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Research Article

Comparison of the Predictive Performance of Revised Trauma Score, Trauma and Injury Severity Score, and BIG Score in Polytrauma Patients

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ABSTRACT

Background: Trauma remains a predominant cause of mortality worldwide, especially among individuals aged 1 to 44 years and in developing nations. To optimize management and improve outcomes, several trauma scoring systems have been developed, including the revised trauma score (RTS), trauma and injury severity score (TRISS), and base deficit, INR, and GCS (BIG) score. This work aimed to evaluate and compare the predictive value of trauma severity scales in polytrauma patients regarding trauma severity outcomes.
Methods: This prospective observational study was carried out on 100 patients aged from 18 to 65 years old, of both sexes, with polytrauma (two or more severe injuries in at least two areas of the body). All three trauma scores were calculated for each polytrauma patient.
Results: RTS and TRISS were significantly lower in the mortality group, whereas the BIG score was significantly higher. Moreover, patients admitted to the ICU and those with hospital stays longer than 9 days had significantly lower RTS and TRISS values and higher BIG scores, indicating that these scores reliably reflect injury severity and help anticipate intensive care needs and length of hospital stay. RTS, TRISS, and BIG showed a significant ability to predict mortality in polytrauma patients, respectively, at cut-offs ≤5.3, <70, and >6 with 86.67%, 86.67%, and 93.7% sensitivity and 77.70%, 80.00%, and 81.2% specificity.
Conclusion: RTS, TRISS, and BIG effectively predicted mortality and ICU requirements in polytrauma patients. BIG showed the highest accuracy, making it the most reliable early mortality predictor. RTS and TRISS also performed well but were slightly less accurate.

Introduction

Traumatic injury is one of the leading causes of morbidity and death worldwide. The World Health Organization estimates that injuries account for 16% of the global illness burden [1]. Traumatic injuries are responsible for over 5.8 million fatalities globally each year [2].

The severity of trauma has increased in line with the current rise in traffic. Furthermore, calamities like typhoons, tsunamis, and earthquakes happen often. For

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people under 40, trauma has emerged as the primary cause of illness and death [3]. Trauma is the third most common cause of mortality in affluent nations, behind cancer and heart disease [4]. Trauma-related mortality is traditionally characterized as having a trimodal distribution. The sole preventive measure that can be taken is to minimize the occurrence of the first peak, which happens in the initial seconds to minutes after trauma, resulting in fatal damage. The second one happens a few hours later and can cause severe, perhaps lethal injuries such as liver cuts, hemopneumothorax, splenic rupture, and subdural and epidural hematomas. When injuries are diagnosed early and treated quickly, mortality in these situations can be decreased. For a more efficient and successful response to trauma sufferers, this is where trauma scoring systems should be implemented. Lastly, the third peak happens a few days to weeks following trauma as a result of consequences such as multiple organ failure and sepsis [5-6]. Accurate and trustworthy methodological techniques are necessary for proper severity rating and outcome prediction while studying the effects of trauma. The goal of trauma scores, a methodically structured approach to trauma assessment and treatment, is to lower hospital stay duration, mortality, and morbidity. Additionally, they aid in directing the allocation of resources and treatment choices in critical care and emergency circumstances [3]. Furthermore, trauma severity scores have been created to categorize and forecast the degree of harm, anticipate and quantify the risk of harm (death and hospitalization) after an accident, assess the extent of harm, identify whether a referral to a trauma center is necessary, and forecast death [7]. In this study, the predictive value of three trauma severity scales—the BIG Score, the Trauma and Injury Severity Score, and the Revised Trauma Score (RTS)—for trauma severity outcomes in patients with polytrauma was assessed and compared.

Methods

One hundred patients with polytrauma (two or more serious injuries in at least two locations of the body) of both sexes, ages 18 to 65, participated in this prospective observational study. Tanta University Hospitals' Ethical Committee gave its clearance for the project (approval code: 36264MD23/1/23). The patients gave their signed, conversant consent. Exclusion criteria were pregnant patients, patients who underwent cardiopulmonary resuscitation upon arrival, and patients who arrived at the emergency section more than 24 hours after the trauma incident. Every patient underwent a thorough history taking, clinical examination, laboratory testing (CBC, serum electrolytes, coagulation profile, serum creatinine, creatine phosphokinase, and arterial blood gases), and radiological testing (CT scans of the brain, chest, pelvis, and entire spine, as well as plain chest, abdomen, and pelvic X-rays). Primary survey: This process establishes the ABCDEs of trauma care and classifies dangerous situations, breathing: Airway maintenance with cervical spine protection and circulation with hemorrhage control, ventilation, disability and, exposure and neurologic status / Environmental control: Completely undress the patient but prevent hypothermia. Secondary survey and management included history and mechanism of injury, head and maxillofacial assessment and management, neck and cervical spine, chest assessment, abdominal assessment, rectum / perineum assessment, musculoskeletal assessment, and neurologic assessment.

Measurements and Data Collection

For each patient, the following data were collected, tabulated using a standardized sheet, and statistically analyzed. Demographic data: gender, age, weight, and body mass index (BMI). Comorbidities: Diabetes mellitus, chronic kidney disease, hypertension, and other chronic illnesses. Vital signs at admission: respiratory rate (RR), systolic blood pressure (SBP), oxygen saturation (SpO_2), heart rate (HR), and Glasgow Coma Scale (GCS).

Trauma characteristics: Manner of trauma: Blunt or penetrating Mechanism of trauma: Road traffic accidents, falls, stab wounds, gunshots, burns, etc. Timing of trauma: Classified as <6 hours, 6–12 hours, or >12 hours from injury to hospital arrival. Areas of injury: head-neck, thorax, face, spine, pelvis, abdomen, lower and and upper extremities.

Calculation of Trauma Scores: The three trauma scores were calculated for each polytrauma patient.

Revised Trauma Score (RTS): Related to SBP, RR, and GCS. Each parameter is given a coded charge from zero to four. The final RTS is calculated using the formula: RTS = (0.9368 × GCS code) + (0.7326 × SBP code) + (0.2908 × RR code) [8].

Injury Severity Score (ISS): For every of 6 body parts. The ISS is the sum of squares of the peak AIS scores in the 3 most strictly injured body parts. $ISS=A^2+B^2+C^2$ [9]

Where A, B, and C are the highest AIS scores (range 1–6) in three different regions. The total ISS ranges from 1 to 75.

Trauma and Injury Severity Score (TRISS): Incorporating RTS, ISS, and patient age (0 if age <55 years; 1 if ≥55 years). b=b0+b1(RTS)+b2(ISS)+b3(Age Index) [10]

Probability of survival for TRISS (Ps): $ps=\frac{1}{(1+e(-b))}$

The coefficients (b_0 to b_3) vary depending on the mechanism of trauma (blunt or penetrating). The score is expressed as a percentage (%), ranging from 0% (no chance of survival) to 100% (maximum survival probability). TRISS > 90% → High probability of survival (mild-to-moderate injuries). TRISS 50–90% → Moderate risk; clinical attention needed. TRISS < 50%

→ Low survival probability; indicates severe trauma or physiological compromise. TRISS < 25% → Very high risk of mortality [10].

BIG score: measured utilizing INR, base deficit, and GCS

BIG Score=Base Deficit+(2.5×INR)+(15−GCS) [11]

A higher BIG score reflects greater physiological derangement and is associated with increased mortality risk. Lower scores (≤6) indicate a better prognosis and are often seen in less severely injured patients. Moderate scores (6–10) suggest a need for close monitoring and may predict ICU admission. Higher scores (>10) are typically linked to severe trauma and poor outcomes, including higher mortality [12]. The primary outcome of this study was to detect the prognostic rate of these scores in polytrauma patients and compare them. The secondary outcome was the post-trauma outcomes regarding morbidity, mortality, and hospital stay.

Statistical analysis

SPSS v26 was utilized for statistical analysis. The 2 sets were likened utilizing the unpaired Student's t-test, and quantitative variables were showed as standard deviation (SD) and mean. The Fisher's exact test or chi-square test, as relevant, was utilized to examine the qualitative variables, which were stated as percentage and frequency. Evaluation of diagnostic performance specificity, sensitivity, negative predictive value (NPV), and positive predictive value (PPV).

Results

This study was a prospective observational study conducted on 100 eligible polytrauma patients (Figure 1).

comorbidities, mode of trauma, Demographic data, mechanism of trauma, time of admission after trauma, and area of injury were enumerated in (Table 1).

Vital signs, laboratory tests, treatment, and trauma scores were enumerated in (Table 2).

Surgical intervention distribution was enumerated in (Table 3).

ICU admission and stay length and mortality were enumerated in (Table 4).

RTS and TRISS were significantly lesser in non-survivors than survivors (P<0.05), indicating their association with mortality. Conversely, BIG was significantly advanced in non-survivors (P=0.032), supporting its predictive value for in-hospital death. Among ICU vs. non-ICU patients, RTS (5.3 ± 1.0 vs. 6.7 ± 0.6; P < 0.001) and TRISS (72.6 ± 12.3 vs. 77.8 ± 11.0; P = 0.039) were lower, while BIG (6.6 ± 4.0 vs. 4.5 ± 3.3; P = 0.005) was higher, reflecting greater severity and ICU need. For ICU length of stay, patients staying >9 days had lower RTS (P<0.001) and TRISS (P=0.033) but higher BIG (P=0.012) (Table 5).

RTS, TRISS, and BIG showed a significant ability to predict mortality in polytrauma patients at cut-offs ≤5.3, <70, and >6 with 86.67%, 86.67%, and 93.7% sensitivity; 77.70%, 80.00%, and 81.2% specificity; 56.1%, 50.5%, and 66.7% PPV; 95.6%, 96.9%, and 93.4% NPV; and 80%, 74%, and 83% diagnostic accuracy, respectively. These findings support the clinical utility of all three scores, particularly the BIG score, for early mortality risk stratification in polytrauma patients (Figure 2).

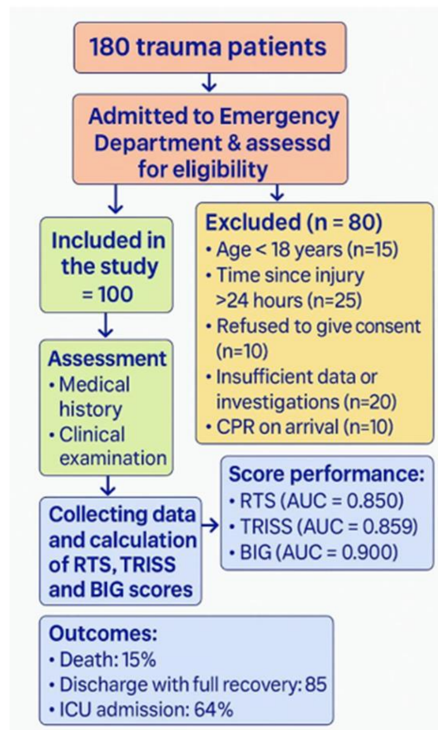

Figure 1- Flowchart showing the pathway of the study

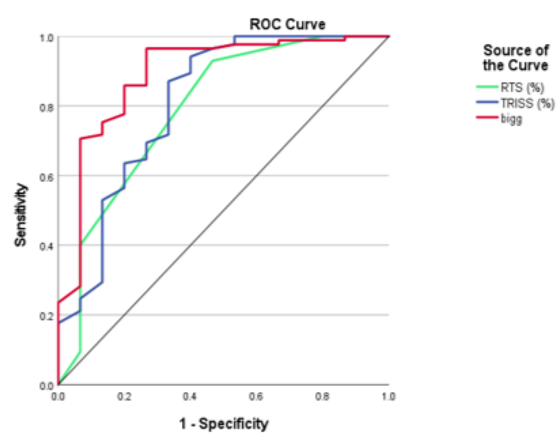

Figure 2- ROC curve of RTS, TRISS, and BIG in the prediction of mortality in polytrauma patients

Table 1- Demographic data, comorbidities, mode of trauma, mechanism of trauma, time of admission after trauma, and area of injury of the studied patients

		N=100
Age (years)		35.3±11.56
≤20 years		5 (5%)
21-30 years		39 (39%)
31-40 years		24 (24%)
41-50 years		20 (20%)
51-60 years		10 (10%)
61-65 years		2 (2%)
Sex	Male	77 (77%)
	Female	23 (23%)
Weight (kg)		74.7±9.92
Height (cm)		168.7±7.24
BMI (kg/m^2)		30.06±6.15
Comorbidities	DM	18 (18%)
	Hypertension	14 (14%)
	CKD	7 (7%)
	Others (cardiac, stroke, liver diseases)	5 (5%)
Mode of trauma	Blunt trauma	82 (82%)
	Penetrating	18 (18%)
Mechanism of trauma	Road traffic accident	62 (62%)
	Falling from Height	15 (15%)
	Railway accident	2 (2%)
	Animal injury	3 (3%)
	Gunshot	3 (3%)
	Stab	9 (9%)
	Falling on a sharp object	2 (2%)
	Burn or electrocution	4 (4%)
Time of admission after trauma	<6h	41 (41%)
	6-12 h	36 (36%)
	12-24 h	23 (23%)
Area of injury	Head-neck	68 (68%)
	Face	47 (47%)
	Thorax	30 (30%)
	Abdomen	22 (22%)
	Spine	25 (25%)
	Pelvis	15 (15%)
	Upper extremity	26 (26%)
	Lower extremity	34 (34%)

Data are presented as mean ± SD or frequency (%). BMI: Body mass index, DM: Diabetes mellitus, CKD: Chronic kidney disease. Note: injury in more than one area may be present in one patient.

Table 2- Vital signs, laboratory tests, treatment, and trauma scores of studied patients

	N=100
Vital signs	
Systolic blood pressure (mmHg)	108.7 ± 20.03
Heart rate (beats/min)	100.7 ± 19.13
RR (breaths/min)	21.3 ± 5.56
SPO_2 (%)	82.2 ± 10.32
GCS	12.5 ± 1.94
Laboratory tests	
Hemoglobin (g/dL)	12.98 ± 2.84
WBCs (10^9/L)	14.9 ± 5.36
Platelets (10^9/L)	229.3 ± 29.8
Sodium (mEq/L)	137.04 ± 3.57
Potassium (mEq/L)	4.3 ± 0.57
INR	0.99 ± 0.15
Creatinine (mg/dL)	0.98 ± 0.43

Creatine phosphokinase (g/dL)		539.7 ± 975.99
PH		7.4 ± 0.15
PaO_2 (mmHg)		85.1 ± 12.39
$PaCO_2$ (mmHg)		32.8 ± 7.78
HCO_3 (mEq/L)		18.1 ± 5.89
Base excess (mmol/L)		-1.7 ± 2.97
Treatment		
Conservation treatment		77 (77%)
Surgical treatment	Neurosurgery	13 (56.5%)
23 (23%)	General surgery	9 (39.1%)
	Orthopedic surgery	15 (65.2%)
	Cardiothoracic	14 (60%)
	Plastic	6 (26.1)
	Vascular surgery	4 (17.4%)
Trauma scores	RTS	5.4 ± 1.28
	TRISS (%)	75.43 ± 13.44
	BIG	5.9 ± 3.33

Data are presented as mean ± SD or frequency (%). RR: respiratory rate, GCS: Glasgow coma scale, WBCs: white blood cells. INR: International normalized ratio, RTS: Revised trauma score, ISS: Injury severity score, TRISS: Trauma and injury severity score. Note: A single patient may have had multiple surgeries across various surgical departments.

Table 3- Surgical intervention distribution among studied participants

Surgical treatment		**N=23**
Neurosurgery	Craniotomy for evacuation of EDH and SDH.	6 (26.1%)
	Decompressive craniectomy for raised ICP.	2 (8.7%)
	Cervical spine fixation	3 (13%)
	Skull fracture repair	4 (17.4%)
General surgery	Splenectomy	5 (21.7%)
	Bowel injury repair	3 (13%)
	Diaphragmatic Injury Repair	1 (4.3%)
	Mesenteric tear repair	1 (4.3%)
	Liver Tear Repair	2 (8.7%)
Orthopedic	Upper limb fractures: ORIF or external fixation	9 (39.1%)
	Lower limb ORIF or external fixation	11 (47.8%)
	Pelvic fracture fixations	6 (26.1%)
	Spinal fixations	2 (8.7%)
	Amputations	1 (4.3%)
Cardiothoracic	Chest tube insertion	14 (60.9%)
	Emergency Thoracotomy	2 (8.7%)
Plastic	Facial fracture repair	3 (13%)
	Reconstruction	1 (4.3%)
Vascular repair		3 (13%)
Fasciotomy		1 (4.3%)

Data are presented as frequency (%). ORIF: Open reduction and internal fixation. Note: A single patient may have had multiple surgeries across various surgical departments.

Table 4- ICU admission, stay length, and mortality of the studied patients

	N=100
ICU admission	64 (64%)
Length of ICU stay (days)	9.2 ± 6.92
Total hospital stays (days)	11.9 ± 5.22
Mortality	15 (15%)

Data are presented as mean ± SD or frequency (%). ICU: Intensive care unit.

Table 5- Relation between trauma scores and mortality, need for ICU admission, and length of ICU stay of the studied patients

	Mortality		**t-test**	**P**
	Died group (n=15)	**Alive group (=85)**		
RTS	4.47±1.05	6.01±0.93	5.825	<0.001*

TRISS (%)	66.7±14.8	75.9±11.0	2.825	0.006*
BIG	7.7±0.60	5.15±0.79	2.182	0.032*
	Need for ICU admission.			
	Need ICU (n=64)	Not needed (=36)		
RTS	5.3±1.0	6.7±0.60	7.494	<0.001*
TRISS (%)	72.6±12.3	77.8±11.0	2.092	0.039*
BIG	6.6±4.03	4.5±3.3	2.912	0.005*
	Length of ICU stay			
	<9 days (n=18)	>9 days (n=46)		
RTS	5.54±1.03	4.63±0.51	3.574	<0.001*
TRISS (%)	76.6±12	62.2±12	2.123	0.033*
BIG	5.02±2.65	7.83±2.7	1.018	0.012*

Data are presented as mean ± SD. * Significant P value < 0.05. ICU: Intensive care unit. RTS: Revised trauma score, TRISS: Trauma and injury severity score.

Discussion

Trauma remains a leading global health concern and is 1 of the primary reason of mortality, hospitalization, and long-term disability, particularly among young adults [13-14].

According to our results, blunt trauma was the predominant mechanism, accounting for 82% of cases, while penetrating injuries represented 18%. Regarding the time elapsed among hospital admission and trauma occurrence, only 41% of patients arrived within the critical first 6 hours post-injury. 36% presented 6 to 12 hours, while 23% presented 12 to 24 hours before reaching definitive care. These results are maintained by Berkeveld et al. [15], who demonstrated that blunt injury was present in 94.2% of the patients. Consistent with our findings, Sutherland et al. [16] stated notable variances in mortality rates between the two trauma types.

In this study, RTS ranged from 3.2 to 6.9 (mean ± SD: 5.4 ± 1.28), TRISS from 46 to 92% (75.4 ± 13.4%), and BIG from 2 to 17 (5.9 ± 3.3). RTS and TRISS were significantly lesser in non-survivors than survivors (P<0.05), whereas BIG was higher, reflecting greater injury severity. ICU admission (n=64) was associated with lower RTS/TRISS and higher BIG, indicating that these scores reliably predict intensive care need. Among ICU patients, those with stays longer than 9 days (n=46) had lower RTS/TRISS and higher BIG than shorter-stay patients (n=18). These results demonstrate that RTS, TRISS, and BIG correlate with both mortality and morbidity, supporting their utility for rapid identification and management of severe polytrauma cases. These findings were compared with those reported by Höke et al. [17], who showed a study on trauma patients admitted to a large trauma center. In their study, the mean RTS was 7.6 ± 0.8 (calculated on a 0–12 scale), while in the present study, the RTS was calculated using the coded method (0–7 scale) with a mean of 5.4 ± 1.28. In contrast, Elfeky et al. [18] reported a markedly lower mean RTS value of 3.50 ± 0.023. This considerably low score suggests a critically ill population, likely dominated by severe head injuries or patients with multi-organ failure, resulting in depressed levels of consciousness and poor vital signs.

In the present study, the hospital mortality rate was 15%, while 85% of patients were discharged with full recovery. These findings are in line with previous literature. For instance, Banerjee et al. [19] found an in-hospital mortality rate of 18.3%. Milton et al. [20] evaluated 200 polytrauma patients and found a mortality rate of 27 patients (13.5%). Bhandarkar et al. [21] stated an total mortality rate of 20.37% among trauma patients, which is slightly higher than the rate observed in our study. In contrast, Höke et al. [17] reported a mortality rate of approximately 8.2% among 426 trauma patients.

In the present study, all three trauma scoring systems, RTS, TRISS, and BIG, demonstrated statistically significant predictive ability for in-hospital mortality amid polytrauma patients.

Regarding the RTS, the current study identified a cut-off value of ≤5.3 with an AUC of 0.850, sensitivity of 86.67%, specificity of 77.70%, and 80% diagnostic accuracy. These results harmonize with those of Az et al. [22], who discovered that RTS ≤8 had a 98.57% sensitivity and a 99.79% specificity in predicting mortality. Additionally, Farzan et al. [23] discovered that RTS (AUC=0.969) had 100% sensitivity and 83.33% specificity in predicting death in patients with multiple trauma. A cutoff of eight with 60% specificity and 81% sensitivity was determined by Milton et al. [20].

Concerning TRISS, the current study identified a cut-off value of <70, with an AUC of 0.859, sensitivity of 86.67%, specificity of 80.00%, PPV of 50.5%, NPV of 96.9%, and 74% diagnostic accuracy, reflecting strong predictive performance. These results are in agreement with those stated by Sheikhi et al. [24], who reported that TRISS had an AUC of 0.889, with a sensitivity of 91.7%, specificity of 77.8%, PPV of 66.6%, and NPV of 95.6%, making it superior to both RTS and base excess in predicting outcomes in polytrauma patients. Yousefi et al. [25] found TRISS to be the most accurate among various scoring systems, with an AUC of 0.934, specificity of 92.8%, and sensitivity of 77.5%.

Regarding the BIG score, the present study identified a cut-off value of >6, achieving the highest predictive accuracy among the three scoring systems, with an AUC of 0.900, 93.7% sensitivity, 81.2% specificity, 66.7% PPV, and 93.4% NPV. These results are supported by previous research. For instance, Az et al. [26] evaluated the BIG score for predicting in-hospital mortality among 563 adult polytrauma patients. They identified a cut-off value of >10.65, which yielded an AUC of 0.847 (ninty five percent CI 0.808–0.886), specificity of 86.5%, sensitivity of 67.7%, and NPV of 89.6%. Also, Höke et al. [17] demonstrated an AUC of 0.87 at a cut-off >7.42 with 85.7% sensitivity and 88% specificity. One of the study's limitations was the very minor sample size. There was only 1 center for the study. Only the initial scoring at admission was examined in this study; score changes over time or their dynamic predictive value were not assessed.

Conclusion

All three scoring systems (RTS, TRISS, and BIG) effectively predicted mortality and ICU needs in polytrauma patients. The BIG score (INR, base deficit, and GCS) demonstrated superior accuracy as the strongest predictor of mortality, making it particularly reliable for early risk assessment. While RTS and TRISS also showed good predictive performance, their accuracy was slightly lower than the BIG score. These findings strongly support incorporating trauma scoring systems (especially the BIG score) into clinical protocols to improve triage, resource allocation, and outcome prediction in polytrauma cases.

Ethics approval and consent to participate

The study protocol was permitted by the Ethical Committee of the Faculty of Medicine, Tanta University (Approval code: 36264MD23/1/23). Written informed consent was gained from all participants or their legal guardians before enrollment in the study.

Authors' contributions

HME calculated and regarded the study. SSAE and SAAI were accountable for data collection and patient enrollment. MHA and SMAH contributed to the clinical management of patients and data acquisition. HME and SAAI performed the statistical analysis and interpretation of data. HME drafted the manuscript. All authors donated to manuscript revision, read, and accepted the final version.

Data availability

The datasets backup the conclusions of this article are involved within the article. Additional data are available from the corresponding author on reasonable request.

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