RESEARCH ARTICLE

P-ISSN : 2527-4627
Warmadewa Medical Journal
Available online http://ejournal.warmadewa.ac.id/index.php/warmadewa_medical_journal

WMJ (Warmadewa Medical Journal), Vol. 11, No.1, May 2026, Page. 1-8

Diagnostic Accuracy of the New Trauma Score and Revised Trauma Score for Predicting In-Hospital Mortality in Adult Multiple Trauma Patients: A Single-Center Study at Prof. Dr. I.G.N.G. Ngoerah General Hospital

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Abstract

Multiple trauma remains a significant contributor to morbidity and mortality within emergency departments, necessitating rapid and precise initial assessments to prioritize treatment and predict patient prognosis effectively. This study evaluates the prognostic validity of the New Trauma Score (NTS) compared to the Revised Trauma Score (RTS) in predicting in-hospital mortality among multiple trauma patients at Prof. Dr. I.G.N.G. Ngoerah General Hospital. A single-center, retrospective cohort study was conducted involving a total of 61 multiple trauma patients selected via consecutive sampling rom patients admitted between January and December 2022. Statistical analyses were performed to determine the Area Under the Curve (AUC) of the Receiver Operating Characteristic for both scoring systems. Validity parameters encompassed sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. The optimal cut-off thresholds were established at 6.285 for the RTS and 15.5 for the NTS. Both the NTS and RTS demonstrated significant predictive performance regarding mortality in multiple trauma cases. The AUC was calculated at 0.885 for the NTS and 0.865 for the RTS, indicating robust discriminative capabilities for both metrics. While both scoring systems exhibited equivalent sensitivity, the NTS consistently outperformed the RTS in terms of specificity, PPV, NPV, and overall accuracy. These findings indicate that the NTS serves as a superior prognostic tool for predicting mortality among multiple trauma patients compared to the RTS. Furthermore, this study underscores the critical importance of local validation for trauma scoring systems and highlights the potential clinical utility of the NTS in optimizing emergency decision-making.

Keywords: Multiple Trauma, New Trauma Score, Revised Trauma Score, Mortality Prediction, Emergency Department.

INTRODUCTION

Trauma remains the third leading cause of death and disability globally. According to the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC), trauma-related injuries account for approximately 5.8 million fatalities annually across all age groups, translating to more than nine deaths every minute (1). Collectively, trauma cases represent roughly 18% of the global disease burden. Specifically, motor vehicle collisions contribute to more than one million deaths each year, with an additional 20 million to 50 million individuals sustaining significant injuries. Notably, over 90% of these vehicular collisions occur in developing countries, and trauma-related fatalities are projected to increase by 80% in low- and middle-income countries (1). At the local level, accidental deaths at Prof. Dr. I.G.N.G. Ngoerah General Hospital are predominantly associated with trauma, with multiple trauma accounting for 16% of cases, followed by head trauma (4%), abdominal trauma (1%), and thoracic trauma (1%) (2). Epidemiological data from 2018–2019 at this institution identified 51 patients with multiple trauma, with a mean age of 32.4 years and a marked male-to-female ratio of 7.6:1 (2). Objective assessment of injury severity requires a standardized system that integrates both clinical description and quantitative measurement. Injury grading systems translate the anatomical and physiological severity of trauma into a numerical index, which is subsequently used in emergency departments to support referral assessment and clinical decision-making. Accordingly, evaluating injury severity constitutes a critical component of effective trauma management. To date, several scoring systems have been developed to estimate patient survival probability, and these are generally categorized into three methodological approaches: anatomical, physiological, and combined systems (3).

In a previous study, Hakkoymaz et al. concluded that the Glasgow Coma Scale (GCS), the Revised Trauma Score (RTS), and other physiological indices serve as pivotal parameters in emergency settings, particularly for the early identification of high-risk elderly patients and prognostic evaluation in geriatric trauma cases (4). Champion et al. reported that the RTS has been widely used in clinical practice for more than three decades to predict trauma patient outcomes. This well-established physiological scoring system incorporates the GCS, systolic blood pressure (SBP), and respiratory rate (RR) (5). Despite its widespread adoption, RTS calculation involves a relatively complex mathematical framework requiring specific coefficients and categorical coding, which may reduce its practicality for rapid, real-time triage in high-acuity emergency departments (6). In response to these operational limitations, recent developments in trauma assessment have led to the introduction of the New Trauma Score (NTS). The NTS modifies the traditional framework by incorporating the actual GCS score, SBP, and peripheral oxygen saturation (SpO_2). In a validation study by Jeong et al., the NTS demonstrated superior discriminative performance compared with the RTS (5). Furthermore, this novel scoring system is methodologically less cumbersome to calculate manually than the RTS, Injury Severity Score (ISS), or Trauma and Injury Severity Score (TRISS). Nevertheless, a primary limitation of the NTS is its exclusion of patient age and the specific mechanism of injury (5,6).

Given these contrasting characteristics, there is a clear need to directly compare the prognostic validity of the NTS and RTS in predicting mortality among multiple trauma patients in local clinical settings. Currently, there is a substantial paucity of published literature evaluating the diagnostic accuracy of the NTS within the Indonesian healthcare system, particularly at Prof. Dr. I.G.N.G. Ngoerah General Hospital. This lack of local empirical evidence has important implications for clinical decision-making in high-acuity emergency settings. Without a validated and streamlined scoring system, clinicians may experience computational delays due to the complex coefficient-based framework of the RTS or encounter triage inaccuracies resulting from subjective respiratory rate assessment. Such limitations may lead to under-triage, in which critically injured patients with occult hypoxia are not promptly identified, or over-triage, which unnecessarily strains limited emergency resources. Consequently, establishing the localized predictive performance of these scoring systems is essential, as it directly influences the timeliness and accuracy of resource allocation, intensive care unit transfer decisions, and urgent surgical interventions. Therefore, this study aims to evaluate and compare the predictive performance of the NTS and RTS in order to generate empirical evidence for optimizing triage efficiency, reducing clinical decision-making errors, and improving survival outcomes in emergency trauma care.

METHODS

This study employed a single-center, observational, retrospective cohort design to evaluate and compare the prognostic validity of the New Trauma Score (NTS) and the Revised Trauma Score (RTS) among patients with multiple trauma. The study protocol was formally approved by the Institutional Review Board (Ethics Committee) under reference number 1887/UN14.2.2.VII.14/LT/2024. The study was conducted in the Emergency Department of Prof. Dr. I.G.N.G. Ngoerah General Hospital, Denpasar, Indonesia.

A total of 61 subjects were selected using consecutive sampling from the hospital's centralized medical registry for the period from January 1, 2022, to December 31, 2022. To ensure a homogeneous and clinically relevant sample, participants were screened according to predefined eligibility criteria. The inclusion criteria comprised all adult patients (aged ≥18 years) with multiple trauma, defined as an Injury Severity Score (ISS) >16, who were admitted to the Emergency Department during the study period. Patients were excluded if they had incomplete medical records, were declared dead on arrival, were referred to another healthcare facility, or were discharged within less than 24 hours of admission.

Clinical data were retrospectively extracted from electronic and physical medical records. The independent variables comprised the initial physiological parameters required to calculate the baseline RTS and NTS, which were obtained upon the patient's arrival at the Emergency Department. These parameters included baseline GCS, SBP, RR, and SpO_2. The primary dependent (outcome) variable was in-hospital mortality, operationalized as the definitive clinical status of the patient (survived or deceased) at the end of the follow-up period.

To evaluate and compare the prognostic discrimination capabilities of both scoring systems, data were analyzed using Receiver Operating Characteristic (ROC) curve analysis. The overall predictive performance of the NTS and RTS was quantified using the Area Under the Curve (AUC) along with their respective p-values. The optimal diagnostic cut-off thresholds for predicting mortality were determined by maximizing the combined sensitivity and specificity (Youden's Index). Finally, the diagnostic validity of each scoring system at the designated cut-off points was systematically assessed using a comprehensive set of performance metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy.

RESULTS

During the one-year study period, a total of 61 multiple trauma patients met the eligibility criteria. Demographically, the sample was predominantly male, accounting for more than four-fifths of the total participants. The cohort primarily represented a young-to-middle-aged adult population, as evidenced by a median age of 31 years (Table 1).

Physiologically, patients presented to the Emergency Department with a varied spectrum of clinical stability. Upon initial admission, the cohort exhibited a tendency toward mild tachypnea and borderline tachycardia, although the median systolic blood pressure remained within hemodynamically stable limits. Neurologically, most patients maintained relatively preserved consciousness, with a median baseline GCS score of 14, although a substantial subset presented with severe neurological impairment. Based on these initial physiological findings, both baseline scoring systems showed distributions skewed toward the higher, more stable score ranges. Ultimately, the overall in-hospital mortality rate in this cohort was 26.2%, with nearly three-quarters of patients surviving to hospital discharge.

Table 1. Baseline Characteristics of the Subjects

Variable	n (%)	Median (IQR)
Gender		
- Male	52 (85.2)	
- Female	9 (14.8)	
Age (years)		31 (23.0-46.5)
Systolic Blood Pressure (mmHg)		110 (100.0-120.0)
Heart Rate (beats/minute)		98 (90.0-110.0)
Respiratory Rate (breaths/minute)		24 (20.0-24.0)
Temperature (°C)		36.5 (36.5-36.7)
Pheripheral Oxygen Saturation (SpO2,%)		95 (92.0-97.0)
Glasgow Coma Scale (GCS)		14 (10.0-15.0)
Revised Trauma Score (RTS)		7.84 (6.90-7.84)
New Trauma Score (NTS)		20.00 (16.00-22.00)
Clinical Outcome		
- Survival	45 (73.8)	
- Death	16 (26.2)	

The ROC curve analysis demonstrated that both triage tools had excellent and statistically significant abilities to differentiate patient survival outcomes (Figure 1).

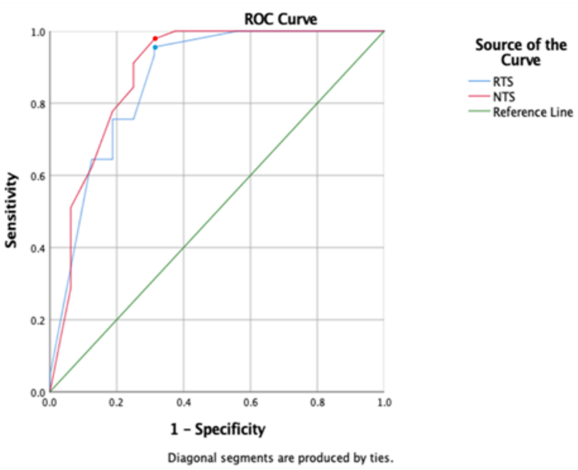

Figure 1. ROC Curve

Based on standard lexicographic criteria for diagnostic accuracy, an Area Under the Curve (AUC) value between 0.80 and 0.90 denotes good-to-excellent discriminative performance. While the traditional Revised Trauma Score (RTS) framework provided a highly robust prediction model, the New Trauma Score (NTS) consistently achieved a higher area under the curve (Table 2). Specifically, the probability of the NTS correctly distinguishing the definitive clinical outcome was 88.5%, outperforming the RTS framework by a margin of 2.0%.

Table 2. AUC

Predictible Variable	AUC	p-value	95% Confidence Interval (95% CI)
RTS	0.865	<0.001	0.746-0.984
NTS	0.885	<0.001	0.768-1.000

This incremental gain in the area under the curve underscores the enhanced discriminative capacity achieved by integrating raw consciousness metrics and objective tissue oxygenation into the novel scoring system. Furthermore, the p-values for both scoring models were highly significant ($p < 0.001$), indicating that the prognostic capabilities of these triage systems were statistically significant and unlikely to have occurred by chance. Ultimately, these findings substantiate that while both modalities are highly clinically viable, the NTS provides superior discriminative performance in distinguishing between high-risk patients who succumb to multiple trauma and those who survive to hospital discharge.

To establish the most clinically applicable thresholds for predicting mortality, the coordinates of the ROC curves were optimized by maximizing Youden's Index (YI). The analysis identified that the NTS achieved its peak balancing index at a slightly higher threshold (YI = 0.665) than the RTS (YI = 0.643). Consequently, these optimal coordinates established the definitive clinical cut-off thresholds at 6.285 for the RTS and 15.5 for the NTS (Table 3), which were subsequently utilized to evaluate the diagnostic performance of each score.

Table 3. Optimal Diagnostic Cut-off Profiles and Associated Indexes

Scoring System	Optimal Cut-off	Sensitivity	Specificity	Youden index (YI)
Revised Trauma Score (RTS)	6.285	0.956	0.687	0.643
New Trauma Score (NTS)	15.5	0.978	0.687	0.665

Using the established cut-off values, the diagnostic validity profiles—including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy—were systematically cross-compared (Table 4).

Table 4. Comparative Diagnostic Performance Metrics of RTS and NTS

Validation Metrics	RTS	NTS
Sensitivity	95.6%	97.8%
Specificity	68.8%	68.8%
Positive predictive value	84.6%	91.7%
Negative predictive value	89.6%	89.8%
Accuracy	88.5%	90.2%

Interestingly, both the RTS and NTS exhibited an identical capacity for correctly identifying surviving patients, generating identical specificity profiles. However, the operational superiority of the NTS became evident across all other validation parameters. The NTS demonstrated a superior ability to correctly identify mortality cases, thereby establishing a higher sensitivity than the RTS. Furthermore, this enhanced performance directly translated into a substantially higher positive predictive value for the NTS, meaning that a critical score on the NTS was a more reliable indicator of true mortality risk. Ultimately, by mitigating triage misclassifications, the NTS achieved a superior overall diagnostic accuracy of 90.2%, confirming its clinical advantage over the conventional RTS model.

DISCUSSION

Demographic and Baseline Physiological Profiles

The epidemiological findings of this study confirm that multiple trauma predominantly affects the young-to-middle-aged productive population, with a median cohort age of 31 years. This demographic trend aligns with global data indicating that trauma is the leading cause of mortality in individuals under the age of 45 (7). Furthermore, a profound gender disparity was observed, with males accounting for 85.2% of the sample. This distribution is consistent with national data from the 2018 Riskesdas report, which noted a higher injury prevalence among Indonesian males (11.0%) than females (7.4%) (8), as well as international literature reporting a male predominance of up to 83.7% in major trauma registries (7). This vulnerability is strongly linked to greater exposure to high-risk activities, hazardous occupations, and motor vehicle collisions among young adult males in developing urban regions such as Denpasar.

Prognostic Discrimination and Component-Level Mechanisms

A critical finding of this investigation is the superior discriminative capacity of the NTS over the conventional RTS, as evidenced by their respective AUC values (0.885 versus 0.865). Although both physiological indices demonstrated robust and statistically significant prognostic capabilities ($p < 0.001$), the 2.0% incremental gain achieved by the NTS underscores the methodological advantages of its structural modifications. These findings corroborate validation studies conducted by Kondo et al. and Shrestha et al., which demonstrated that the NTS yields enhanced predictive accuracy, particularly in hemodynamically unstable cohorts (9,10).

The operational superiority of the NTS can be explained by two fundamental pathophysiological and practical mechanisms. The traditional RTS framework relies on respiratory rate (RR), a parameter that is notoriously difficult to measure accurately in a high-acuity, overcrowded emergency department. Clinicians frequently resort to subjective visual estimations, and the parameter itself may be confounded by patient anxiety, pain, and compensatory hyperventilation. In contrast, the NTS replaces RR with peripheral oxygen saturation (SpO_2). Measured continuously via pulse oximetry, SpO_2 provides an objective, rapid, and continuous assessment of systemic oxygenation, allowing the detection of occult hypoxia that visual respiratory assessments often fail to identify (9,10). In addition, the NTS incorporates the actual raw Glasgow Coma Scale (GCS) score (ranging from 3 to 15) directly into its mathematical model. By contrast, the RTS employs a rigid categorical coding system (0 to 4) that groups broad ranges of consciousness levels into a limited number of categories. By preserving the raw scale, the NTS provides a more linear and granular representation of neurological decline in patients with concomitant traumatic brain injuries, enabling the statistical model to detect subtle but clinically significant changes in intracranial status (11–13).

Optimization of Cut-Off Thresholds and Triage Parameters

Through the application of Youden's Index, the optimal diagnostic cut-off thresholds for this localized Indonesian cohort were established at 6.285 for the RTS and 15.5 for the NTS. At these thresholds, an intriguing diagnostic profile emerged: both scoring models demonstrated an identical sensitivity of 68.8%, indicating an equivalent capacity to correctly identify true positive mortality cases. However, the clinical advantage of the NTS lay in its superior specificity (97.8% versus 95.6%) and positive predictive value (PPV; 91.7% versus 84.6%).

In an acute emergency setting, a high PPV is a critical asset. The 91.7% PPV demonstrated by the NTS implies that among all patients mathematically classified as high-risk, the vast majority ultimately experience mortality outcomes (14,15). This substantially minimizes the false-positive rate, thereby reducing the risk of over-triage, in which non-severe patients are erroneously misclassified as critically ill, and ensuring that limited emergency resources, such as operating theaters and intensive care unit (ICU) beds, are not unnecessarily exhausted.

When contextualized within the broader literature, the performance metrics observed in our study demonstrate notable geographical and institutional variations. For example, Alam et al. reported an exceptionally high RTS accuracy of 98% with an AUC of 0.988 at a cut-off of 6.37 (7), which exceeds the 88.5% accuracy observed in our cohort. Conversely, in evaluating the NTS, Rio et al. reported a substantially lower AUC of 0.734 and an accuracy of 84% using a cut-off threshold of 9.6 (16).

These marked disparities are likely attributable to differences in sample size, institutional triage protocols, and the distinct racial or ethnic distributions of the study populations (16). More importantly, our sample consisted exclusively of severe multiple trauma patients (ISS > 16), whereas other validation studies often evaluated heterogeneous trauma cohorts. The fact that the NTS maintained a high accuracy (90.2%) and specificity (97.8%) within a high-severity cohort reinforces its utility as a reliable tool for identifying "concealed" or clinically stable-appearing patients who carry a high risk of sudden deterioration due to occult hypoxemic or neurological insult (17).

Limitations and Future Research Directions

Despite its strong empirical findings, several limitations must be acknowledged. First, the retrospective design inherently relies on the quality of archived data, introducing potential documentation bias, as physiological parameters may have been missing or subject to recording errors. Second, the single-center nature of the study and the relatively modest sample size (n = 61) limit the generalizability of the findings across the broader Indonesian healthcare system.

To build upon these findings, future research should focus on large-scale, prospective, multicenter trials that evaluate the NTS and RTS immediately upon patient presentation, thereby minimizing historical documentation bias. Furthermore, future investigations should assess the prognostic value of combining the physiological NTS with anatomical indices, such as the Injury Severity Score (ISS), to construct a modernized iteration of the Trauma and Injury Severity Score (TRISS) framework (18). Such a hybrid system could further optimize both short-term (24-hour) and long-term (30-day) mortality prediction, ultimately advancing emergency trauma management and improving survival rates.

CONCLUSION

In summary, this investigation demonstrates that the New Trauma Score (NTS) exhibits superior diagnostic validity compared with the conventional Revised Trauma Score (RTS) in predicting in-hospital mortality among multiple trauma patients in the acute care setting of Prof. Dr. I.G.N.G. Ngoerah Hospital.

Although both physiological indices demonstrated an identical sensitivity profile, the clinical and statistical superiority of the NTS is strongly supported by its higher specificity, improved positive and negative predictive values, and superior overall diagnostic accuracy. These findings underscore the methodological advantage of substituting the highly subjective and error-prone respiratory rate parameter with objective peripheral oxygen saturation, while also utilizing uncoded, granular Glasgow Coma Scale values. Ultimately, by reducing triage misclassification and maximizing predictive precision, the NTS provides emergency clinicians with a highly reliable, rapid, and objective decision-making tool. Its integration into emergency triage protocols holds substantial potential for optimizing critical resource allocation and facilitating timely definitive care for high-risk trauma patients.

ACKNOWLEDGMENTS

The author would like to thank all parties who supported the preparation of this research article, both morally and materially.

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