# Comparison of Injury Severity Score (ISS), New Injury Severity Score (NISS), Revised Trauma Score (RTS), and Trauma and Injury Severity Score (TRISS) In Predicting Mortality In Polytrauma Patients At Haji Adam Malik General Hospital

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**ABSTRACT**

**Background**: Polytrauma is a trauma that involves injury to 2 or more body regions, where at least one of them can cause death. Definitive follow-up of trauma patients can reduce mortality. Trauma scoring can make it easier for clinicians to assess the severity of a patient's trauma and assist in deciding what management to choose.

**Methods**: This study used an observational diagnostic test design by taking secondary data from medical records from January 2019-July 2021 as many as 150 people. This study aimed for differences in the sensitivity and specificity values of the ISS, NISS, RTS, and TRISS scoring systems in predicting mortality of polytrauma patients at RSUP HAM.

**Results**: The sensitivity, specificity, positive predictive value and negative predictive value of ISS with a cut-off point of 37.5 were 83.9%, 90.8%, 70.3%, 95.6%; NISS with 49 cut-off points are 67.7%, 96.6%, 84%, and 92%, respectively; RTS with a cut-point value of 6.952 are 9.7% and 22.7%, respectively, and TRISS with a cut-point value of 96.83, respectively, is 3.2% and 55.5%.

**Discussion**: ISS and NISS can be used as predictors of mortality in polytrauma patients, while RTS and TRISS cannot be predictors of mortality due to their low sensitivity and specificity because these scores relied on physiological factors and didn't exclude systemic comorbidities.

**Keywords**: *ISS, NISS, RTS, TRISS, predictor, mortality, polytrauma*

## INTRODUCTION

Trauma is the leading cause of death and disability worldwide. More than 5 million people worldwide die each year from injuries caused by traffic accidents, falls from a height, drowning, fire, poisoning, suicide, violence, or war. These trauma deaths are responsible for 9% of global mortality, more than HIV/AIDS, malaria, and tuberculosis combined.[1] The incidence of trauma can continue to increase, especially in developed countries with industrialization, where motorized vehicles are increasingly used.[2]

Polytrauma is trauma that involves injury to 2 or more body regions, where at least one of them can cause death. Polytrauma injuries are severe, some require ICU care, and often require surgical intervention, with high mortality.[3] Mortality of polytrauma

patients reached 18-23% worldwide in 2000-2005, with 4 deaths from 17 polytrauma patients at dr. Cipto Mangunkusumo from January 2011 to December 2014.[4]

Several studies have shown that many trauma patients die at the time of the incident or within the first 48 hours after being brought to the ED.[5] The cause of death is the main thing studied in scientific research whose main goals are efforts to improve life safety and reduce the incidence of complications that can develop into patient death. The literature shows that the most common cause of early death (first 24 hours) in polytrauma patients is central nervous system (CNS) injury, followed by blood loss due to internal organ injury. The most common causes of advanced death are complications from CNS injury, infection, sepsis, and Multiple Organ Failure (MOF).[6]

Definitive follow-up of trauma patients can reduce mortality. Trauma scoring can make it easier for clinicians to assess the severity of a patient's trauma and assist in deciding what management to choose.[7] Trauma scoring was introduced more than 30 years ago to numerically assess anatomic lesions and physiological changes after injury. Physiological scoring describes changes in vital signs and consciousness. Anatomical scoring describes all injuries recorded at the time of clinical examination, imaging, surgery, or autopsy. Both are used to stratify trauma patients and measure the severity of the injury.[8,9] Several scoring systems are based on anatomies such as AIS (Abbreviated Injury Scale), ISS (Injury Severity Score), NISS (New Injury Severity Score), and others. While the scoring system based on physiology is like RTS (Revised Trauma Score), Glasgow Coma Score, and others.[10]

Based on the AIS, the ISS was introduced in 1974 as a tool for measuring injury severity. Since then, the ISS has been validated in many studies and has become one of the scoring tools to describe the severity of injury in trauma patients.[11] However, one of the drawbacks of the ISS was that the ISS could not describe multiple injuries in one body region. Of these limitations, Osler et al. (1997) modified the scoring to create NISS, using the 3 most severe injuries in any region, even within 1 body region.[12] Champion et al. (1989) introduced the RTS, a scoring widely used to assess prognosis in trauma patients. This physiological scoring consists of GCS, systolic blood pressure, and respiratory rate, which are included in certain equations.[13] However, its use is not easy in the ED. The Trauma and Injury Severity Score (TRISS) was developed by Boyd et al. (1987) to predict posttraumatic survival. The TRISS consists of a combination of physiological (RTS) and anatomical (ISS) and age scoring, stratified by the mechanism of injury (blunt or penetrating). TRISS shows a stronger prediction of posttraumatic survival than RTS and has been validated in several studies.[14] Although its use is too complex, TRISS is most commonly used worldwide to evaluate trauma patients, being a predictor and determining appropriate management and prevention of complications in trauma.[15]

In several previous studies, comparisons have been made between these scoring systems. Research by Yadollahi et al. (2020) showed that the TRISS, RTS, GCS, and ISS scoring systems all have an effective approach in evaluating the prognosis, mortality, and possible complications in patients with trauma cases. Thus, this scoring system can be recommended for use in trauma centers.[16] In another study by Kuo et al. (2017), have not found any difference between ISS and NISS in their predictive properties. Several studies have found that TRISS has the highest effectiveness.[17] Based on this background, it can be seen that polytrauma causes a fairly high mortality rate. In this study, the researchers wanted to compare the ISS, NISS, RTS, and TRISS scoring systems in predicting mortality in polytrauma patients at Haji Adam Malik Hospital Medan.

## METHODS

This study uses an observational diagnostic test design by taking secondary data from the patient's medical record. In this study, researchers will analyze the differences in the sensitivity and specificity of the ISS, NISS, RTS, and TRISS scoring systems in predicting the mortality of polytrauma patients at Haji Adam Malik General Hospital. The implementation time is in October 2021 after obtaining approval from the Faculty of Medicine Universitas Sumatera Utara ethics committee.

The population in this study was the medical records of all patients in the Emergency Department of Haji Adam Malik General Hospital with polytrauma in the period January 2019 – July 2021. The sample of this study was part of the population that met the inclusion criteria. Samples were taken using non-probability sampling, namely consecutive sampling technique. The

inclusion criteria of this study were patients aged >18 years and the patient was still alive when he was brought and received treatment at the ER Haji Adam Malik General Hospital. Selected research subjects using the inclusion criteria that have been determined. Data were collected on research subjects including age, gender, and data from medical records. ISS, NISS, RTS, TRISS scoring were measured and the cut-off point, sensitivity, and specificity were measured in predicting mortality. To analyze the cut-off point, sensitivity, specificity, positive predictive value, and negative predictive value, the data will be tabulated in a 2x2 table for each score. Then it will be seen the accuracy value for the four scores is compared.

## RESULTS

In this study, 150 research subjects were obtained which included the inclusion criteria who had polytrauma at Haji Adam Malik General Hospital from January 2019 to July 2021. The characteristics of the research subjects are presented in table 4.1. The majority of the subjects were 112 men (74.7%) and 38 women (25.3%). The average age of the research subjects was 39 years.

All subjects were polytrauma patients as many as 150 patients (100%), of which 31 patients died (20.7%) and 119 patients (79.3%) survived. The most common trauma mechanism was blunt trauma in 142 patients (94.7%) while penetrating trauma was 8 people (5.3%). The patient's average consciousness was GCS 12. The average hemodynamic state of the systolic blood pressure was 117 mmHg and the respiratory rate was 24x/minute.

Based on the use of a scoring system in patients with polytrauma, this study uses 4 types of scoring. The mean ISS score in the patients in this study was 30.84, in survived patients was 27.1 and in patients who died was 45.16. The average NISS score was 38.14, the average RTS score was 7.159, and the average TRISS score was 83.54, which is shown in Table 1.

**Table 1. Characteristics of Research Subjects**

| Characteristics | n=150 |
|---|---|
| Age, (years) | 39,48 ±15,22 |
| Gender, n(%) | |
| Man | 112 (74,7) |
| Woman | 38 (25,3) |
| Mechanism of Trauma, n(%) | |
| Blunt | 142 (94,7) |
| Penetrating | 8 (5,3) |
| GCS scale | 12,6 ± 3,37 |
| Systolic blood pressure, (mmHg) | 117 ± 23 |
| Respiratory rate, (x/minute) | 24,8 ± 5,68 |
| Trauma scoring | |
| ISS Score | 30,84 ± 10,14 |
| Mortality | 45,1613±9,05942 |
| Survive | 27,1092±6,94017 |
| NISS Score | 38,15 ± 14,46 |
| Mortality | 54,0968±16,88659 |
| Survive | 33,9916±10,35922 |
| RTS Score | 7,16 ± 1,09 |
| Mortality | 5,6134±1,27597 |
| Survive | 7,5588±0,5478 |
| TRISS Score | 83,54 ± 22,54 |

| | |
|---|---|
| Mortality | 49,0087±24,8176 |
| Survive | 92,5388±9,49671 |
| Output, n(%) | |
| Die | 31 (20,7) |
| Survive | 119 (79,3) |

The value of determining the ISS score in predicting mortality in polytrauma patients is presented on the ROC curve and the AUC (area under the curve) value, namely [AUC 0.943 (0.888 – 0.997); p-value <0.001]], meaning that the ISS score has a strong ability to predict mortality in polytrauma patients. Next, the plotting is done to find out the optimal cut-off point along with the sensitivity, specificity, positive predictive value, and negative predictive value of the cut-off point. The graph shows that the optimal cut-off point is 37.50, meaning that polytrauma patients who have an ISS score of 37.50 have a mortality probability with a sensitivity of 83.9%, specificity of 90.8%, positive predictive value (PPV) 70.3%, and a negative predictive value (NPV) of 95.6% as shown in Figure 1.

The determination value of the NISS score in predicting mortality in polytrauma patients is presented on the ROC curve and the AUC (area under the curve) value, namely [AUC 0.857 (0.765 – 0.950); p-value <0.001], meaning that the NISS score has a strong ability to predict mortality in polytrauma patients.

**Table 2. Mortality Based on Scoring Cut Point Value**

| Scoring | Mortality | Survive | Total |
|---|---|---|---|
| ISS ≥37,5 | 26 (70,3%) | 11 (29,7%) | 37 (100%) |
| ISS <37,5 | 5 (4,4%) | 108 (95,6%) | 113 (100%) |
| NISS ≥49 | 21 (84%) | 4 (16%) | 25 (100%) |
| NISS <49 | 10 (8%) | 115 (92%) | 125 (100%) |
| RTS <6,952 | 29 (51,8%) | 27 (48,2%) | 56 (100%) |
| RTS ≥6,952 | 2 (2,1%) | 92 (97,9%) | 94 (100%) |
| TRISS <96,83 | 31(31,3%) | 68(68,6%) | 99(100%) |
| TRISS ≥96,83 | 1(1,96%) | 50 (98,03%) | 51 (100%) |

Next, the plotting is done to find out the optimal cut-off point along with the sensitivity, specificity, positive predictive value, and negative predictive value of the cut-off point. The graph shows that the optimal cut-off point is at a score of 49.0, meaning that polytrauma patients who have a NISS score of 49 have a mortality probability with a sensitivity of 67.7%, specificity of 96.6%, positive predictive value (PPV) 84%, and negative predictive value. (NPV) 92% as in Figure 2.

The value of determining the RTS score in predicting mortality in polytrauma patients is presented on the ROC curve and the AUC (area under the curve) value, namely [AUC 0.047 (0.014 – 0.080); p-value < 0.001], meaning that the RTS score cannot be a predictor of mortality in polytrauma patients as shown in Figure 3.

The value of determining the TRISS score in predicting mortality in polytrauma patients is presented on the ROC curve and the AUC (area under the curve) value, namely [AUC 0.045 (0.003 – 0.086); <0.001], meaning that the TRISS score cannot be a predictor of mortality in polytrauma patients as shown in Figure 4.

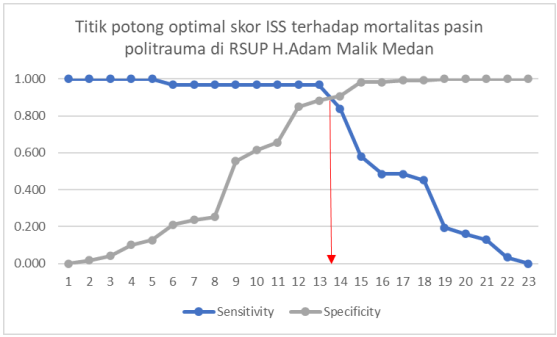
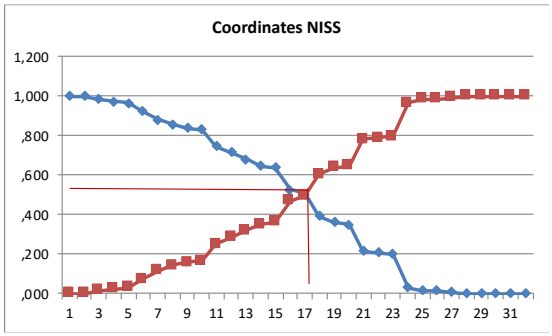
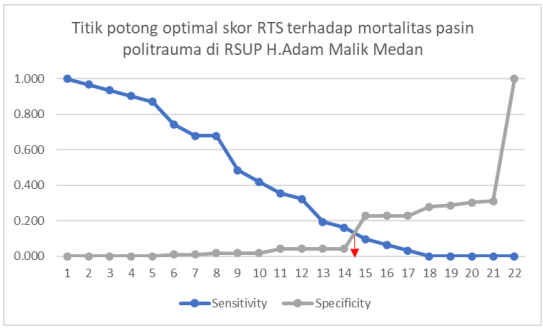


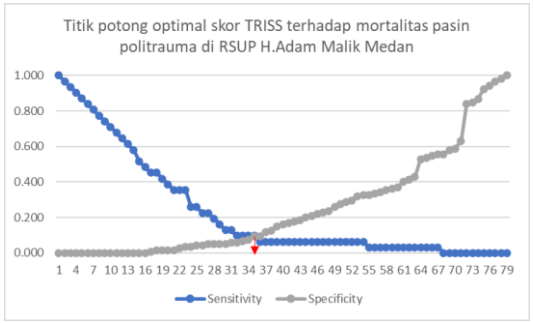

Figure 1. ISS Cut-off Score




Gambar 2. NISS Cut-off Score




Gambar 3. RTS Cut-off Score




Gambar 4. TRISS Cut-off Score

## DISCUSSIONS

In this study, based on gender, polytrauma patients were dominated by men, namely 112 patients (74.4%) and 38 women (25.3%) with a mean age of 39 years. There is some consistent literature including the study by Patil et al. In India, which recorded 200 elderly polytrauma patients, 74% were male with a mean age of 66.35 years.[18] The study by Wui et al. in 2014 in Singapore of

48,317 trauma cases, male patients were 69.19% compared to 30.18% women, and more than half (59.43%) were under 60 years old, with the most vulnerable age group being between 20 -29 years (18.25%; 215 patients) followed by the age group of 60-69 years (15.37%; 181 patients) which may be due to men having more outdoor activities.[19] Fifty patients were collected randomly. randomized to the ED in the study by Rizk et al. found an average age of 37.04 ± 13.42 years consisting of 42 men (84%) and 8 women (16%).[20]

The most trauma mechanism found in this study were blunt trauma as many as 142 patients (94.7%) and penetrating trauma by 8 people (5.3%). This is in line with research by Wui et al. which stated that the mechanism of trauma was dominated by blunt trauma, approximately 98.13%.[19] In this study the overall mortality rate of the sample was 31 people (20.7%). This prevalence value is close to the prevalence of mortality due to polytrauma in the study of Mohtasam-Amiri et al. ie 17%, the study of Yousefzadeh-Chabok et al. reported at 13.9%, and the study of Patil et al. reported a mortality of 17% with the mechanism of injury dominated by traffic accidents (94%).[18,21] Mortality of polytrauma patients reached 18-23% worldwide in 2000-2005, with 4 deaths from 17 polytrauma patients at dr. Cipto Mangunkusumo from January 2011 to December 2014.[4]

This study obtained an average ISS score in the patients of this study, which was 30.84, with a cut-off point of 37.50, a sensitivity predicting mortality of 83.9%, and a specificity of 90.8%. The study by Patil et al that got the ISS cut-off point of 15 showed a sensitivity value of 91% and a specificity of 89%, in line with the results that the researchers found.[18] Another study by Samin et al showed that the ISS score was used as the cut-off point 38 with a sensitivity value of 91% and a specificity of 90.%.[22]

This disparity in results can be explained by a study conducted by Honarpisheh in 2012 which stated that anatomical damage factors, physiological disorders, and patient conditions affected the ISS score assessment, where this could have an impact on the final score assessment results and its relationship with polytrauma.[21,22]

This study found that the mean NISS score for the patients in this study was 38.14 with a cut-off point of 49.0. The sensitivity predicted mortality was 67.7% and specificity was 96.6%, with the mean NISS in patients who died being 54.09 ± 16, 8 when compared with the living 33.9±10.3. In contrast to Patil et al, the NISS cut-off value was <17 (91% sensitivity, 93% specificity) and the mean NISS value in patients who died was 27.65±7.49 and 8.80±6.19 for survivors.[18] Orhon et al added the mean NISS for non-survivors 27.62 ± 12,85.[23]

The discrepancy between this study and other studies may be due to the limited number of patients in the study and the greater proportion of patients with severe injuries. NISS has an advantage over ISS, which is that it can account for multiple injuries in the same location, for example in head trauma and penetrating abdominal trauma.[18]

The calculation of the mean RTS score in this study was 6.952 with a cut-off point of 6.952, sensitivity prediction of mortality 9.7%, specificity 22.7%, AUC 0.047. It can be concluded that in the study population, the RTS score cannot be used as a predictor of mortality. A systematic review by Manoochechry et al of 11 studies (total trauma patients = 20,631) that assessed RTS had a sensitivity of 82% and a specificity of 91%. The study was conducted in six different countries, including Colombia, India, Iran, Nigeria, Turkey, and Uganda where the majority of the sample consisted of men (76.68%).[24] The mean RTS in Patil's study was 7.108 (97% sensitivity, specificity). 80%).[18]

Meanwhile, in a cohort study in Egypt of 200 emergency room patients at Kasr Al Ainy Hospital, Egypt, it was found that 78.5% of male individuals with blunt abdominal trauma had a mean RTS score of 11.41. There was a statistically significant correlation between RTS and mortality with a cut-off value of <11 (RTS=10 or less), a sensitivity of 92.9%, and a specificity of 81.8%.[25]

The study by Rizk et al found that RTS was better than ISS in predicting mortality among polytrauma patients. The prevalence of death was significantly high in patients with low RTS scores and high ISS scores. Several reasons why RTS is better than ISS include (1) in injured patients, the direct cause of death is physiological disorders of various body systems; (2) patients with the same ISS may have significantly different physiological disorders; (3) there is a significant correlation between RTS and

duration of hospitalization for trauma patients, and (4) ISS has a debilitating nature when more than one major injury occurs in the same body region.[20]

RTS accuracy as a predictor of mortality can be influenced by various factors and RTS results can be found differently in each demographic group. Research by Manoochehry in 2019 showed that the sensitivity value of the RTS was found to be higher in studies conducted on a sample of >1000, which indicates that better mortality predictor results will be obtained in studies with much larger samples.[24]

This sensitivity value increases in studies with larger sample sizes, which is related to the heterogeneity of the samples studied in different populations. Moreover, related factors such as age and physiological factors can also influence the outcome of the RTS which contributes significantly in determining the sensitivity and specificity of the RTS.[24]

The mean TRISS score in the patients in this study was 83.54 with a mean score of 92.5 ± 9.4 in living patients and 49 ± 24.8 in patients who died (the cut-off point was 96.83 with a mortality prediction sensitivity of 3.2%, specificity). 55.5%, AUC 0.045). It can be concluded that in the study population, the TRISS score cannot be used as a predictor of mortality. Patil et al obtained the cut-off point of 91.6 with a sensitivity of 97% and a specificity of 88%. In the group who died, the mean TRISS was 58.48 ± 25.58 and 95.49 ± 4.41 for those who recovered.18 In Orhon et al., the mean TRISS rate in the group who died was higher, namely 72.80 ± 19.35 and 98. .34 ± 6.58 for cured.[23] Accordingly, of the 426 trauma cases involved in the Hoke et al study, the TRISS score was able to predict mortality with a sensitivity of 97.1% and a specificity of 76,7%.[25]

In a study conducted by Mitchell et al in Canada in 2007, it was reported that the TRISS scoring system has a good ability to predict the prognosis of patients with trauma.[26] In a study conducted in India, Hariharan et al concluded that using the TRISS system to predict Morbidity and mortality after falls in the elderly can play an important role in treatment planning.[26]

Studies by Milton et al in Africa reported the sensitivity and specificity of TRISS 87% and 68%, ISS 81% and 61%, and RTS 81% and 60%, respectively. Among these scores, TRISS has a sensitivity for predicting mortality in the polytrauma population.[27] The statistically significant difference between ISS, NISS, RTS, and TRISS was also examined by Patil et al with $p < 0.0001$, where the ISS and NISS scores for the recovered were significantly lower than those who died, while the RTS and TRISS scores of survivors were higher than those of those who died.[18]

The role of TRISS as a predictor of mortality could be influenced by various factors. Gunawan explained in 2017 that the score could not account for multiple injuries in the same body region. Second, the score didn't exclude systemic comorbidities, which also played a role in the patient's prognosis. Third, the score could not evaluate intubated patients, because the score depends on the patient's respiratory rate.[4]

Other special conditions such as trauma epidemiology, emergency care, referral systems, and medical care cannot be ignored. Ultimately, the outcome of the polytrauma patient depends on these factors, including the severity of the trauma, comorbidities, emergency personnel, and the trauma management system. Another study by Siritongtaworn in 2009 also stated that TRISS can predict survival after trauma. Prediction accuracy was improved by recalculation of the TRISS coefficients, but additional improvements were not seen with models that included information about comorbidities. Moreover, variation in trauma may be the result of several factors, including the severity of the patient's injury and comorbidities, the clinician's handling of each patient, and the treatment of the trauma center's specific system.[28] The limitation of this study is that the results could be influenced by many biased factors that can affect trauma scores. These relied on physiological factors and didn't exclude systemic comorbidities so we wished that further researches can exclude comorbid variables.

## CONCLUSION

A total of 150 patients at the Haji Adam Malik General Hospital in the period January 2019 - July 2021 experienced polytrauma. The majority of trauma patients were 112 men (74.7%) and 38 women (25.3%) with the mean age of the study subjects 39 years. The mortality rate in this study was 31 patients (20.7%) and 119 patients (79.3%) were alive. The intercept value for the

ISS in this study was 37.5; the cut-off point for the NISS in this study was 49; the value of the RTS cut-off point in this study was 6.952; The TRISS cut-off point is 96.83 in this study.

Meanwhile, the sensitivity, specificity, positive predictive value, and negative predictive value of ISS with a cut-off point of 37.5 are 83.9%, 90.8%, 70.3%, 95.6%; the sensitivity, specificity, positive predictive value, and negative predictive value of NISS with a cutoff point of 49 were 67.7%, 96.6%, 84%, and 92%, respectively; the sensitivity and specificity values of RTS with a cut-off value of 6.952 were 9.7% and 22.7%, respectively. In this study, RTS could not be a predictor of mortality in polytrauma patients; and the sensitivity and specificity of TRISS with a cut-off value of 96.83 were 3.2% and 55.5%, respectively. In this study, TRISS could not be a predictor of mortality in polytrauma patients.

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