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# Early Risk Stratification in a High-Mortality Study of Adult Trauma Patients: A Comparative Validation of RTS, SI, and ISS

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**ABSTRACT**

**Introduction:** Accurate, early risk stratification is paramount in managing severe trauma, especially in resource-limited settings. This study aimed to compare the predictive performance of the revised trauma score (RTS), shock index (SI), and injury severity score (ISS) for in-hospital mortality in a group of severely injured adult trauma patients at a tertiary center in Indonesia. **Methods:** A retrospective analysis was conducted on a purposively selected study population of 100 adult trauma patients (age 20-60) admitted to the Emergency Department of Dr. Saiful Anwar Regional General Hospital over a three-month period in 2023. This selection method yielded a high-mortality sample (50% mortality) to ensure sufficient statistical power for analyzing fatal outcomes. The predictive performance of RTS, SI, and ISS was evaluated using individual logistic regression models. Discriminatory ability was assessed by calculating the area under the receiver operating characteristic curve (AUC-ROC) for each score. Model calibration was evaluated using the Hosmer-Lemeshow goodness-of-fit test. **Results:** All three scoring systems were significant predictors of mortality in individual regression analyses. The injury severity score (ISS) demonstrated the highest discriminatory power for predicting mortality with an AUC of 0.88 (95% CI, 0.81-0.95). The revised trauma score (RTS) also showed good discrimination with an AUC of 0.83 (95% CI, 0.75-0.91). The Shock Index (SI) was a significant predictor but had the most modest discriminatory ability with an AUC of 0.76 (95% CI, 0.67-0.85). All models were well-calibrated. **Conclusion:** In this study of severely injured adult trauma patients, the anatomically-based ISS was the most accurate predictor of mortality. The physiological scores, RTS and SI, remain valuable for their utility in rapid, initial patient assessment. The findings support a complementary approach, using the simple physiological scores for immediate triage and the more comprehensive ISS for definitive prognostication.

## 1. Introduction

Trauma persists as a profound global health crisis, a relentless engine of mortality and long-term disability that disproportionately affects the young and economically productive.[1] The World Health Organization has consistently documented that injuries are a leading cause of death worldwide, with the stark reality that nearly 90% of this burden falls upon low- and middle-income countries (LMICs).[2] This disparity is not merely a statistic; it represents a critical failure of global health equity, where the systems designed to save lives are most strained in the regions where they are needed most. Indonesia, as the world's fourth most populous nation, exists at the epicenter of this challenge. A burgeoning economy and rapid motorization have led to an epidemic of road traffic injuries, which, combined with interpersonal violence and occupational hazards, impose a crushing weight on the nation's emergency medical infrastructure.[3] For the clinician at the bedside and the patient on the stretcher, the moments following a catastrophic injury are a crucible. The "golden hour" concept, while a simplification, captures an essential truth: the trajectory towards survival or death is often determined by the speed, precision, and appropriateness of interventions delivered in the initial phase of care. The emergency department (ED) is the primary arena for this struggle, a dynamic environment where life-altering decisions must be made under conditions of extreme stress and informational uncertainty.[4] The fundamental process governing this environment is triage—the disciplined sorting of patients by urgency to allocate limited resources to those in greatest need. The integrity of the triage process is paramount. An error in judgment can have cascading consequences. Undertriage, the failure to recognize the severity of a critically injured patient, can lead to fatal delays in life-saving interventions like hemorrhage control or neurosurgical decompression.[5] Conversely, overtriage, the misallocation of high-level resources to less injured patients, can paralyze an emergency system, denying timely care to others and precipitating systemic failure, a particularly devastating outcome in resource-constrained hospitals. To fortify the triage process against subjectivity and to standardize the assessment of the injured, a panoply of trauma scoring systems has been developed and refined over the past half-century. These scores are the clinical language of trauma, translating a complex constellation of signs and injuries into a single, quantitative metric.[6] This allows for objective risk stratification, clear communication among providers, and robust quality assurance. These systems can be broadly classified into two philosophical approaches: physiological scores, which capture the degree of functional derangement in a patient's vital systems, and anatomical scores, which quantify the physical burden of their injuries.

The revised trauma score (RTS) is a venerable and widely used physiological tool. As a composite of the Glasgow coma scale (GCS), systolic blood pressure, and respiratory rate, it provides a rapid, integrated snapshot of a patient's neurological, cardiovascular, and respiratory status.[7] Its elegant simplicity and reliance on basic clinical signs make it an indispensable instrument for both pre-hospital and initial ED assessment. A declining RTS score is a clear and immediate signal of escalating physiological distress and an increased probability of mortality. An even simpler, yet remarkably potent, physiological tool is the shock index (SI).[8] Calculated as the ratio of heart rate to systolic blood pressure, the SI functions as a sensitive canary in the coal mine for hemodynamic instability. It frequently becomes elevated during the phase of compensated shock, where the body's sympathetic nervous system masks ongoing blood loss with tachycardia, often before the ominous sign of hypotension appears. The SI thus unmasks this hidden danger, identifying patients who are at high risk of sudden collapse and require immediate, aggressive resuscitation. The benchmark for quantifying the physical insult of trauma is the injury severity score (ISS). The ISS is an anatomical scoring system derived from the abbreviated injury scale (AIS), a comprehensive, dictionary-like system that assigns a severity grade to thousands of specific injuries.[9] By mathematically aggregating the severity of injuries across the three most affected body regions, the ISS produces a single, powerful metric of the patient's total anatomical damage. A high ISS is one of the most robust predictors of mortality, morbidity, length of stay, and functional outcome in trauma patients. Its unparalleled predictive power makes it the gold standard for trauma research and auditing. However, its clinical utility for immediate triage is limited by its complexity; a definitive ISS can often only be calculated after comprehensive diagnostic imaging and, in some cases, surgical exploration has been completed.

While these scoring systems form the bedrock of modern trauma assessment, their predictive accuracy is not a universal constant. The overwhelming majority of validation studies have been conducted within the sophisticated, well-funded, and highly organized trauma networks of North America and Europe. The direct extrapolation of these findings to the vastly different clinical landscape of LMICs like Indonesia is fraught with uncertainty. Trauma care in this context is frequently shaped by factors such as prolonged pre-hospital transport times, limited access to advanced diagnostic modalities like immediate pan-scan CT, and variable availability of critical resources such as blood products and interventional radiology. These systemic realities can fundamentally alter a patient's physiological trajectory and potentially the performance of scoring systems calibrated in other environments. Therefore, a rigorous, context-specific validation of these foundational tools is not a redundant academic pursuit, but a clinical and ethical imperative. The scientific novelty of this investigation is its specific and intentional focus on a group of the most severely injured adult trauma patients within a representative Indonesian tertiary hospital. By constructing and analyzing a high-mortality sample, this study provides a unique lens through which to examine the performance of these scoring systems at the critical end of the severity spectrum—precisely for the patient population where accurate prognostication is most challenging and most vital. While many studies assess performance across a heterogeneous mix of minor and major trauma, this work concentrates on the fundamental clinical question of differentiating survival from death when the physiological and anatomical insults are maximal. This approach allows for a robust test of the limits and capabilities of each score under the most demanding clinical conditions.[10] The aim of the study was to evaluate and compare the predictive performance of the revised trauma score, shock index, and injury severity score for in-hospital mortality in a group of severely injured adult trauma patients.

## 2. Methods

A single-center, retrospective analysis was conducted on a purposively selected population of trauma patients. The study was performed at the Emergency Department of Dr. Saiful Anwar Regional General Hospital in Malang, East Java, Indonesia. This facility functions as a provincial-level, tertiary referral hospital and is one of the primary trauma centers for the region, managing a high volume of complex injuries. This setting provides a rich source of data on severe trauma representative of urban centers in Indonesia. Patient data were retrospectively collected from medical records for admissions occurring during a three-month period from September 1st, 2023, to November 30th, 2023. To ensure sufficient statistical power to analyze predictors of the fatal outcome, a purposive sampling strategy was employed to create a high-mortality sample. The hospital's medical records database was queried to identify all trauma admissions during the study period. From this pool, a sample of 100 patients was selected to achieve a balanced distribution of outcomes, resulting in a final study sample with a 50% mortality rate (50 survivors, 50 non-survivors). This non-probabilistic sampling method was chosen specifically to test the performance of the scoring systems in a population with a high prevalence of the primary outcome (death), which is a common approach in the development and validation of prognostic models. It must be explicitly noted that this study population is therefore not representative of the general trauma population at the institution but is instead a concentrated sample of the most severely injured patients.

The selection of patient records was guided by the following predefined criteria: Inclusion Criteria: Patients aged between 20 and 60 years, inclusive. This age range was selected to create a homogenous adult, non-geriatric study sample, thereby minimizing the confounding effects of the unique physiological responses to trauma seen in pediatric and elderly populations; A primary diagnosis of physical trauma resulting from mechanisms such as blunt force, penetrating injury, or burns; Availability of a complete medical record containing all data points necessary for the calculation of RTS, SI, and ISS, and a definitive record of the final in-hospital outcome. Exclusion Criteria: Patients declared dead on arrival at the ED; Patients with incomplete, illegible, or missing medical records; Patients who were transferred to another facility before a final outcome could be determined; Patients with significant, pre-existing comorbidities that could act as major independent confounders for mortality. This was operationally defined as a Charlson Comorbidity Index score of 3 or greater, indicating a high burden of chronic disease. A standardized data extraction form was used to collect information from the selected medical records. To ensure consistency, all data were extracted by a single researcher trained in the study protocol. Independent Variables (Predictors): Revised Trauma Score (RTS): Calculated using the first set of vital signs documented by a physician or nurse in the ED resuscitation bay. The formula used was the standard weighted equation: RTS = (0.9368 × GCS code) + (0.7326 × SBP code) + (0.2908 × RR code). The Glasgow Coma Scale (GCS), Systolic Blood Pressure (SBP), and Respiratory Rate (RR) were coded on a 0-4 scale per standard RTS methodology. Shock Index (SI): Calculated from the same initial set of vital signs as the RTS, using the formula: SI = Heart Rate / Systolic Blood Pressure. Injury Severity Score (ISS): This was calculated based on a thorough review of all clinical notes, radiological reports (X-ray, CT, ultrasound), and operative summaries to determine the severity of injuries in each of six body regions. Each injury was assigned an abbreviated injury scale (AIS) code (2005 version, 2008 update) by a trained research assistant. The final ISS was calculated by summing the squares of the highest AIS scores from the three most severely injured body regions. Dependent Variable (Outcome): In-Hospital Mortality: A binary variable recorded as 'Survived' if the patient was discharged alive from the hospital, or 'Deceased' if the patient died from any cause during the index hospitalization for the traumatic injuries. Recognizing the potential for subjectivity in retrospective ISS calculation, a quality control measure was implemented. A second, independent reviewer, who was also trained in AIS coding, blindly scored a random subset of 20% of the patient charts (n=20). The inter-rater reliability for the calculated ISS was then assessed using Cohen's kappa statistic, which yielded a value of $\kappa = 0.84$, indicating a high degree of agreement between the two coders and supporting the reliability of the ISS data.

All data were analyzed using IBM SPSS Statistics, Version 26. The statistical analysis plan was designed to address the study's hypotheses while accounting for the nature of the data and study design: 1) Descriptive Statistics: The characteristics of the study population were summarized using frequencies and percentages for categorical variables (gender, mechanism of injury) and means with standard deviations (SD) for continuous variables (age, trauma scores); 2) Assessment of Predictive Performance: To avoid the statistical instability associated with severe multicollinearity, a multivariate regression model including all three scores was not used. Instead, the predictive performance of each scoring system (RTS, SI, ISS) was assessed independently; Logistic Regression: Three separate binary logistic regression models were constructed, with in-hospital mortality as the dependent variable and each of the scores (RTS, SI, and ISS) entered as the sole continuous predictor variable in its respective model. The results were reported as Odds Ratios (OR) with 95% Confidence Intervals (CI); Discriminatory Ability: The primary metric for comparing the performance of the scores was their ability to discriminate between survivors and non-survivors. This was quantified by calculating the Area Under the Receiver Operating Characteristic Curve (AUC-ROC) for each of the three models. An AUC of 0.5 indicates no discrimination better than chance, while an AUC of 1.0 represents perfect discrimination. The AUC values and their 95% CIs were reported; Model Calibration: The calibration of each model, which is the agreement between predicted probabilities and observed outcomes, was assessed using the Hosmer-Lemeshow goodness-of-fit test. A non-significant p-value ($p > 0.05$) indicates that the model is well-calibrated; 3) Correlation Analysis: To understand the relationship between the scores, a Pearson correlation matrix was generated. This was done with the a priori understanding that the purposive sampling method might inflate the correlation coefficients, and the results were interpreted in that context. A p-value of $< 0.05$ was considered statistically significant for all analyses.

The study protocol received full approval from the Institutional Review Board and Ethics Commission of Dr. Saiful Anwar Regional General Hospital (Approval No. 400 / 043 / K.3 / 102.7 / 2023). The research was conducted in strict adherence to the principles outlined in the Declaration of Helsinki. Given the retrospective nature of the study and the use of de-identified data, the ethics committee granted a waiver of the requirement for individual patient consent. All patient data were anonymized prior to analysis to protect confidentiality.

## 3. Results

Figure 1 provides a comprehensive summary of the baseline characteristics of the high-mortality study population, which comprised 100 trauma patients. The data reveals a significant gender disparity, with males representing a 64% majority of the cases, while females constitute the remaining 36%. The mean age of the patients in this study was 43.8 years, with a standard deviation of ±11.2 years, indicating a concentration of severe trauma among the adult, economically productive population.A critical finding of this study is the 50% mortality rate, with an equal split of 50 patients surviving and 50 patients succumbing to their injuries. This highlights the extreme severity of the cases included in this analysis. The predominant mechanisms of injury were related to traffic incidents; multiple-vehicle accidents were the most common cause at 30%, followed closely by single-vehicle accidents at 24%. Together, these road-related events accounted for over half of all injuries. Other significant causes included burns (20%), falls from height (14%), and penetrating injuries (12%), illustrating the diverse aetiologies of severe trauma managed at this tertiary center.

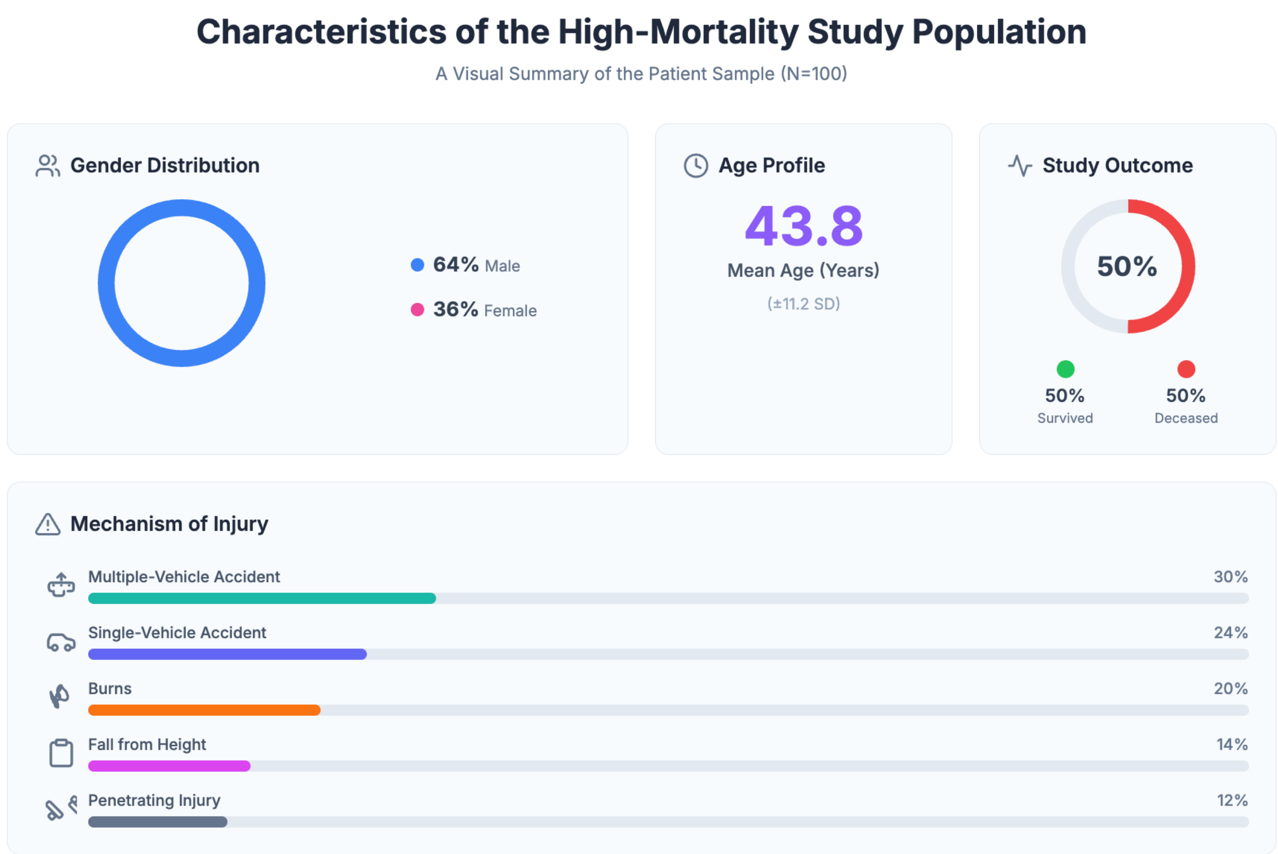


Figure 1. Characteristics of the high-mortality study population.

Figure 2 provides a detailed statistical summary of the initial trauma scores for the high-mortality study population, graphically representing the severe nature of the injuries sustained. The Revised Trauma Score (RTS), a measure of physiological stability, had a mean score of 6.8 with a standard deviation of ±2.1. Given that the normal score is 7.84, this lower average indicates significant physiological derangement across the study group. The wide range of observed scores, from a near-fatal 1.16 to a normal 7.84, highlights the diverse spectrum of physiological responses to severe injury. The shock index (SI), which assesses hemodynamic instability, showed a mean index of 1.1 (±0.4). An SI greater than 0.9 is generally considered abnormal and indicative of shock. The elevated mean and a range extending up to 2.1 confirm that a state of circulatory compromise was prevalent among these patients. Reflecting the anatomical damage, the injury severity score (ISS) had a mean score of 28.5 (±10.3). An ISS greater than 15 is typically classified as major trauma, and a score greater than 24 indicates a very severe injury with a high risk of mortality. The high mean score and a range from 9 to 50 underscore the extensive and severe anatomical burden carried by this patient population, aligning with the study's focus on high-mortality cases.

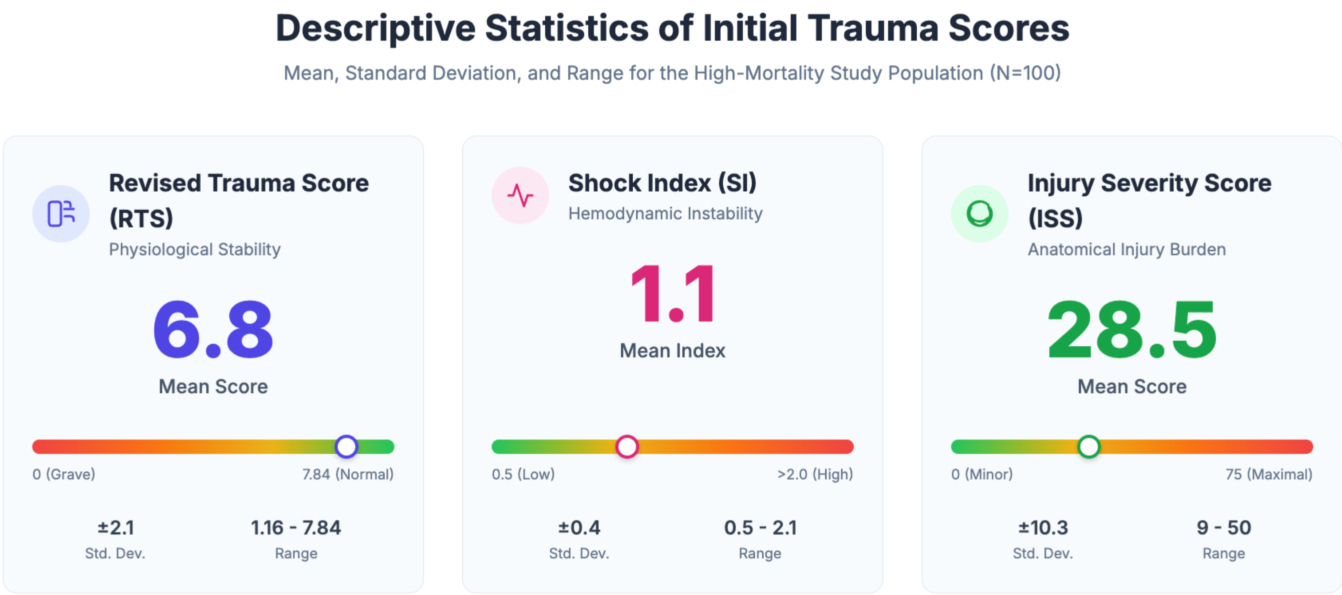


Figure 2. Descriptive statistics of initial trauma scores.

Figure 3 presents a comparative analysis of the predictive performance of the three trauma scoring systems—ISS, RTS, and SI—in determining the likelihood of in-hospital mortality. The primary metric for this comparison is the area under the curve (AUC) from the receiver operating characteristic (ROC) analysis, which measures a score's ability to discriminate between patients who survived and those who died. The injury severity score (ISS), which quantifies the anatomical burden of injury, emerged as the most powerful predictor, with an AUC of 0.88 (95% CI: 0.81 - 0.95). This indicates a high degree of accuracy in distinguishing between survivors and non-survivors. The odds ratio of 1.15 confirms that for every one-point increase in a patient's ISS, the odds of mortality increase by 15%. The revised trauma score (RTS), a measure of physiological stability, also demonstrated strong predictive performance with an AUC of 0.83 (95% CI: 0.75 - 0.91). Its odds ratio of 0.45 signifies a protective effect; for every one-point increase in a patient's RTS, the odds of mortality are more than halved, decreasing by 55%. The Shock Index (SI), a simple marker of hemodynamic instability, was a significant predictor but showed the most modest performance of the three, with an AUC of 0.76 (95% CI: 0.67 - 0.85). However, its odds ratio of 4.12 was the most dramatic, indicating that for every one-unit increase in a patient's SI, the odds of mortality more than quadrupled, highlighting its value as a potent red flag for severe circulatory compromise.

Figure 4 visually compares the discriminatory ability of the three trauma scores—ISS, RTS, and SI—using receiver operating characteristic (ROC) curves to predict in-hospital mortality. The area under the curve (AUC) serves as the primary metric, where a higher value indicates a better ability to distinguish between patients who will live and those who will die. The curve representing the injury severity score (ISS) is positioned closest to the top-left corner, corresponding to the highest AUC of 0.88 (95% CI: 0.81 - 0.95). This confirms its superior performance as the most accurate predictor among the three. The revised trauma score (RTS) also demonstrated strong predictive power, with its curve showing significant discrimination and yielding an AUC of 0.83 (95% CI: 0.75 - 0.91). The shock index (SI), while a statistically significant predictor, had the most modest performance, with its curve positioned lowest and resulting in an AUC of 0.76 (95% CI: 0.67 - 0.85). All three curves lie well above the diagonal dashed line (which represents an AUC of 0.5, or no better than chance), confirming that all scores have meaningful predictive value.

Figure 5 displays the results of the Hosmer-Lemeshow goodness-of-fit test, which assesses the calibration of each predictive model. Calibration refers to how well the predicted probabilities of mortality match the actual observed mortality rates. A well-calibrated model is one where, if it predicts a 20% risk of death for a group of patients, approximately 20% of those patients actually die. The results indicate that all three models demonstrated good calibration. For the ISS Model, the Chi-Square value was 8.91 with a p-value of 0.350. The RTS Model yielded a Chi-Square value of 10.24 and a p-value of 0.248. Finally, the SI Model had a Chi-Square value of 7.66 with a p-value of 0.467.In all three cases, the p-value was substantially greater than the 0.05 threshold for significance. This non-significant result is the desired outcome, as it indicates that there is no statistical evidence of a difference between the predicted and observed mortality rates. Therefore, it can be concluded that all three scoring systems, when modeled individually, produce reliable and well-calibrated mortality predictions for this study population.

## 4. Discussion

This study was designed to critically evaluate and compare the performance of three cornerstone trauma scoring systems—RTS, SI, and ISS—in predicting mortality within a unique, high-risk group of adult trauma patients in Indonesia. The findings confirm that all three scores are statistically significant predictors of outcome, but they differ meaningfully in their discriminatory power.[11] The anatomically-based ISS emerged as the superior predictor (AUC = 0.88), followed by the composite physiological score, RTS (AUC = 0.83), and the simple hemodynamic ratio, SI (AUC = 0.76). This hierarchy of performance is not only statistically informative but is also deeply rooted in the complex pathophysiology of trauma, from initial physiological shock to the systemic consequences of anatomical destruction.[12]

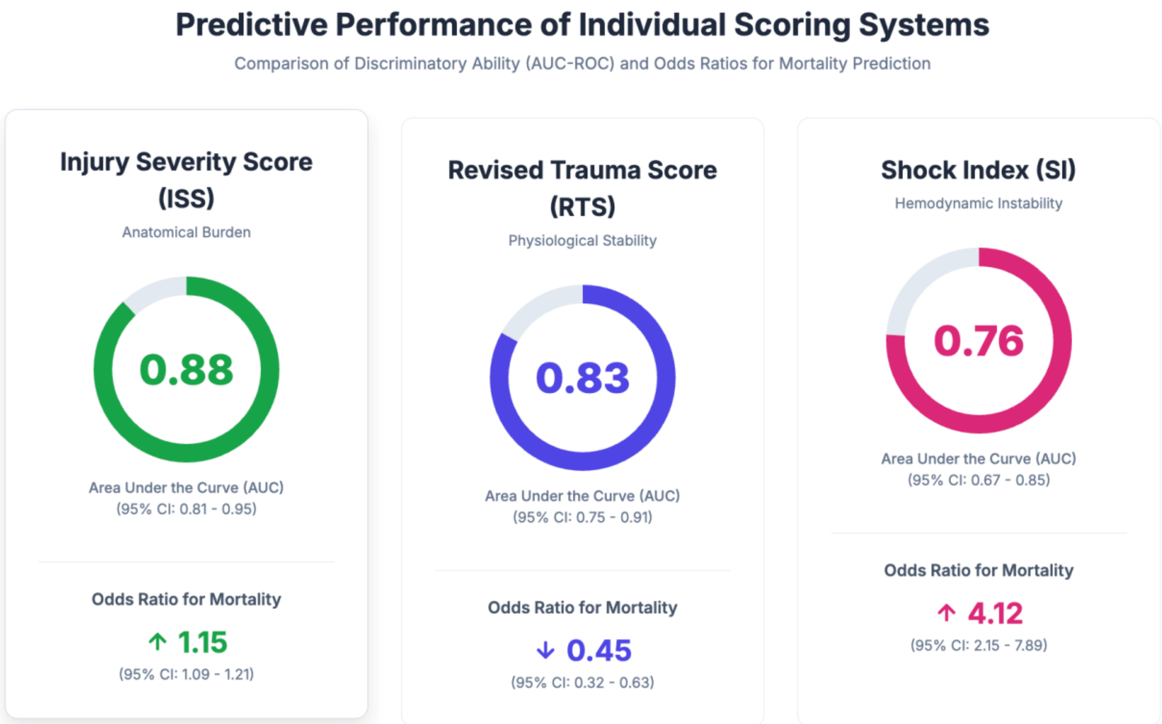

Figure 3. Predictive performance of individual scoring systems.

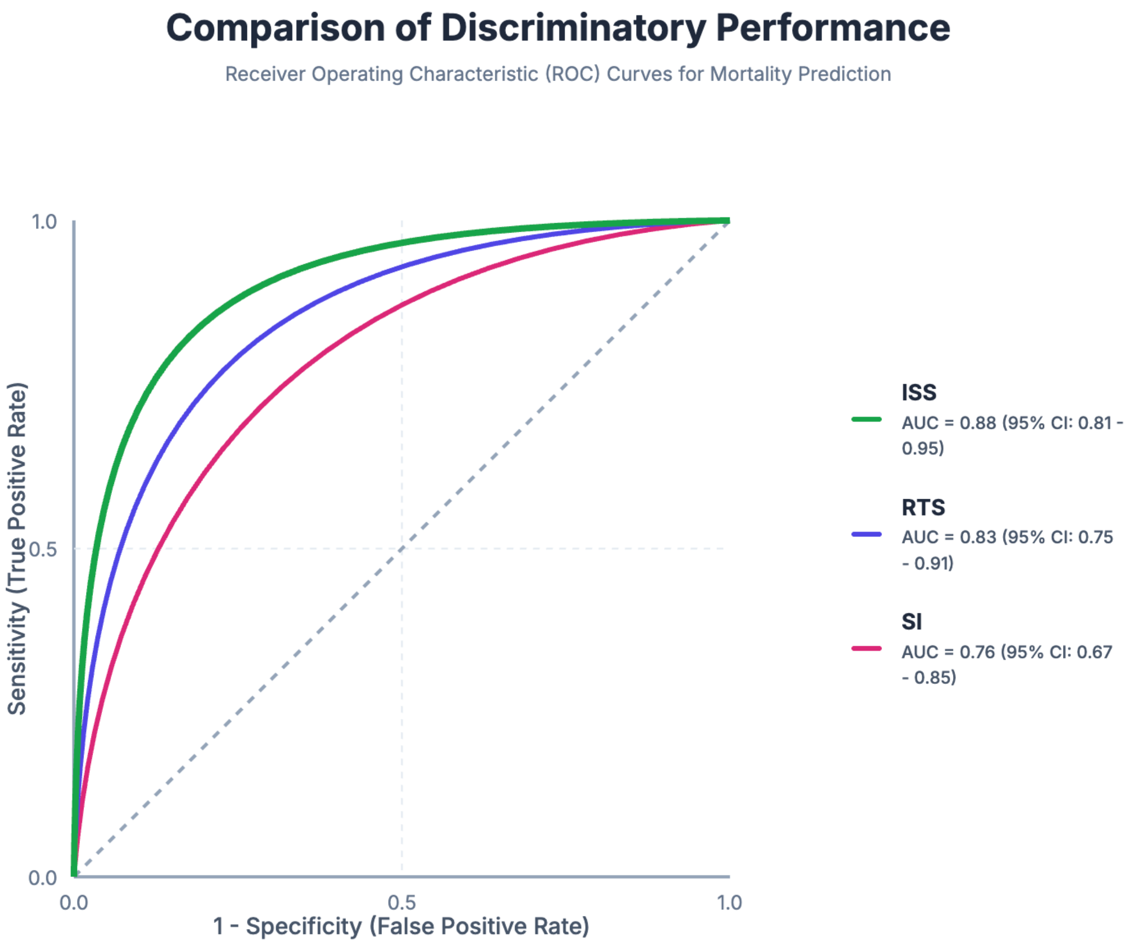


Figure 4. Comparison of discriminatory performance.

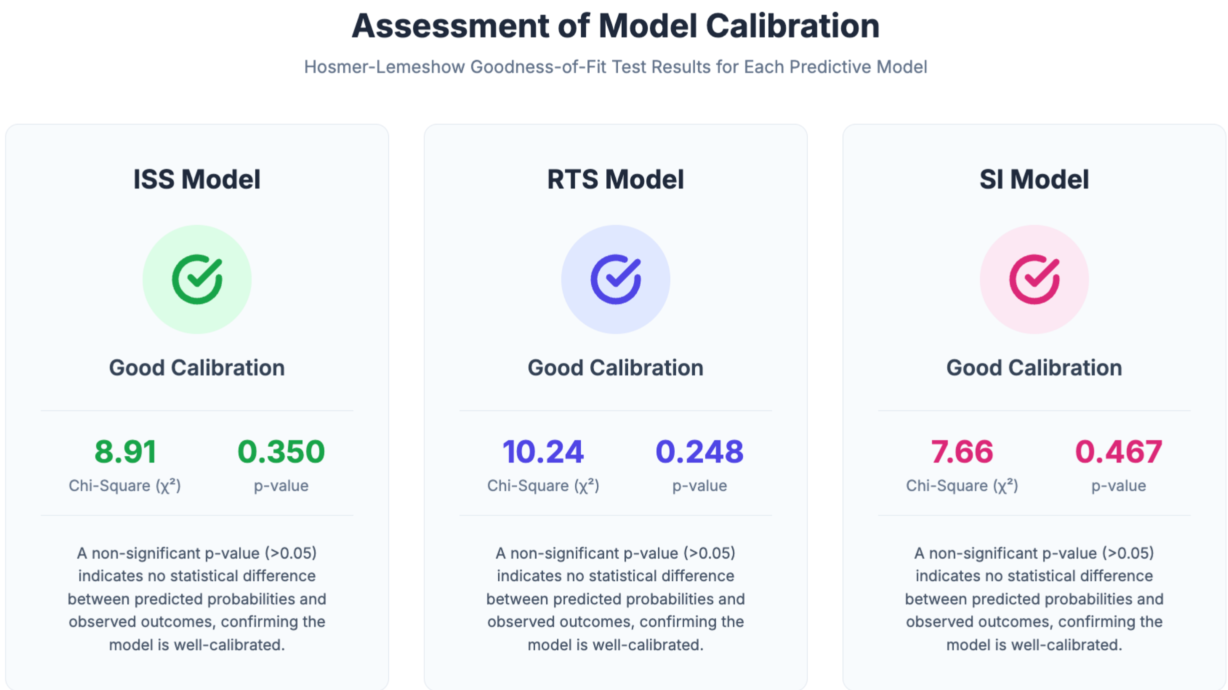


Figure 5. Assessment of model calibration.

The superior performance of the injury severity score in our analysis is both expected and illuminating. The ISS does not measure the body's response to injury; it quantifies the injury itself. Its strength lies in its ability to provide an integrated measure of the total anatomical insult across multiple body regions. A high ISS signifies a massive disruption of tissue, a profound loss of structural integrity, and damage to vital organs.[12] This anatomical burden is the primary driver of the two interconnected processes that lead to late trauma mortality: the systemic inflammatory response and acute traumatic coagulopathy.[13] From a pathophysiological standpoint, severe tissue damage, as quantified by a high ISS, acts as a massive trigger for the innate immune system. The destruction of cells releases a flood of damage-associated molecular patterns (DAMPs), such as mitochondrial DNA and high-mobility group box 1 (HMGB1) proteins. These molecules are recognized by pattern recognition receptors on immune cells, unleashing a torrential and dysregulated systemic inflammatory response syndrome (SIRS). This "cytokine storm" leads to widespread endothelial activation and dysfunction. The endothelium, once a passive barrier, becomes a key player in the inflammatory cascade, leading to increased vascular permeability, profound vasodilation, and interstitial edema.[14] This "capillary leak" syndrome effectively reduces the circulating volume, impairs oxygen delivery to tissues, and is a key driver of multiple organ dysfunction syndrome (MODS)—the leading cause of late death in trauma patients. The ISS, by measuring the initial insult, serves as an excellent proxy for the magnitude of this subsequent inflammatory firestorm.[15] Simultaneously, massive trauma precipitates acute traumatic coagulopathy (ATC). This is not merely a consumption of clotting factors but a distinct entity driven by the combination of shock, tissue injury, and systemic inflammation. The hypoperfusion and acidosis associated with severe hemorrhage directly impair the function of clotting enzymes, which are pH and temperature-sensitive. Furthermore, the damaged endothelium releases large amounts of tissue plasminogen activator, leading to a state of hyperfibrinolysis where clots are broken down as quickly as they are formed. The ISS, by reflecting the extent of tissue factor release from crushed tissues and the severity of associated hemorrhage, provides a strong indication of the likely severity of ATC. Therefore, the ISS's premier predictive power stems from its ability to quantify the root cause of the downstream biological chaos that ultimately determines a patient's fate.[16]

The revised trauma score demonstrated good discriminatory power in our study (AUC = 0.83), second only to the ISS. The strength of the RTS lies in its composite assessment of three interdependent physiological pillars: central nervous system function (GCS), cardiovascular perfusion (SBP), and respiratory control (RR). A significant derangement in any one of these components is life-threatening; a concurrent failure of all three, as captured by a low RTS, is a state of profound physiological collapse.[17] The heaviest weighting in the RTS formula is given to the GCS. This reflects the brain's status as the ultimate end-organ. A declining GCS in a multi-trauma patient is a powerful indicator of either direct cranial trauma or, more ominously, global cerebral hypoperfusion due to systemic shock. When the brain is starved of oxygen and glucose, consciousness fades. A low GCS is thus a sentinel sign that the entire circulatory system is failing to meet the metabolic demands of its most critical organ. The SBP and RR components act as direct measures of the "pump and lungs." A low SBP signifies decompensated shock, a state where the body's compensatory tachycardia and vasoconstriction have failed.[18] This represents a critical loss of circulating volume and is a direct harbinger of cardiac arrest. The respiratory rate, in turn, reflects the body's desperate attempts to compensate for the metabolic acidosis of shock by expelling $CO_2$. An abnormal respiratory rate—either too fast (tachypnea) or too slow (bradypnea, indicating brainstem failure or exhaustion)—is a clear sign of severe systemic distress. The RTS succeeds by integrating these three vital signs into a single score that effectively quantifies the degree of failure across the body's most essential life-sustaining systems. Its strong performance in our study validates its continued use as a rapid, reliable tool for initial risk assessment at the bedside.[19]

The shock index, while having the lowest AUC in our comparison (0.76), remained a statistically significant predictor of mortality. Its clinical value is not in its ultimate precision but in its simplicity and its sensitivity as an early warning sign. The pathophysiology it detects is the very first step in the body's response to hemorrhage: the baroreceptor-mediated sympathetic surge. In response to a drop in cardiac preload from blood loss, the heart rate increases to maintain cardiac output, often long before blood pressure begins to fall. The SI, by relating these two variables, captures this compensated state of shock. An SI approaching or exceeding 1.0 indicates that the cardiovascular system is under significant strain. It is a red flag for ongoing, significant hemorrhage and identifies a patient who, while appearing stable, is at high risk of sudden and catastrophic decompensation. In a busy ED, where a patient's "normal" blood pressure might be overlooked, the calculated SI can draw a clinician's attention to the impending danger. Its lower discriminatory power compared to RTS and ISS is understandable. It measures only one aspect of physiology (hemodynamics) and provides no information on neurological status or the anatomical extent of injury.[20] However, as a simple, rapid, and universally calculable alarm bell for occult hemorrhage, its role in triggering aggressive resuscitation and the search for a source of bleeding remains critically important.

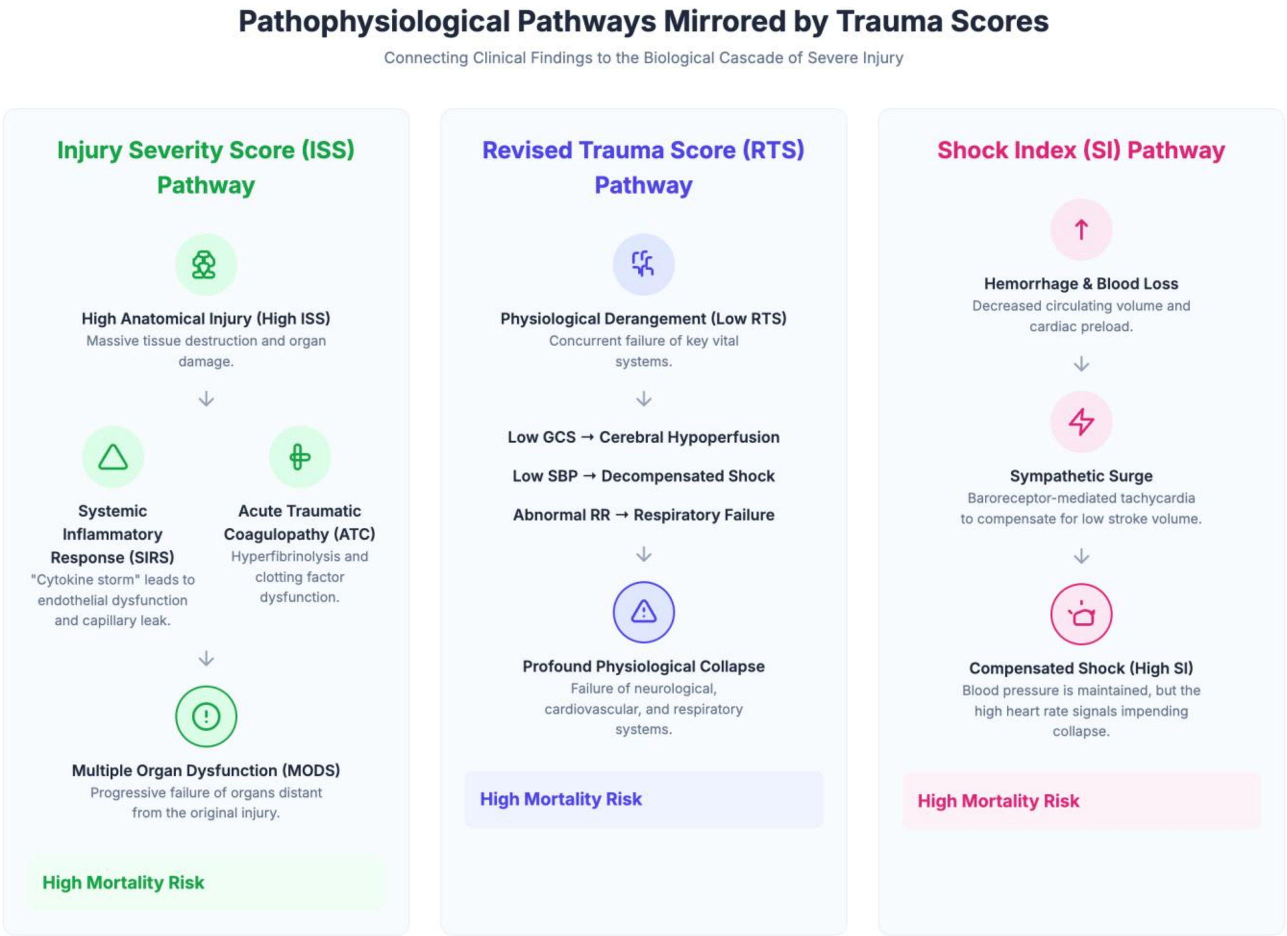


Figure 6. Pathophysiological pathway mirrored by trauma scores.

Figure 6 showed a schematic illustration of the distinct pathophysiological pathways that are measured and reflected by the three primary trauma scores: the injury severity score (ISS), the revised trauma score (RTS), and the shock index (SI). Each pathway connects the initial clinical finding to the ultimate outcome of a high mortality risk, providing a biological basis for the statistical findings of the study. The ISS pathway originates from a high anatomical injury, as indicated by a high ISS score, which represents massive tissue destruction and organ damage. This initial insult triggers a devastating dual-pronged systemic reaction. The first branch is the development of a systemic inflammatory response syndrome (SIRS), a state often described as a "cytokine storm" that leads to widespread endothelial dysfunction and capillary leak. Concurrently, the body enters a state of acute traumatic coagulopathy (ATC), which is characterized by hyperfibrinolysis and the dysfunction of clotting factors. The convergence of these inflammatory and coagulopathic cascades leads to the progressive failure of organs not directly injured in the initial trauma, a condition known as multiple organ dysfunction syndrome (MODS). This relentless systemic collapse is the final common pathway that places the patient at a high risk for mortality. The RTS pathway illustrates a state of physiological derangement, signified by a low RTS score, which reflects the concurrent failure of key vital systems. This collapse is broken down into its three constituent parts. A low Glasgow coma scale (GCS) score is shown to be a clinical marker for cerebral hypoperfusion. A low Systolic Blood Pressure (SBP) indicates the patient has entered decompensated shock. Finally, an abnormal Respiratory Rate (RR) is a sign of impending respiratory failure. The simultaneous failure of these neurological, cardiovascular, and respiratory functions culminates in a state of profound physiological collapse , which is directly associated with a high mortality risk. The SI pathway begins with hemorrhage and significant blood loss, which leads to a decrease in the body's circulating volume and cardiac preload. The body’s initial compensatory mechanism is a sympathetic surge, where baroreceptors trigger an increase in heart rate to compensate for a falling stroke volume. This leads to the critical clinical state of compensated shock, where blood pressure is deceptively maintained, but the elevated heart rate, resulting in a high SI, signals an impending and catastrophic collapse. This state of compensated shock is a strong predictor of a high mortality risk if aggressive resuscitation is not initiated promptly.

Our findings do not suggest an "either/or" choice between these scores but rather champion a complementary, integrated approach to trauma stratification. Immediate Triage (Seconds to Minutes): Upon patient arrival, the SI should be calculated instantly from the first set of vital signs. An elevated SI should immediately trigger a high-level trauma activation and preparation for massive transfusion. Primary survey assessment (Minutes): As the primary survey (ABCDE) is completed, the RTS should be calculated. It provides a more comprehensive physiological snapshot than the SI alone. A low RTS should confirm the need for aggressive resuscitation and prompt consultation with surgery and critical care. Definitive prognostication (Hours): Once the patient is stabilized and advanced imaging is complete, the ISS should be meticulously calculated. This score provides the most accurate overall prognosis and should be used to guide decisions regarding ICU resource allocation, surgical planning, and communication with the patient's family about the likely long-term outcome. Limitations of the Study It is imperative to interpret these findings within the context of the study's significant limitations. First and foremost, the purposive sampling strategy resulting in a high-mortality sample limits the generalizability of our findings. The predictive performance and correlation values reported here may not apply to a general, unselected population of trauma patients with a lower overall injury severity. Our results are most applicable to the risk stratification of patients who are already identified as being at high risk. Second, the retrospective nature of the study carries an inherent risk of information bias from incomplete or inconsistently recorded data, although we sought to mitigate this through strict inclusion criteria and quality checks on ISS coding. Third, as a single-center study, our findings reflect the specific patient demographics, injury patterns, and care protocols of our institution and may not be directly transferable to other centers with different characteristics. Finally, our analysis was limited to the three scoring systems and did not account for other potentially important predictors, such as age (which was restricted), pre-existing comorbidities (which were excluded), time to hospital arrival, or specific laboratory markers like serum lactate or base deficit.

## 5. Conclusion

In a selected group of severely injured adult trauma patients in an Indonesian tertiary center, this study confirms that the Injury Severity Score, Revised Trauma Score, and Shock Index are all significant predictors of in-hospital mortality. The anatomically-based ISS demonstrated the highest discriminatory accuracy, underscoring the critical role of the total injury burden in determining a patient's ultimate fate. The physiological scores, RTS and SI, while less discriminating, are invaluable for their speed and simplicity, enabling rapid risk identification at the point of care. These findings advocate for a multi-modal and temporally-staged approach to trauma prognostication: leveraging the immediate utility of physiological scores to guide initial resuscitation, followed by the comprehensive anatomical assessment of the ISS to inform definitive care and prognostication. While limited by its study design, this research provides valuable, context-specific evidence supporting the complementary use of these foundational tools to improve trauma care in resource-variable settings.

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