinical Score (TICCS) (35)	2014, Tonglet et al.	SBP, resuscitation status, injured body regions	0-18	≥10: elevated risk of massive transfusion

Table 2. Descriptive characteristics of patients

Feature	n (%)	Mean±SD
Age	41.3±18.4	
Gender*		
Male	88 (75.2)	
Female	29 (24.8)	
Height (cm)		174±7
Weight (kg)		79.0±10.8
BMI (kg/m2)		25.8±2.8
At Admission		
Pulse (bpm)		113±17
SBP (mmHg)		94.3±19.5
DBP (mmHg)		59.9±15.5
RR (/min)		20.9±7.2
GCS		12.0±3.7
SpO2 (%)		92.8±5.3
Mechanism of Injury		
Pedestrian Traffic Accident	27 (23.1)	
Vehicle Traffic Accident	22 (18.8)	
Stab/Cut Injury	28 (23.9)	
Firearm Injury	12 (10.3)	
Fall from Height	25 (21.4)	
Blunt Trauma/Assault	3 (2.6)	
Penetrating Injury	40 (34.2)	
FAST (+)	53 (45.3)	

†SBP: Systolic blood pressure; DBP: Diastolic blood pressure; RR: Respiration rate; GCS: Glasgow Coma Scale; SpO_2: Oxygen saturation; BMI: Body Mass Index.

(10.7%) who received at least 1 unit of red blood cell suspension within the first four hours were included in the study. The descriptive characteristics of the cases are presented in Table 2.

Trauma and transfusion assessment scoring systems were applied to the patients. Literature regarding massive transfusion prediction was utilized to determine the cut-off values for the scores. The results of the trauma and transfusion scoring systems for the cases are presented in Table 3.

Trauma and transfusion scoring systems were compared based on the presence of massive transfusion. All scoring systems were found to be significantly different between the groups with and without massive transfusion (Table 4).

The predictive value of trauma and transfusion scoring systems in patients with massive transfusion was evaluated with ROC analyses. In the ROC analysis, all scoring systems were observed to be predictive for massive transfusion. The most predictive scores were observed as the Shock Index

Table 3. Trauma and transfusion scoring systems in the study cohort

Feature	n (%)	Mean±SD
Shock Index*		1.29±0.51
<1	39 (33.3)	
≥1	78 (66.7)	
ISS*		30.2±14.2
Moderate (9-15)	16 (13.7)	
Severe (16-24)	31 (26.5)	
Very Severe (>24)	70 (59.8)	
TRISS*		72.1±33.2
RTS*		6.5±1.6
Mild	59 (50.4)	
Urgent	15 (12.8)	
Very Urgent	40 (34.2)	
Fatal	3 (2.6)	
EMTRAS*		3.3±2.0
ABCS*		1.5±1.1
Low (<2)	55 (47.0)	
High (≥2)	62 (53.0)	
MTS*		2.6±1.8
Low (<3)	62 (53.0)	
High (≥3)	55 (47.0)	
Vandromme Score*		2.4±1.4
Low (<5)	111 (94.9)	
High (≥5)	6 (5.1)	
Larson Score*		2.2±1.4
Low (<2)	37 (31.6)	
High (≥2)	80 (68.4)	
Schreiber Score*		0.95±0.74
TASH Score*		11.8±6.0
Low (<16)	80 (68.4)	
High (≥16)	37 (31.6)	
PWHRS*		3.3±2.9
Low (<6)	98 (83.8)	
High (≥6)	19 (16.2)	
ETS*		5.3±1.5
Low (<4)	17 (14.5)	
High (≥4)	100 (85.5)	
TBSS*		17.2±9.3
Low (<15)	58 (49.6)	
High (≥15)	59 (50.4)	
TICCS*		7.4±4.3
Low (<10)	78 (66.7)	
High (≥10)	39 (33.3)	

†SI: Shock Index; ISS: Injury Severity Score; TRISS: Trauma and Injury Severity Score; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score; ABCS: Assessment of Blood Consumption Score; MTS: Massive Transfusion Score; TASH: Trauma-Associated Severe Hemorrhage Score; ETS: Emergency Transfusion Score; TBSS: Traumatic Bleeding Severity Score; TICCS: Trauma-Induced Coagulopathy Clinical Score.

Table 4. Comparison of trauma and transfusion scoring results of patients based on the presence of massive transfusion

Score Subtype	MT (+) (n=23)	MT (-) (n=94)	P†
SI	1.9±0.5	1.1±0.3	<0.001
ISS	42.5±11.6	27.2±13.2	<0.001
TRISS	44.3±29.1	78.9±30.7	<0.001
RTS	5.0±1.5	6.9±1.4	<0.001
EMTRAS	4.8±1.3	2.9±1.9	<0.001
ABCS	2.9±0.9	1.2±1.0	<0.001
MTS	4.8±1.2	2.1±1.4	<0.001
Vandromme Score	3.9±0.6	2.1±1.3	<0.001
Larson Score	3.7±0.5	1.9±1.4	<0.001
Schreiber Score	1.5±0.7	0.8±0.6	<0.001
TASH Score	18.3±4.0	10.3±5.4	<0.001
PWHRS	6.5±3.7	2.5±2.1	<0.001
ETS	6.2±1.4	5.1±1.5	=0.003
TBSS	27.2±6.2	14.8±8.3	<0.001
TICCS	10.9±3.6	6.5±4.0	<0.001

*MT: Massive Transfusion; SI: Shock Index; ISS: Injury Severity Score; TRISS: Trauma and Injury Severity Score; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score; ABCS: Assessment of Blood Consumption Score; MTS: Massive Transfusion Score; TASH: Trauma-Associated Severe Hemorrhage Score; ETS: Emergency Transfusion Score; TBSS: Traumatic Bleeding Severity Score; TICCS: Trauma-Induced Coagulopathy Clinical Score. †Independent Samples t-test was used for all analyses.

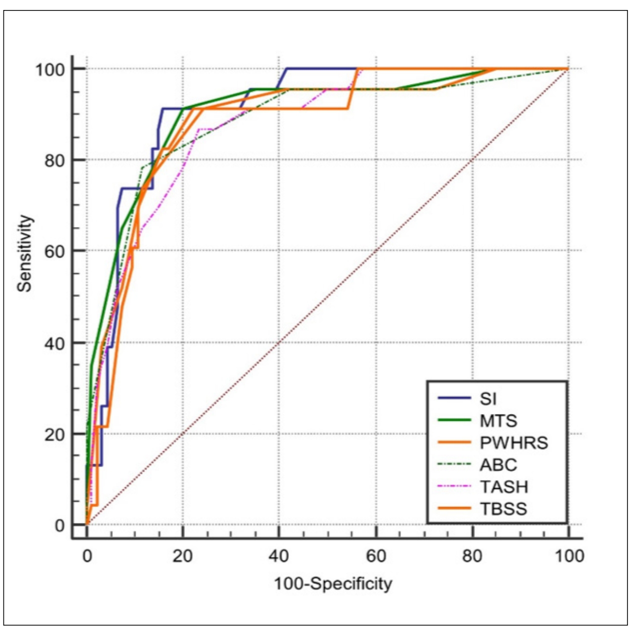

Figure 1. Receiver Operating Characteristic (ROC) curve showing the predictive value of scoring systems in massive transfusion.

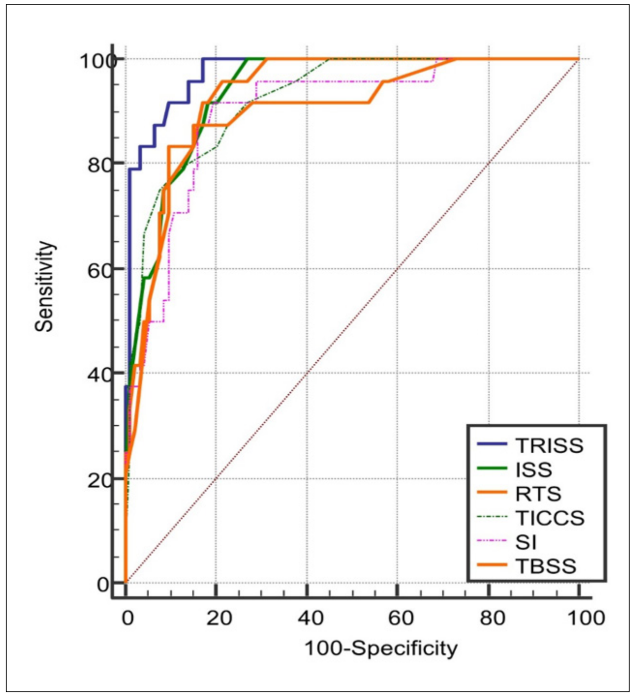

Figure 2. Receiver Operating Characteristic (ROC) curve showing the predictive value of scoring systems in mortality.

Table 5. Determinacy of scoring systems in massive transfusion

Scoring System	AUC	95% CI	P†
SI	0.911	0.844-0.956	<0.001
MTS	0.905	0.837-0.951	<0.001
PWHRS	0.886	0.814-0.937	<0.001
ABCS	0.883	0.810-0.935	<0.001
TASH Score	0.877	0.803-0.930	<0.001
TBSS	0.877	0.804-0.931	<0.001
Vandromme Score	0.869	0.794-0.924	<0.001
Larson Score	0.861	0.785-0.918	<0.001
RTS	0.847	0.769-0.907	<0.001
TRISS	0.815	0.733-0.881	<0.001
EMTRAS	0.808	0.725-0.875	<0.001
ISS	0.804	0.720-0.871	<0.001
TICCS	0.781	0.695-0.852	<0.001
Schreiber Score	0.739	0.650-0.816	<0.001
ETS	0.705	0.613-0.785	<0.001

*SI: Shock Index; ISS: Injury Severity Score; TRISS: Trauma and Injury Severity Score; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score; ABCS: Assessment of Blood Consumption Score; MTS: Massive Transfusion Score; TASH: Trauma-Associated Severe Hemorrhage Score; ETS: Emergency Transfusion Score; TBSS: Traumatic Bleeding Severity Score; TICCS: Trauma-Induced Coagulopathy Clinical Score; AUC: Area Under the Curve; CI: Confidence Interval.

Table 6. Effectiveness of scoring systems in predicting massive transfusion

Scoring System	Threshold (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
SI	>1.42	91.3	84.0	58.3	97.5
MTS	>3	91.3	79.7	52.5	97.4
PWHRS	>3	91.3	75.5	47.7	97.3
ABCS	>2	78.2	88.3	62.1	94.3
TASH Score	>14	86.9	76.6	47.6	96.0
TBSS	>21	91.3	77.6	50.0	97.3
Vandromme Score	>2	100	59.5	37.7	100
Larson Score	>3	78.2	81.9	51.4	93.9
RTS	≤6.9	95.6	67.0	41.5	98.4
TRISS	≤84.6	91.3	71.2	43.7	97.1
EMTRAS	>2	100	51.0	33.3	100
ISS	>38	69.5	77.6	43.2	91.2
TICCS	>7	86.9	71.2	42.6	95.7
Schreiber Score	>1	52.1	86.1	48.0	88.0
ETS	>5.5	73.9	65.9	34.7	91.2

*SI: Shock Index; ISS: Injury Severity Score; TRISS: Trauma Related Injury Severity Score; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score; ABCS: Assessment of Blood Consumption Score; MTS: Massive Transfusion Score; TASH: Trauma-Associated Severe Hemorrhage Score; ETS: Emergency Transfusion Score; TBSS: Traumatic Bleeding Severity Score; TICCS: Trauma-Induced Coagulopathy Clinical Score; PPV: Positive Predictive Value; NPV: Negative Predictive Value.

(SI) (AUC=0.911, 95% confidence interval [CI]: 0.844-0.956), the Massive Transfusion Score (MTS) (AUC=0.905, 95% CI: 0.837-0.951), and the Prince of Wales Hospital Risk Score (PWHRS) (AUC=0.886, 95% CI: 0.814-0.937), respectively (Table 5).

Figure 1 shows the ROC curve of the most predictive scoring systems (SI, MTS, PWHRS, Assessment of Blood Consumption Score [ABC] Score, Trauma-Associated Severe Hemorrhage Score [TASH] Score, and Trauma Blood Supply Score [TBSS]) for massive transfusion.

The performance of trauma and transfusion scoring systems in predicting massive transfusion was analyzed. An SI score above 1.42 had a sensitivity of 91.3% and a specificity of 84% for predicting massive transfusion. An MTS score above 3 had a sensitivity of 91.3% and a specificity of 79.7%, while a PWHRS score above 3 had a sensitivity of 91.3% and a specificity of 75.5% (Table 6).

The predictive value of trauma and transfusion scoring systems in mortality was analyzed. In the ROC analyses, all scoring systems except Schreiber were observed to be predictive for mortality. The most predictive scores were the Trauma and Injury Severity Score (TRISS) (AUC=0.975, 95% CI: 0.927-0.995), the Injury Severity Score (ISS) (AUC=0.937, 95% CI: 0.876-0.973), and the Revised Trauma Score (RTS) (AUC=0.934, 95% CI: 0.873-0.972), respectively (Table 7).

Table 7. Determinacy of scoring systems in mortality

Scoring System	AUC	95% CI	P†
TRISS	0.975	0.927-0.995	<0.001
ISS	0.937	0.876-0.973	<0.001
RTS	0.934	0.873-0.972	<0.001
TICCS	0.924	0.860-0.965	<0.001
SI	0.899	0.830-0.947	<0.001
TBSS	0.897	0.828-0.946	<0.001
PWHRS	0.862	0.785-0.918	<0.001
TASH Score	0.826	0.745-0.890	<0.001
ETS	0.823	0.742-0.888	<0.001
EMTRAS	0.808	0.725-0.87	<0.001
MTS	0.783	0.698-0.854	<0.001
Vandromme Score	0.771	0.685-0.844	<0.001
Larson Score	0.768	0.681-0.841	<0.001
ABCS	0.728	0.638-0.806	<0.001
Schreiber Score	0.572	0.477-0.663	0.273

*SI: Shock Index; ISS: Injury Severity Score; TRISS: Trauma and Injury Severity Score; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score; ABCS: Assessment of Blood Consumption Score; MTS: Massive Transfusion Score; TASH: Trauma-Associated Severe Hemorrhage Score; ETS: Emergency Transfusion Score; TBSS: Traumatic Bleeding Severity Score; TICCS: Trauma-Induced Coagulopathy Clinical Score; AUC: Area Under the Curve; CI: Confidence Interval.

Table 8. Effectiveness of scoring systems in predicting mortality

Scoring System	Threshold (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
TRISS	≤68.66	100	82.8	60.0	100
ISS	>36	91.6	81.7	56.4	97.4
RTS	≤5.97	91.6	82.8	57.9	97.5
TICCS	>11	75.0	92.4	72.0	93.5
SI	>1.39	91.6	80.6	55.0	97.4
TBSS	>22	87.5	84.9	60.0	96.3
PWHRS	>4	70.8	88.1	60.7	92.1
TASH Score	>16	70.8	86.0	56.7	92.0
ETS	>5.5	83.3	68.8	40.8	94.1
EMTRAS	>2	100	51.0	33.3	100
MTS	>2	91.6	64.5	40.0	96.8
Vandromme Score	>2	87.5	56.9	34.4	94.6
Larson Score	>2	87.5	62.3	37.5	95.1
ABCS	>1	83.3	54.8	32.3	92.7
Schreiber Score	>1	33.3	81.7	32.0	82.6

*SI: Shock Index; ISS: Injury Severity Score; TRISS: Trauma and Injury Severity Score; RTS: Revised Trauma Score; EMTRAS: Emergency Trauma Score; ABCS: Assessment of Blood Consumption Score; MTS: Massive Transfusion Score; TASH: Trauma-Associated Severe Hemorrhage Score; ETS: Emergency Transfusion Score; TBSS: Traumatic Bleeding Severity Score; TICCS: Trauma-Induced Coagulopathy Clinical Score; PPV: Positive Predictive Value; NPV: Negative Predictive Value.

Figure 2 shows the ROC curve of the most predictive scoring systems (TRISS, ISS, Revised Trauma Score (RTS), Trauma-Induced Coagulopathy Clinical Score (TICCS), SI, TBSS) for mortality.

The diagnostic performances of the trauma and transfusion scoring systems in predicting mortality were analyzed. A TRISS score below 68.6 showed 100% sensitivity and 82.8% specificity for mortality. An ISS score above 36 had 91.6% sensitivity and 81.7% specificity, while an RTS score below 5.97 had 91.6% sensitivity and 82.8% specificity (Table 8).

DISCUSSION

This study, which included 117 patients, aimed to evaluate the effectiveness of scoring systems in assessing patients who required blood product transfusion due to trauma. The demographic profile of the study population revealed a mean age of 41.3 years and a male-to-female ratio of approximately 3:1. Regarding the mechanism of injury, penetrating-incisive instrument injuries were the most frequent, accounting for 23.9% of cases, followed by blunt trauma. Notably, a third of the patients presented with penetrating injuries to body cavities due to penetrating-incisive instruments or other causes. The observation that falls from height, which are frequently reported as the leading trauma mechanism in many studies, ranked third in this cohort may be attributable to the exclusion of patients who did not require blood transfusion.[41]

When cut-off values consistent with the literature were applied to assess trauma severity using trauma and transfusion scoring systems, it was observed that the majority of patients in the Assessment of Blood Consumption Score (ABCS), MTS, Laboratory Score (LS), Schreiber Score (SS), Emergency Transfusion Score (ETS), and TBSS scores exceeded these thresholds, indicating classification as severe trauma.[25,26,28,29,33,34] The observation of very low rates of severe trauma according to the Vital Signs Score (VS) and PWHRS scores was interpreted as indicating that the cut-off values defined for these scores in the literature may not be appropriate for the patient group included in this study.[27,31]

Regarding the discriminative power of trauma scoring systems on patient parameters, the Shock Index was found to be effective in differentiating mortality. While SI is a physiological scoring system and its ability to reflect differences in patient vital signs is expected, the fact that the Injury Severity Score, an anatomical scoring system, also demonstrated this differentiation is noteworthy. Considering the injury mechanism, the ISS was significantly higher in blunt trauma due to traffic accidents and falls from height, which better represent multiple traumas; conversely, it was significantly lower in penetrating-incisive instrument injuries and the penetrating injury group, which involve single-region injuries. This may reflect a limitation of this scoring system.[42] When patients were grouped according to RTS scores, two groups with an equal number of patients emerged, and in this seemingly homogeneous distribution, RTS was observed to effectively differentiate not only mortality and massive transfusion but also patients requiring follow-up.[19,43] The average TRISS score of 72.1% for the entire patient group implies that the TRISS scoring system predicted a mortality rate of 27.9%. Considering that the actual mortality rate was 20.5%, this might not be considered an inaccurate prediction. However, this observation, along with the fact that TRISS involves a logarithmic calculation and its constant coefficients are updated through periodic cohort studies, could suggest the need for a comprehensive and regional study to refine the TRISS methodology for this specific setting.[44,45]

When trauma and transfusion scoring systems were evaluated in terms of their success in predicting massive transfusion, as expected, a significant difference was found in the mean values between the groups with and without massive transfusion for all systems. This is an anticipated outcome given that these scores are designed for this purpose.

When the predictive value of all trauma and transfusion scoring systems for massive transfusion was evaluated, all were found to have statistically significant results, and this success is also evident in the ROC curves. The systems with the highest predictive value were SI, MTS, and PWHRS, in descending order. In this study, there are several scores that rely on multiple physiological and anatomical patient data, and sometimes even complex calculations based on this data. It is noteworthy that SI, a simple physiological score, topped the list in massive transfusion prediction. A review of the literature also easily reveals the confusion regarding the importance of SI; while some studies argue that it provides insufficient information, others—similar to this study—have obtained significant results regarding its predictive value.[46,47]

It was mentioned that there was a significant difference between the trauma and transfusion scores of the massive transfusion and non-massive transfusion groups according to all scoring systems. However, this analysis based on averages does not necessarily mean that the cut-off values in the literature are accurate for our study. When the most accurate cut-off values of the scores for massive transfusion are determined based on the ROC curves, the following conclusions are reached:

- For trauma scoring systems, there are no definitive established cut-off values for predicting massive transfusion. In this study, the probability of massive transfusion increases when the SI is >1.42, ISS is >38, RTS is <6.9, TRISS is <84.6, and the Emergency Trauma Score (EMTRAS) is >2. For transfusion prediction scoring systems, the following values appear to be more suitable as massive transfusion thresholds based on the data from this study: >3 for MTS (instead of >2), >3 for PWHRS (instead of >6), >14 for TASH (instead of >16), >21 for TBSS (instead of >15), >2 for VS (instead of >4), >1 for SS, and >5.5 for ETS.[26,27,29–31,33,34]

- The values >2 for ABCS, >10 for TICCS, and >2 for LS were found to be consistent with the cut-off values reported in the literature.[25,28,35]

Regarding the predictive value of trauma and transfusion scoring systems for mortality, all except SS demonstrated remarkable results. As anticipated, trauma scores ranked highest; TRISS, ISS, and RTS were identified as scoring systems with the highest predictive value for mortality. TRISS, with a value of <68.66, reached a sensitivity of 100% and a specificity of 82.8%. The cut-off values for ISS and RTS were >36 and <5.97, respectively. The reason for SS alone failing to predict mortality is thought to be its design as a military-based scoring system primarily focused on penetrating injuries for rapid triage.

Limitations of the Study: This study has several limitations. One is its retrospective design and the small sample size resulting from the inclusion of only trauma patients who received transfusion. This situation may have hindered the homogenization of groups and limited the identification of further meaningful results. Additionally, the exclusion of ongoing transfusions and patient data after the initial four-hour period can be considered another limitation.

CONCLUSION

In trauma patients requiring blood product transfusion, all analyzed scoring systems exhibited significant early predictive ability. Notably, the Shock Index emerged as the top predictor for massive transfusion, while the highest accuracy in forecasting mortality was observed with the TRISS score. These findings underscore the significant potential of these scoring systems for guiding early clinical decisions in the emergency management of trauma. However, further large-scale, multicenter studies are warranted to validate these findings and potentially refine the cut-off values for optimal clinical application across diverse trauma populations.

Ethics Committee Approval: This study was approved by the SBÜ Gülhane Ethics Committee (Date: 25.10.2022, Decision No: 2022/20).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Travma sonrası erken dönemde masif transfüzyon ve mortalite öngörüsü: Skorlama sistemlerinin retrospektif bir analizi

AMAÇ: Hemorajik şok, özellikle travmanın ilk saatlerinde, önlenebilir travma ölümlerinin başlıca nedenlerinden biridir. Masif transfüzyon gereksinimi olan veya yüksek mortalite riski taşıyan hastaların erken dönemde tanımlanması, travma yönetiminin optimize edilmesi açısından kritik öneme sahiptir. Masif transfüzyonun erken öngörülmesi, kan ürünlerinin hazırlanmasına zaman kazandırır. Ayrıca, mortalite riskinin erken dönemde belirlenmesi, tedavi yaklaşımını yönlendirme potansiyeline sahiptir. Bu amaçla birçok travma ve transfüzyon skorlama sistemi geliştirilmiş olsa da bu sistemlerin erken dönemdeki karşılaştırmalı öngörü performansı hâlâ net değildir. Bu çalışmada, travmadan sonraki ilk 4 saat içinde masif transfüzyon gereksinimi ve hastane içi mortaliteyi öngörmede travma ve transfüzyon skorlama sistemlerinin etkinliği değerlendirildi.

GEREÇ VE YÖNTEM: 2018- 2022 yılları arasında üçüncü basamak bir sağlık merkezinin acil servisine travma nedeniyle başvurup ilk 4 saat içinde en az 1 ünite eritrosit süspansiyonu verilen 117 hasta retrospektif olarak incelendi. Demografik veriler, travma mekanizmaları, klinik ve laboratuvar bulguları toplandı. Her hastaya 16 farklı travma ve transfüzyon skorlama sistemi uygulandı. Masif transfüzyon, ilk 4 saat içinde ≥5 ünite kan ürünü verilmesi olarak tanımlandı. ROC analizi ile her bir skorun öngörü gücü değerlendirildi ve optimal eşik değerler Youden İndeksi ile belirlendi.

BULGULAR: Masif transfüzyonun 23 hastaya uygulandığı görüldü (%19.7); bu grup içerisinde en yaygın travma mekanizması ateşli silah yaralanmalarıydı. Tüm 16 skorlama sistemi, masif transfüzyon alan ve almayan hastaları anlamlı şekilde ayırt etti. Masif transfüzyonu öngörmede en yüksek doğruluk Şok İndeksi'ne (AUC=0.911) aitti. Hastane içi mortaliteyi öngörmede, Schreiber Skoru dışındaki tüm sistemler anlamlı öngörü kabiliyeti gösterdi. TRISS, mortalite için en yüksek öngörü gücüne sahipti (AUC=0.975). Bazı skorların eşik değerlerinin kohorta özgü olarak yeniden belirlenmesi gerektiği görüldü.

SONUÇ: Travma hastalarında skorlama sistemlerinin erken dönemde uygulanması, klinik sonuçların öngörülmesinde değerli bilgiler sağlar. İncelenen sistemler arasında, Şok İndeksi masif transfüzyonu öngörmede en güvenilir sistem olarak öne çıkarken, TRISS hastane içi mortaliteyi tahmin etmede en başarılı sistem olmuştur. Bu bulgular, travmanın erken yönetiminde hızlı ve skora dayalı değerlendirme yöntemlerinin önemini vurgulamakta ve bu sistemlerin farklı hasta gruplarında daha geniş çaplı çalışmalarla doğrulanması gerektiğini göstermektedir.

Anahtar sözcükler: Hasar kontrol resüsitasyonu; hemorajik şok/tedavisi; masif transfüzyon; resüsitasyon; travma şiddet skorları.

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