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ASSESSMENT OF FACTORS PREDICTING MORTALITY IN TRAUMA PATIENTS USING REVISED TRAUMA SCORE: A PROSPECTIVE OBSERVATIONAL STUDY AT A TERTIARY CARE HOSPITAL IN WEST BENGAL, INDIA

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Abstract

Introduction: Trauma constitutes a major public health burden globally, with developing countries bearing a disproportionate share of mortality and morbidity. Early identification of high-risk patients through validated scoring systems is essential for optimal triage and resource allocation. The Revised Trauma Score (RTS), incorporating Glasgow Coma Scale, systolic blood pressure, and respiratory rate, serves as a widely utilized physiological scoring tool for mortality prediction. This study aimed to assess factors predicting mortality in trauma patients using RTS and evaluate its predictive accuracy in an Indian tertiary care setting.

Methods: A prospective observational study was conducted at Gouri Devi Institute of Medical Sciences and Hospital, West Bengal, from July 2024 to December 2024. A total of 168 trauma patients meeting inclusion criteria were enrolled through consecutive sampling. Demographic data, injury characteristics, and RTS parameters were recorded. Mortality prediction accuracy was assessed using receiver operating characteristic curve analysis, and logistic regression identified independent predictors.

Results: The study population comprised predominantly males (82.1%) with mean age of 37.42 years. Road traffic accidents were the leading mechanism (66.7%). Overall mortality was 16.7%. Non-survivors had significantly lower mean RTS (3.68 vs. 6.82, $p<0.001$) compared to survivors. The RTS demonstrated excellent discriminatory ability with area under curve of 0.924. At optimal cutoff of 5.68, sensitivity was 89.3% and specificity was 87.1%. Glasgow Coma Scale below 9 emerged as the strongest mortality predictor (OR: 8.64).

Conclusion: The Revised Trauma Score effectively predicts mortality in trauma patients, demonstrating excellent discriminatory ability. Implementation of RTS-based triage protocols is recommended for emergency departments in resource-limited settings to facilitate early identification of high-risk patients.

Keywords: Revised Trauma Score, Trauma mortality, Glasgow Coma Scale, Injury severity, Emergency triage

Introduction

Trauma remains one of the foremost public health challenges worldwide, contributing substantially to morbidity, mortality, and socioeconomic burden across populations. According to global estimates, traumatic injuries account for approximately 5.8 million deaths annually, representing nearly 10% of all deaths worldwide (Nantulya & Reich, 2002). The burden is particularly severe in low and middle-income countries, where over 90% of trauma-related mortality occurs, often affecting the most economically productive age groups between 15 and 44 years (Hofman et al., 2005). Road traffic accidents constitute the leading cause of traumatic injuries globally, claiming approximately 1.35 million lives each year and leaving millions more with temporary or permanent disabilities (Stewart et al., 2016).

In developing nations like India, the scenario is particularly concerning due to rapid urbanization, increasing motorization, inadequate road infrastructure, and limited emergency medical services. Indian hospitals witness a tremendous influx of trauma patients daily, with road traffic injuries, falls, assaults, and occupational accidents being the predominant etiologies. Studies conducted across various Indian tertiary care centers have consistently demonstrated that young males represent the majority of trauma victims, reflecting their greater exposure to occupational hazards and vehicular travel (Singh et al., 2011). The economic consequences are staggering, with trauma-related costs estimated at 3% of global GDP and up to 5% in developing economies, placing enormous strain on healthcare systems and family resources.

Early identification of patients at high risk of mortality is crucial for optimal trauma care management. The ability to accurately predict outcomes enables clinicians to make informed decisions regarding triage, resource allocation, and treatment prioritization. Over the past several decades, numerous trauma scoring systems have been developed to quantify injury severity and predict survival outcomes. These scoring systems generally fall into three categories: physiological scores that assess the patient's immediate clinical status, anatomical scores that evaluate the extent and distribution of injuries, and combined scores that integrate both parameters along with demographic factors.

The Revised Trauma Score (RTS) represents one of the most widely utilized physiological scoring systems in trauma care globally. Developed by Champion and colleagues in 1989, the RTS evolved from the original Trauma Score introduced in 1981, which incorporated five parameters including Glasgow Coma Scale, systolic blood pressure, respiratory rate, respiratory expansion, and capillary refill time (Champion et al., 1989). The revision eliminated the subjective components of respiratory expansion and capillary refill, which proved difficult to assess accurately in field conditions, particularly during nighttime or in austere environments. The streamlined RTS comprises three objective physiological parameters: Glasgow Coma Scale (GCS) for neurological assessment, systolic blood pressure (SBP) for circulatory function evaluation, and respiratory rate (RR) for ventilatory status monitoring.

The mathematical calculation of the RTS involves assigning coded values ranging from 0 to 4 to each parameter based on predefined ranges, followed by multiplication with weighted coefficients derived through logistic regression analysis. The formula is expressed as: RTS = (0.9368 × GCS coded value) + (0.7326 × SBP coded value) + (0.2908 × RR coded value). The resulting score ranges from 0 to 7.8408, with higher values indicating better physiological status and improved survival probability. The weighting coefficients reflect the relative contribution of each parameter to mortality prediction, with GCS receiving the highest weight to account for the significant impact of head injuries on trauma outcomes (Moore et al., 2006).

Several studies have validated the predictive accuracy of the RTS across diverse trauma populations. Research conducted in India by Hariharan et al. (2011) demonstrated that the RTS exhibited good discriminatory ability for predicting mortality in trauma patients, with a graded increase in death rates corresponding to decreasing RTS values. Similarly, investigations in other developing countries have supported the utility of RTS in resource-limited settings where sophisticated diagnostic modalities may be unavailable (Manoochehry et al., 2019). The score's reliance on readily obtainable bedside parameters makes it particularly valuable for prehospital triage and emergency department assessment.

Comparative evaluations with other scoring systems have yielded valuable insights. Javali and colleagues conducted a prospective study at JSS Hospital, Mysuru, comparing the performance of RTS, Injury Severity Score (ISS), New Injury Severity Score (NISS), and Trauma and Injury Severity Score (TRISS) in elderly trauma patients, demonstrating that RTS achieved an area under the ROC curve of 0.947 for mortality prediction (Javali et al., 2019). International studies have reported similar findings, with RTS showing sensitivity exceeding 80% and specificity above 90% for identifying patients at risk of adverse outcomes (Galvagno et al., 2019).

Despite its widespread application, the RTS has certain limitations that warrant consideration. The score may underestimate injury severity in patients with isolated head trauma who maintain normal cardiovascular and respiratory parameters. Additionally, factors such as age, comorbidities, and mechanism of injury are not incorporated into the basic RTS calculation, potentially affecting predictive accuracy in specific patient subgroups. Research by Yu et al. (2021) comparing RTS with the Modified Early Warning Score found differences in predictive performance for short-term mortality, suggesting that optimal scoring system selection may depend on the clinical context and patient population characteristics.

In the context of Indian healthcare settings, understanding the factors that predict mortality in trauma patients assumes critical importance for improving outcomes. Regional variations in trauma epidemiology, healthcare infrastructure, and patient characteristics necessitate local validation studies to establish appropriate cutoff values and assess the applicability of scoring systems developed in Western populations. West Bengal, with its dense population, extensive road networks, and mix of urban and rural healthcare facilities, provides an appropriate setting for investigating trauma outcomes and mortality prediction.

The aim of this study is to assess the factors predicting mortality in trauma patients using the Revised Trauma Score (RTS) and to evaluate the predictive accuracy of RTS for in-hospital mortality among trauma patients.

Methodology

Study Design

The present study was conducted as a prospective observational study.

Study Site

The study was undertaken at Gouri Devi Institute of Medical Sciences and Hospital, West Bengal, India.

Study Duration
The study was conducted over a period of six months, extending from July 2024 to December 2024.

Sampling Technique and Sample Size
A consecutive sampling technique was employed for patient recruitment, wherein all eligible trauma patients presenting to the emergency department during the study period were approached for enrollment. This non-probability sampling method was chosen to minimize selection bias and ensure inclusion of a representative cross-section of trauma patients across varying severity levels and injury mechanisms. The calculated sample size was established at 168 patients based on review of previous studies examining trauma scoring systems in similar settings and statistical considerations for achieving adequate power for the planned analyses. Studies by Kondo et al. (2011) and Yousefzadeh-Chabok et al. (2016) employed comparable sample sizes for validation of trauma scores, supporting the adequacy of this target for the current investigation.

Inclusion and Exclusion Criteria
The study enrolled adult patients aged 18 years and above who presented to the emergency department following acute traumatic injury, irrespective of the mechanism of trauma, and for whom all parameters required for RTS calculation (Glasgow Coma Scale score, systolic blood pressure, and respiratory rate) could be obtained at the time of initial presentation. Patients were required to provide informed consent either directly or through legally authorized representatives when the patient was incapacitated. The exclusion criteria encompassed patients below 18 years of age due to different physiological parameters and scoring considerations in pediatric populations, patients who were declared dead on arrival to the emergency department, those with isolated burn injuries given the distinct pathophysiology and prognostic factors, patients with incomplete data precluding accurate RTS calculation, individuals who left against medical advice before definitive outcome determination, pregnant women due to altered physiological baselines, and patients or their representatives who declined to participate in the study.

Data Collection Tools and Techniques
Data collection was performed using a pre-designed, semi-structured proforma developed specifically for this study. The proforma was validated through pilot testing on an initial cohort of 15 patients who were not included in the final analysis, with necessary modifications incorporated based on feedback and practical considerations. The data collection instrument captured demographic information including age, sex, occupation, and residence; details of trauma including mechanism of injury, time elapsed since injury, and prehospital care received; physiological parameters at presentation comprising Glasgow Coma Scale score assessed using the standard 15-point scale evaluating eye opening, verbal response, and motor response, systolic blood pressure measured in millimeters of mercury using standard sphygmomanometry, and respiratory rate documented as breaths per minute through direct observation over sixty seconds; clinical findings and anatomical distribution of injuries; treatment administered including surgical interventions, blood transfusion requirements, and intensive care admission; and outcome measures specifically in-hospital mortality status and duration of hospital stay.

The RTS was calculated for each patient using the standard formula: RTS = (0.9368 × GCS coded value) + (0.7326 × SBP coded value) + (0.2908 × RR coded value), where coded values were assigned according to established criteria (Champion et al., 1989). All assessments were performed by trained emergency department personnel following standardized protocols, and data were collected by the principal investigator and trained research assistants. Inter-rater reliability was ensured through periodic training sessions and supervision of data collection procedures.

Data Management and Statistical Analysis

The collected data were entered into Microsoft Excel spreadsheets with appropriate coding for categorical variables and verification through double-entry methodology to minimize transcription errors. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 26.0 software. Continuous variables were expressed as mean with standard deviation for normally distributed data and median with interquartile range for skewed distributions, while categorical variables were presented as frequencies and percentages. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. Comparison of continuous variables between survivor and non-survivor groups was performed using independent samples t-test or Mann-Whitney U test as appropriate, while categorical variables were compared using Chi-square test or Fisher's exact test.

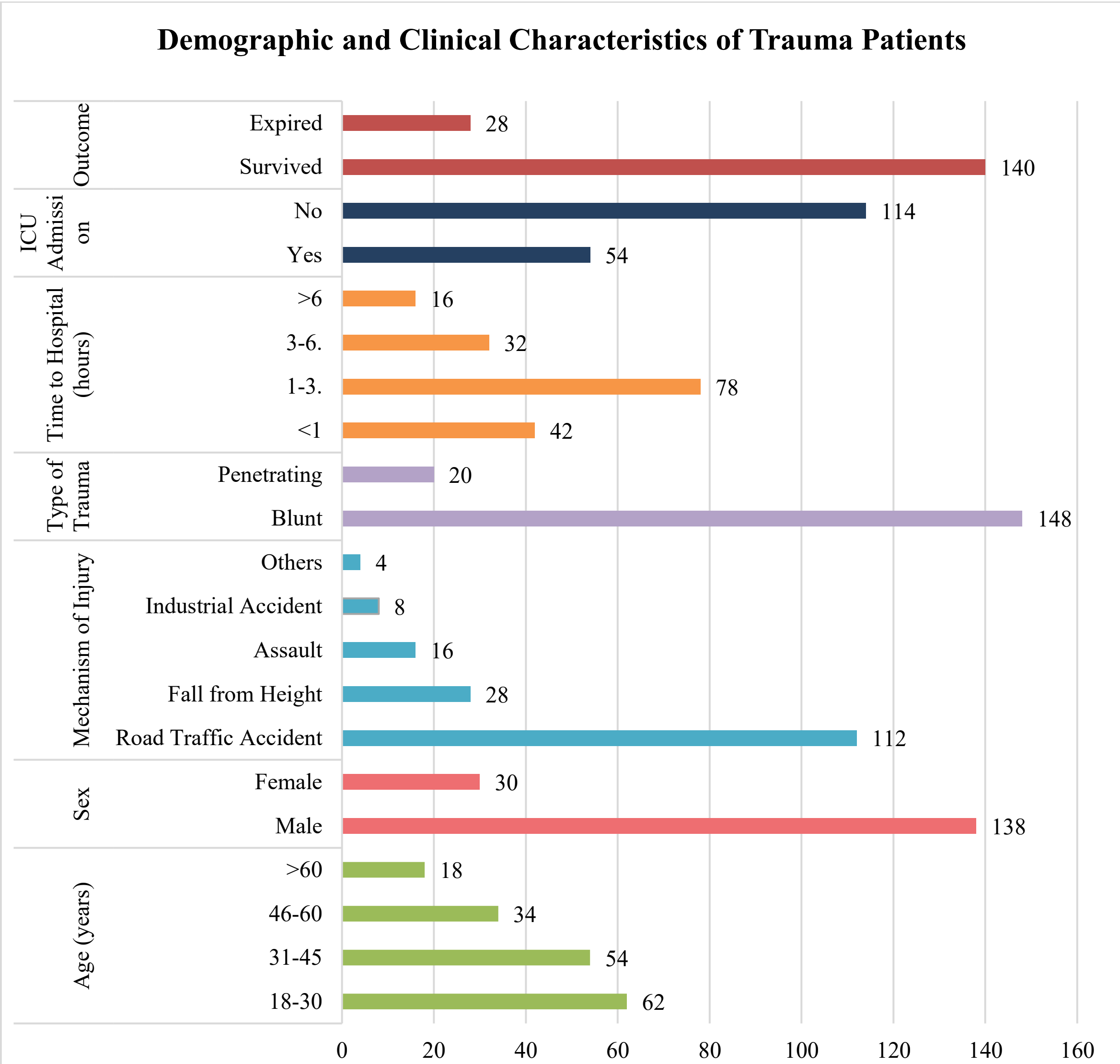
Ethical Considerations

The study protocol was submitted to the Institutional Ethics Committee for review and approval prior to commencement of data collection. Ethical clearance was obtained in accordance with the Indian Council of Medical Research guidelines for biomedical research and the principles enshrined in the Declaration of Helsinki governing ethical conduct of research involving human subjects. Written informed consent was obtained from all participants or their legally authorized representatives in cases where patients were unable to provide consent due to altered consciousness or severity of injuries.

Results

Table 1: Demographic and Clinical Characteristics of Trauma Patients (N=168)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18-30	62	36.9
	31-45	54	32.1
	46-60	34	20.2
	>60	18	10.7
Sex	Male	138	82.1
	Female	30	17.9
Mechanism of Injury	Road Traffic Accident	112	66.7
	Fall from Height	28	16.7
	Assault	16	9.5
	Industrial Accident	8	4.8
	Others	4	2.4
Type of Trauma	Blunt	148	88.1
	Penetrating	20	11.9
Time to Hospital (hours)	<1	42	25
	1-3	78	46.4
	3-6	32	19
	>6	16	9.5
ICU Admission	Yes	54	32.1
	No	114	67.9
Outcome	Survived	140	83.3
	Expired	28	16.7



Mean age: 37.42 ± 14.68 years; Mean hospital stay: 8.6 ± 6.2 days

Fig: 1

Table 2: Distribution of Revised Trauma Score Components Among Study Participants (N=168)

Parameter	Coded Value	Range/Category	Frequency (n)	Percentage (%)
Glasgow Coma Scale	4	13-15	98	58.3
	3	9-12	36	21.4
	2	6-8	18	10.7
	1	4-5	10	6
	0	3	6	3.6
Systolic Blood Pressure (mmHg)	4	>89	124	73.8
	3	76-89	22	13.1
	2	50-75	14	8.3
	1	1-49	6	3.6
	0	0	2	1.2
Respiratory	4	10-29	132	78.6

Rate (breaths/min)	3	>29	18	10.7
	2	6-9	12	7.1
	1	1-5	4	2.4
	0	0	2	1.2
RTS Category	-	>6 (Mild)	104	61.9
	-	4-6 (Moderate)	42	25
	-	<4 (Severe)	22	13.1

Mean RTS: 6.24 ± 1.86; Median RTS: 6.90 (IQR: 5.12-7.84)

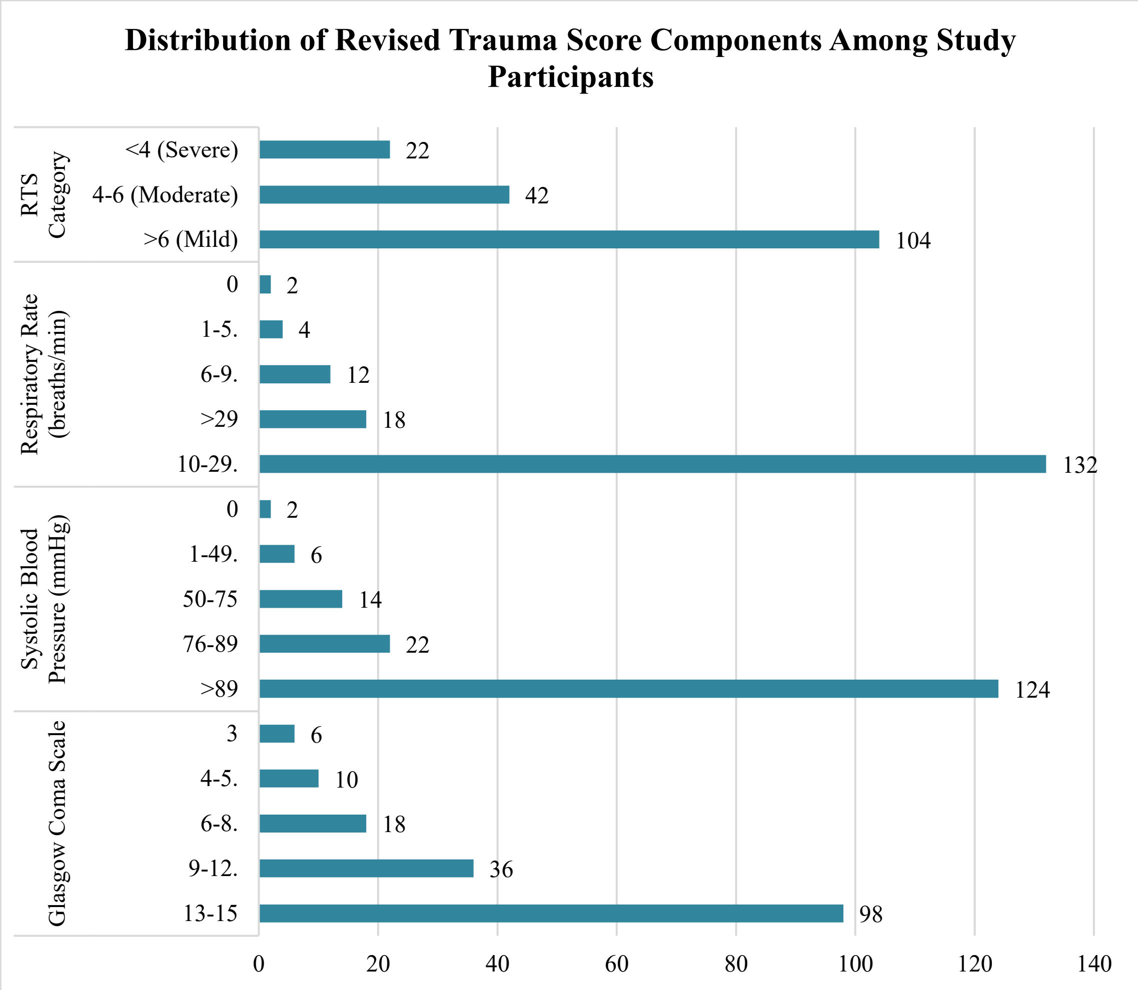


Fig: 2

Table 3: Comparison of RTS Parameters Between Survivors and Non-Survivors

Parameter	**Survivors (n=140)**	**Non-Survivors (n=28)**	**t-value/χ²**	**p-value**
Age (years) Mean ± SD	35.86 ± 13.92	45.21 ± 16.34	3.12	0.002*
GCS Mean ± SD	12.84 ± 2.46	6.18 ± 3.24	11.86	<0.001*
SBP (mmHg) Mean ± SD	118.62 ± 18.74	78.42 ± 26.38	9.24	<0.001*
RR (breaths/min) Mean ± SD	18.24 ± 4.86	12.68 ± 8.92	4.18	<0.001*
RTS Mean ± SD	6.82 ± 1.24	3.68 ± 1.72	11.42	<0.001*
GCS Coded Value Mean ± SD	3.62 ± 0.68	1.54 ± 1.26	10.84	<0.001*
SBP Coded Value Mean ± SD	3.78 ± 0.52	2.14 ± 1.18	9.68	<0.001*
RR Coded Value Mean ± SD	3.72 ± 0.64	2.46 ± 1.42	6.24	<0.001*
Hospital Stay (days) Mean ± SD	7.42 ± 4.86	4.28 ± 3.62	3.18	0.002*

ICU Admission n (%)	32 (22.9%)	22 (78.6%)	32.46	<0.001*

*GCS: Glasgow Coma Scale; SBP: Systolic Blood Pressure; RR: Respiratory Rate; RTS: Revised Trauma Score; SD: Standard Deviation; *Statistically significant (p<0.05)*

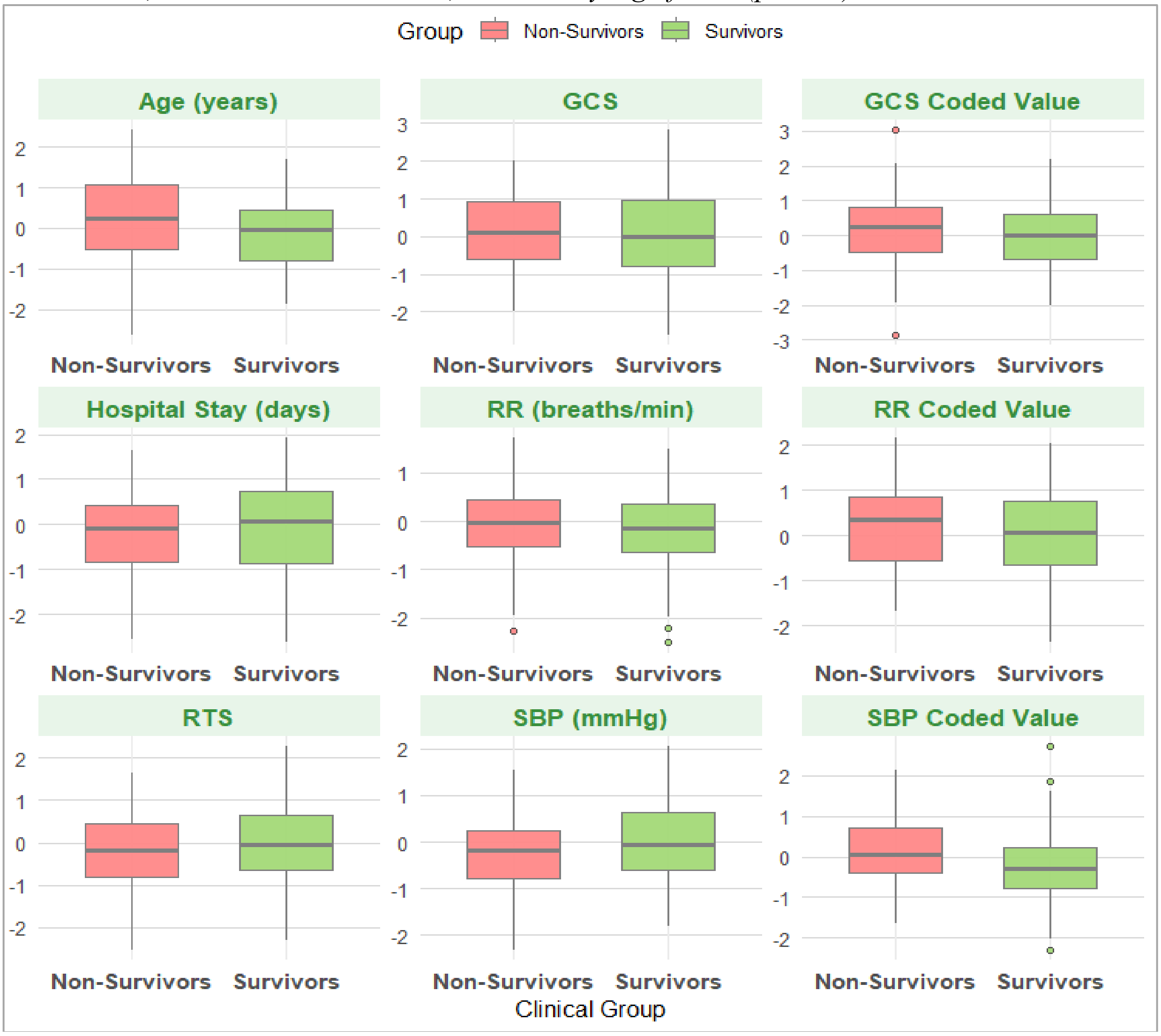


Fig: 3(i)

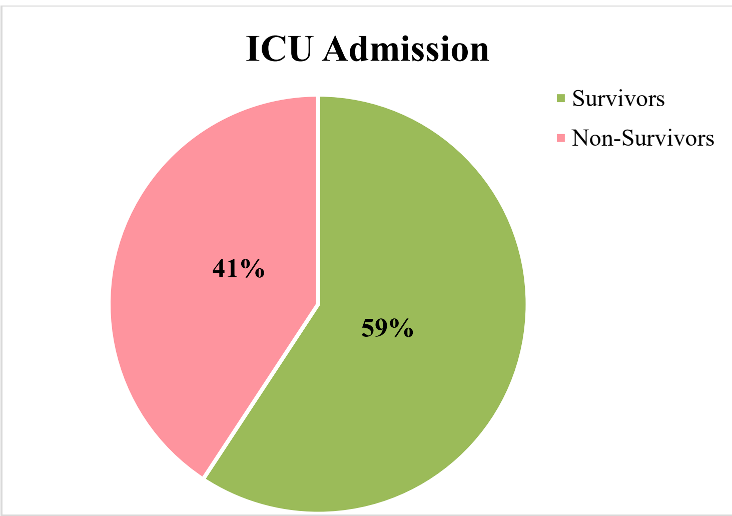


Fig: 3(ii)

Table 4: Predictive Accuracy of Revised Trauma Score for Mortality Prediction

Parameter	**Value**	**95% Confidence Interval**
Area Under ROC Curve (AUC)	0.924	0.876 - 0.972
Optimal RTS Cut-off	5.68	-
Sensitivity	89.3%	82.4 - 96.2
Specificity	87.1%	80.8 - 93.4
Positive Predictive Value	58.1%	48.6 - 67.6
Negative Predictive Value	97.6%	94.2 - 100.0
Positive Likelihood Ratio	6.92	4.86 - 9.84
Negative Likelihood Ratio	0.12	0.06 - 0.24
Diagnostic Accuracy	87.5%	82.1 - 92.9
Youden's Index	0.764	-
Hosmer-Lemeshow Test	$\chi^2 = 6.84$	p = 0.554

Logistic Regression Analysis for Mortality Predictors:

Variable	**Odds Ratio**	**95% CI**	**p-value**
RTS (per unit decrease)	2.84	1.92 - 4.18	<0.001*
Age >60 years	3.42	1.28 - 9.14	0.014*
GCS <9	8.64	3.42 - 21.82	<0.001*
SBP <90 mmHg	4.26	1.68 - 10.82	0.002*
ICU Admission	6.18	2.46 - 15.52	<0.001*

*CI: Confidence Interval; *Statistically significant (p<0.05)*

Discussion

The present study evaluated the factors predicting mortality in trauma patients using the Revised Trauma Score at Gouri Devi Institute of Medical Sciences and Hospital, West Bengal, over a six-month period. A total of 168 trauma patients were enrolled, and the findings provide valuable insights into the epidemiological profile, clinical characteristics, and predictive accuracy of RTS in this regional population.

The demographic analysis revealed a predominance of male patients (82.1%) over females (17.9%), with a male to female ratio of approximately 4.6:1. This gender disparity aligns with findings reported by multiple investigators globally and reflects the greater occupational and vehicular exposure experienced by males. Hariharan et al. (2011) reported similar male predominance (83.7%) in their study of 1000 trauma patients at Dayanand Medical College, Ludhiana, attributing this to occupational hazards and higher mobility patterns among males. The mean age of 37.42 years in our study, with the majority (69%) falling within the economically productive age group of 18-45 years, corresponds with observations by Nantulya and Reich (2002), who emphasized that road traffic injuries predominantly affect individuals during their most productive years, thereby amplifying the socioeconomic impact of trauma.

Road traffic accidents constituted the leading mechanism of injury (66.7%), followed by falls (16.7%) and assaults (9.5%). This pattern is consistent with the findings of Singh et al. (2011) and Stewart et al. (2016), who documented that motor vehicle collisions represent the primary etiology of traumatic injuries in developing countries. The World Health Organization has identified road traffic injuries as the eighth leading cause of mortality globally, with projections indicating escalation to the fifth leading cause by 2030 (Injuries and Violence Prevention Department, 2018). The predominance of blunt trauma (88.1%) over penetrating injuries (11.9%) in our study reflects the trauma epidemiology characteristic of Indian settings, differing from Western urban centers where penetrating trauma may be more prevalent.

The overall mortality rate of 16.7% (28 out of 168 patients) in our study is comparable to figures reported from similar tertiary care centers in India. Javali et al. (2019) documented a 17% mortality rate among elderly trauma patients at JSS Hospital, Mysuru, while Murlidhar and Roy (2001) reported mortality rates ranging from 10% to 21% across various Indian institutions. The mean RTS of 6.24 ± 1.86 in our cohort indicates that the majority of patients presented with moderate to good physiological status, though significant variation existed across the severity spectrum.

Analysis of RTS components demonstrated that Glasgow Coma Scale exhibited the strongest association with mortality outcomes. Non-survivors had significantly lower mean GCS scores (6.18 ± 3.24) compared to survivors (12.84 ± 2.46), with this difference achieving high statistical significance ($p<0.001$). This finding supports the weighted emphasis placed on GCS within the RTS formula, as originally proposed by Champion et al. (1989), who recognized the substantial impact of neurological status on trauma survival. Moore et al. (2006) validated this weighting through statistical analysis of 22,388 patients, confirming that GCS contributes most significantly to mortality prediction accuracy.

The Revised Trauma Score demonstrated excellent discriminatory ability for mortality prediction, with an area under the ROC curve of 0.924 (95% CI: 0.876-0.972). This performance exceeds the commonly accepted threshold of 0.80 for good predictive accuracy and aligns with values reported in international validation studies. Galvagno et al. (2019) reported an AUC of 0.841 for RTS in their analysis of 32,798 trauma patients from a Level I trauma center, while Yu et al. (2021) documented an AUC of 0.799 in Chinese emergency trauma patients. The superior performance observed in our study may reflect the patient population characteristics or differences in healthcare system factors affecting outcome variability.

The optimal RTS cutoff value of 5.68 identified through Youden's index analysis provided sensitivity of 89.3% and specificity of 87.1% for mortality prediction. This cutoff is consistent with recommendations from previous investigators. Champion et al. (1989) originally proposed an RTS threshold of less than 4 for identifying patients requiring trauma center care, while subsequent studies have suggested higher cutoff values for mortality prediction specifically. Kondo et al. (2011) identified optimal cutoffs ranging from 5.5 to 6.5 depending on the specific outcome measure and population characteristics in their analysis of the Japan Trauma Data Bank.

The high negative predictive value of 97.6% observed in our study has important clinical implications, suggesting that patients with RTS values above the threshold can be reliably identified as low-risk for mortality. This finding supports the utility of RTS for triage purposes, enabling appropriate allocation of limited intensive care resources. Conversely, the moderate positive predictive value of 58.1% indicates that additional factors beyond physiological parameters influence mortality outcomes, warranting comprehensive assessment incorporating anatomical injury severity and patient-specific variables.

The comparative analysis revealed statistically significant differences between survivors and non-survivors across all measured parameters. Non-survivors were significantly older (45.21 vs. 35.86 years, $p=0.002$), consistent with the established understanding that advancing age adversely affects trauma outcomes through diminished physiological reserve, increased comorbidity burden, and altered immune responses. Yousefzadeh-Chabok et al. (2016) demonstrated that age significantly influenced mortality prediction in elderly trauma patients, with TRISS incorporating age as a key prognostic variable for this reason.

The significantly lower systolic blood pressure (78.42 vs. 118.62 mmHg, $p<0.001$) and respiratory rate (12.68 vs. 18.24 breaths/min, $p<0.001$) among non-survivors reflect the hemodynamic instability and respiratory compromise that characterize severe trauma states. Sartorius et al. (2010) identified systolic blood pressure as an independent predictor of mortality in their development of the MGAP score, assigning specific point values based on pressure thresholds. The mean RTS of 3.68 among non-survivors compared to 6.82 among survivors ($p<0.001$) demonstrates the clear stratification achievable through this scoring system.

Multivariate logistic regression analysis identified several independent predictors of mortality. Each unit decrease in RTS was associated with 2.84-fold increased odds of death (95% CI: 1.92-4.18), confirming the score's prognostic significance. Glasgow Coma Scale below 9 emerged as the strongest individual predictor, with 8.64-fold increased mortality risk, supporting findings by Manoochehry et al. (2019), who reported GCS as the most influential component of physiological trauma scores in their meta-analysis.

Age greater than 60 years conferred 3.42-fold increased mortality risk, aligning with observations by Javali et al. (2019) regarding the vulnerability of geriatric trauma patients. The association between ICU admission and mortality (OR: 6.18) likely reflects confounding by indication, wherein sicker patients requiring intensive care inherently carry higher mortality risk. Shiraishi et al. (2019) incorporated age alongside physiological parameters in developing the TRIAGES score, demonstrating improved prognostication over RTS alone.

Conclusion

This study demonstrates that the Revised Trauma Score serves as an effective predictor of mortality among trauma patients presenting to the emergency department at Gouri Devi Institute of Medical Sciences and Hospital, West Bengal. The RTS exhibited excellent discriminatory ability with an AUC of 0.924 and optimal cutoff of 5.68 for mortality prediction. Glasgow Coma Scale emerged as the most influential component, followed by systolic blood pressure and respiratory rate. The findings support routine implementation of RTS calculation for trauma triage and prognostication in resource-limited settings, facilitating appropriate allocation of intensive care resources and timely identification of high-risk patients requiring aggressive management.

Recommendations

The Revised Trauma Score should be incorporated into routine emergency department protocols for initial assessment and triage of trauma patients. Healthcare institutions should ensure staff training in standardized RTS calculation and interpretation. Future multicenter studies with larger sample sizes incorporating anatomical scoring systems are recommended to develop region-specific prognostic models with enhanced predictive accuracy for Indian trauma populations.

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