

## Original Research Article

# Study of the efficacy of trauma and injury severity score to predict survival in patients of polytrauma

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### ABSTRACT

**Background:** Trauma is one of the major cause of mortality and morbidity in both developed and developing countries. Polytrauma patients present particular challenges as profile of the patient varies with different types and severity of injuries. Prediction of survival in trauma patients is an essential requirement of trauma care. Trauma and injury severity score (TRISS) have been considered as a standard of the quality of trauma care. Study was carried out to evaluate the performance of TRISS in predicting survival in patients of polytrauma.

**Methods:** Prospective observational study was conducted in emergency department of a tertiary care centre. 100 patients were evaluated in the study for a period of 18 months between November 2019 and April 2021. Patient demographics, details of trauma, pattern of injuries and physiological status were recorded. Overall outcome were studied and data analysis was done on the basis of TRISS. Statistical analysis was performed using statistical package for the social sciences (SPSS) program for windows, version 25.0 (SPSS Chicago, Illinois).

**Results:** Young patients with mean age of 34.54 were most commonly affected in polytrauma with male preponderance. Road traffic accidents were the most common mode of trauma followed by fall from height. Blunt trauma was the most common type of injury. TRISS strongly predicted survival in polytrauma patients (AUC 0.926 CI 95% 0.868-0.985). TRISS has high sensitivity 97.62% and specificity 62.50% at a cut off of 64.50%.

**Conclusions:** TRISS is an effective method for predicting survival of polytrauma patients and thus can be utilized to evaluate and compare trauma care.

**Keywords:** TRISS, Polytrauma, Outcome

### INTRODUCTION

Trauma is one of the major causes of morbidity and mortality in both developed and developing countries. The usual causes are road traffic accident, assault, fall from height, occupational injuries etc. Inadequate pre hospital treatment, lack of definitive care and prompt resuscitation are among the factors which can influence mortality.

Challenge arises when polytrauma patients presents with different combinations of injuries of varying severities. To make comparisons across different groups of patients, valid and reliable means of numerically summarizing patients' injuries are required. Prediction of survival after

injury is the major problem in trauma research. If accurate predictions can be made, such predictions can allow meaningful comparisons of results between different treatment modalities.<sup>1</sup>

Trauma and injury severity score (TRISS), introduced in 1981, is a combination index based on revised trauma score (RTS), injury severity score (ISS), and patient's age. Champion et al showed that this score which is a combination of physiological index, anatomic index and age is a powerful predictor of outcome in trauma patients.<sup>2</sup>

However, many studies conducted previously have given conflicting results regarding the efficacy of TRISS. Hence

this study was undertaken with an aim to evaluate the efficacy of TRISS.

**METHODS**

Observational Prospective Study was conducted in the emergency department of a tertiary care centre for 18 months from November 2019 to April 2021.100 patients were enrolled in the study. Before starting the study ethical clearance was obtained.

All patients presenting to surgical emergency department with penetrating and blunt trauma were included in the study. Any associated systemic diseases, e.g. congestive heart failure, chronic renal failure, chronic liver disease, chronic obstructive pulmonary disease etc. that may affect final outcome, patients below the age of 12 years and burn patients were excluded from the study.

Patient were clinically assessed and managed as per the latest advanced trauma life support (ATLS) guidelines (10<sup>th</sup> edition).<sup>3</sup> After stabilizing the patient, detailed history was recorded and general physical/systemic examination was done. Details of each patient from the time of arrival in the emergency department until the time of discharge from hospital or death, was recorded.

The data collected included demographics, trauma incident details (place, mode, day, type, time, etc) and physiologic status of the patients (revised trauma score [RTS]) at admission.

After stabilization of the patient, the injury severity score (ISS) was obtained from the trauma chart, imaging studies and intraoperative findings.

In TRISS methodology the probability of survival was calculated using TRISS index (RTS, ISS, and age combination index). We assessed the prediction of thirty days mortality.

TRISS was used to predict probability of survival P(s) based on formula:

$$P(s) = 1/(1 + e - b)$$

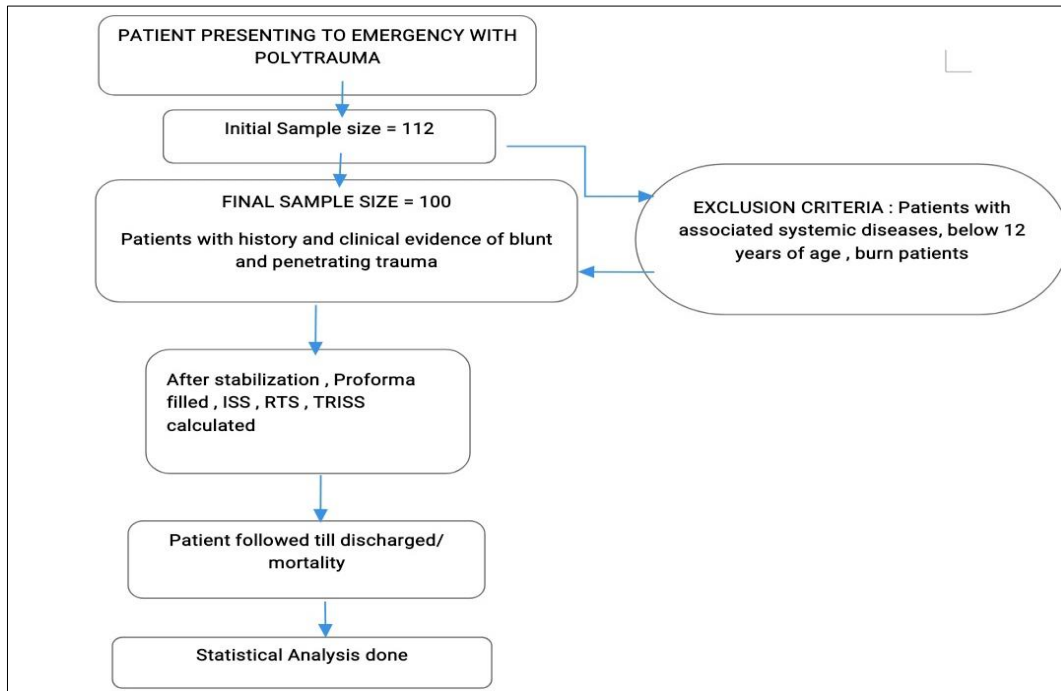
Where e=2.718282 (base of natural logarithm).

$$b = b_0 + b_1 (RTS) + b_2 (ISS) + b_3 (age\ index).$$

The coefficients b<sub>0</sub>, b<sub>1</sub>, b<sub>2</sub>, b<sub>3</sub> are derived from multiple regression analysis of the major trauma outcome study (MTOS) database. b<sub>0</sub> to b<sub>3</sub> are coefficients which are different for blunt and penetrating trauma. If the patient is less than 15, the blunt coefficients are used regardless of mechanism.

**Table 1: Coefficients.**

Coefficients	Blunt	Penetrating
<b>b<sub>0</sub></b>	-0.4499	-2.5355
<b>b<sub>1</sub></b>	0.8085	0.9934
<b>b<sub>2</sub></b>	-0.0835	-0.0651
<b>b<sub>3</sub></b>	-1.7430	-1.1360



**Figure 1: Study flow.**

The two resulting formulas for b are as follow:

$$b_{\text{Blunt}} = -0.4499 + 0.8085 \times \text{RTS} - 0.0835 \times \text{ISS} - 1.7430 \times \text{age index}$$

$$b_{\text{Penetrating}} = -2.5355 + 0.9934 \times \text{RTS} - 0.0651 \times \text{ISS} - 1.1360 \times \text{age index}$$

For patients under 55 years old, the age index is equal to 0, but for patient >55 years old the age index is equal to 1. Final prediction regarding the survival of each patient was calculated using the TRISS.

Statistical analysis was performed by the statistical package for the social sciences (SPSS) program for Windows, version 25.0 (SPSS, Chicago, Illinois). Continuous variables were presented as mean±standard deviation (SD), and categorical variables were presented as absolute numbers and percentage. Data was checked for normality before statistical analysis. Normally distributed continuous variables were compared using the unpaired t test between died and live groups, whereas the Mann-Whitney U test were used for those variables that were not normally distributed. Categorical variables were analysed using either the chi square test or Fisher's exact test. P<0.05 was considered statistically significant. A receiver operator curve analysis was done for finding the optimal cut off point for TRISS suggestive of survival. Based on that score cut off, a contingency analysis was done with calculation of sensitivity, specificity, positive predictive values (PPV) and negative predictive values (NPV).

## RESULTS

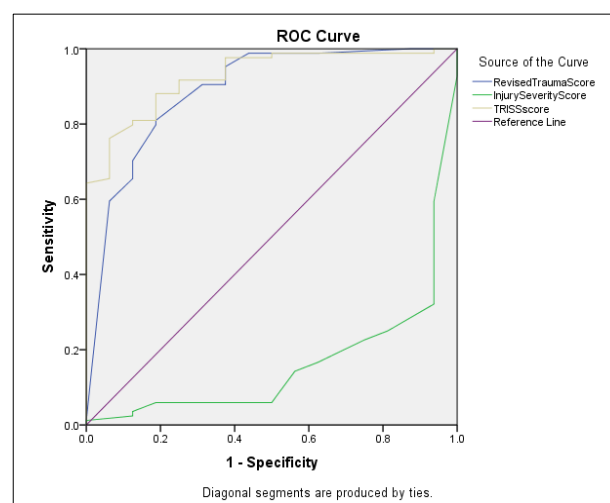
The average age of the patients was 34.54 years with median age of 30.50 years (standard deviation of the age distribution was 14.40 years). Most of the patients in the study were males (75%). RTA (74%) were the most common mode of trauma followed by fall from height (16%). Blunt trauma (93%) was the commonest type of injury observed. RTAs were the most common cause of blunt trauma. Gunshot injuries were the most common cause of penetrating trauma (57.14%) followed by stab injury. Extremity injury (75%) was the commonest region to be involved in trauma followed by abdomen (55%).

The average time to reach hospital was 1.88 hours with a median time duration of 2 hours. TRISS of patients reaching hospital in 2 hours or less is 90.01 as compared to the patients reaching hospital in more than 2 hours (81.99). The time to reach hospital was correlated with TRISS by using Pearson correlation coefficient. The negative r value (-0.1517, 95% CI -0.03381 to 0.04608) means as the time to reach hospital increases, the TRISS score or the probability of survival falls. The association is weak as reflected by the r value at 0.15 (minus). Mortality observed in above 60 and above age group was 66.67% compared to 11.11% in that of 20-40 age group. The mortality in the age categories increased as the age of the study population increased. The GCS was significantly

higher for the survivors (12.85±3.47) as compared to that of non survivors (6.75±3.73). This correlation is statistically significant (p value <0.0001). A receiver operator curve (ROC) analysis for the three scores was done to assess their propensity to adequately predict survival as an outcome. The area under the curve (AUC) models were found to be significant for all three scores. RTS score was a good predictor of survival with an AUC of 88.88%.ISS was a poor predictor of survival with an AUC of 16.30% only.

**Table 2: Characteristics of study subjects.**

Variables	Description (%)
<b>No. of patients</b>	100
<b>Age (in years)</b>	34.54±14.40
<b>Gender</b>	
Male	75
Female	25
<b>Mode of trauma</b>	
Road traffic accidents	74
Fall from height	16
<b>Type of trauma</b>	
Blunt	93
Penetrating	07
Mean time to reach hospital in hours	1.88
<b>Region of trauma</b>	
Head and neck	35
Face	17
Chest	51
Abdomen	55
Eextremity	75
<b>Outcome</b>	
Alive	84
Dead	16
<b>Trauma scoring</b>	
RTS (mean±SD)	6.90±1.28
ISS (mean±SD)	20.90±9.03
TRISS (mean±SD)	88.41±18.93



**Figure 2: ROC curve.**

**Table 3: Mean ISS, RTS and TRISS among survivors and non survivors.**

Index	Mean±SD (survivors)	Mean±SD (non survivors)	P value
ISS	19.36±8.53	29.00±7.21	<0.0001
RTS	7.24±0.94	5.14±1.38	<0.0001
TRISS	93.95 ± 10.67	59.31±25.72	<0.0001

**Table 4: Comparison of area under roc curve for trauma scoring systems.**

Index	Area under the curve	CI : 95%	P value
ISS	0.163	0.06-0.265	<0.0001
RTS	0.888	0.79-0.986	<0.0001
TRISS	0.926	0.868-0.985	<0.0001

TRISS score was the best predictor of survival in terms of area under the curve (92.60%). Based on the ROC coordinate points, a TRISS cutoff of 64.65% was seen to be associated with high concomitant levels of sensitivity and specificity. The sensitivity for this cut off was 97.60% and specificity was 62.50%. The sensitivity levels fell to 91% for a TRISS cutoff of 79.00% with no concomitant increase in the specificity levels. Based on the contingency analysis, the accuracy of TRISS cut off was 92% with a misclassification rate of 8%. The results were statistically significant with a p value of <0.0001. The sensitivity levels of TRISS cut off 64.65% were 97.62% and specificity of 62.50%. The precision levels associated with this were 93.18% with a negative predictive value of 83.33%.

Based on a logistic regression model for survival as an outcome keeping age, gender, and time to reach the hospital being same for a given patient, it was seen that increasing TRISS was associated with higher odds of survival. The B coefficient was positive (0.113). The results were statistically significant ( $p < 0.0001$ ).

## DISCUSSION

We observed that the mean age of polytrauma patients was 34.5 years. Similar results were reported by Rathore et al with mean age of 30.49 years and Gunawan et al with mean age of 32.4 years.<sup>5,6</sup> We noted in our study that 63% of total number of polytrauma patients were between 20-40 age group which is classified as productive age group. Our results were comparable with studies of Saad et al where 71.4% of the patients were between 20-40 years age.<sup>7</sup> This fact is worrisome as disability and prolonged hospital stay of young patients are likely to impair productivity of the population. In our study, the incidence of trauma was more common among males comprising 75% of the cases against 25% in females. This is comparable with other studies by Singh et al (83.7% males and 16.3% females), Rathore et al (81.4 % males and 18.6% females).<sup>5,8</sup> It is probably because the male

population is the major working force and is involved in travel more frequently than the female population.

Road traffic accidents were the most common mode of trauma responsible for about 74% of the cases followed by fall from height which was responsible for about 16% of cases. Studies like Singh et al showed that Road traffic accidents were responsible for about 72% of total cases followed by 12% cases of fall. Deshmukh et al<sup>1</sup> observed similar results with 71% cases of RTAs followed by 11% cases of fall from height.

Type of injury had significant effect on outcome of trauma patients. Blunt trauma was the commonest type of injury seen in 93% of all cases, mostly due to high incidence of RTAs cases in New Delhi. Rest 7% of cases in our study were of penetrating trauma where firearm injury (57%) was more common followed by stab injury (43%). Study conducted by Rathore et al reported 93% blunt trauma cases as compared to 7% cases of penetrating trauma, Deshmukh et al reported (98.25% blunt and 1.75% penetrating trauma).<sup>1,5</sup> Chaudhary et al<sup>9</sup> reported that firearm injury (64%) was the most common cause of penetrating trauma followed by stab Injury (14%).

Average time to reach hospital in our study was 1.8 hours. Saad et al in their study reported that 96% of patients reached the hospital in the first 2 hours.<sup>7</sup> Singh et al found out that there was a graded increase in mortality with increase in delay in arrival which is comparable to our results.<sup>8</sup> It was observed that the mortality in age categories increased as per the age of study population increased. The patients whose age was 60 or more had higher mortality (66.67%) compared to patients belonging to age group of 20 to 40 (11.11%). Similar results were also obtained in studies of Saad et al where 37.5% patient of above 60 years old age group expired in comparison with 13% patients in the 20 to 40 years age group.<sup>7</sup> This could be attributed to poor physiological reserve of old patients and associated comorbidities. In our study, most commonly involved body region was extremity (75%), followed by abdomen (55%). Gunawan et al reported body regions in their study as extremity (97%), head (60%), abdomen (48.6), chest (32.9) and face (11.4).<sup>6</sup> Injuries to extremity was the most common type of injury as per body region involved in most of the studies including ours.

Many studies have shown that GCS score can be an easy tool in predicting mortality related to trauma patients. Our study also confirmed this as there was difference in GCS score of survivors (12.85±3.47) and the non-survivors (6.75± 3.73) ( $p$  value <0.0001), where the later had poorer GCS score. Similar results were seen by study conducted by Rathore et al which showed that survivors had a better GCS (14.71±1.509) than non survivors (7.05±4.576).<sup>5</sup> GCS was found to be statistically significant variable in terms of the outcome in our study.

The overall RTS score of our patients was 6.90±1.28. Study conducted by Deshmukh et al reported the RTS to

be  $6.63 \pm 1.79$ , Gaikwad et al reported it to be  $(6.98 \pm 1.14)$ .<sup>1,10</sup> The patient who expired showed a significantly lower RTS ( $5.14 \pm 1.38$ ) as compared to that of survivors ( $7.24 \pm 0.94$ ) ( $p$  value  $< 0.0001$ ). Rathore et al reported that the patients who expired showed a significantly lower RTS ( $4.59 \pm 2.09$ ) as compared to that among survivors ( $7.76 \pm 0.445$ ).<sup>5</sup> Deshmukh et al reported RTS of survivors was  $7.49 \pm 0.57$ , whereas that of non survivors was  $4.9 \pm 2.16$  ( $p$  value  $< 0.001$ ).<sup>1</sup> Results of these studies are in consonance with the result of our study. Delay in transportation and underdeveloped prehospital care could be a reason for low RTS of expired patients as it affects physiological parameters of patient. The disadvantage of RTS is that it doesn't take into account the pre-hospital time.

The mean ISS in our study was  $20.90 \pm 9.03$  which were comparable to findings of Gaikwad et al ( $25.47 \pm 12.74$ ) and Deshmukh et al ( $23.7 \pm 8.17$ ).<sup>1,10</sup> The mean ISS was significantly higher than those who died  $29.00 \pm 7.21$  as compared to those who survived  $19.36 \pm 8.53$  ( $p$  value  $< 0.0001$ ). Deshmukh et al reported that mean ISS of survivors was  $20 \pm 5$ , while that of non survivors was  $30.9 \pm 8.48$ .<sup>1</sup> General trend observed was that with increased ISS the percentage of survival is reduced. The high mean ISS of non survivors compared to survivors showed that former had more severe injuries.

The mean TRISS in our study was  $88.41 \pm 18.93$ . Study conducted by Gaikwad et al obtained mean TRISS to be  $85.10 \pm 22.79$ .<sup>10</sup> Similar results were obtained by study conducted by Gunawan et al.<sup>6</sup> TRISS in our study among survivors was calculated to be  $93.65 \pm 10.67$  as compared to  $59.31 \pm 25.72$  among non survivors ( $p < 0.0001$ ). Area under ROC curve using ISS, RTS, and TRISS for predicting death was 0.163, 0.888, and 0.926 respectively; all of these scores were statistically significant in terms of mortality prediction. This was comparable with study by Yousefzadeh-Chabok et al where area under ROC curve for ISS, RTS and TRISS was 0.76, 0.87 and 0.94 respectively showing TRISS to be a better predictor of survival when compared to other scores.<sup>11</sup>

In our study, TRISS score had good sensitivity and specificity at a cut off of 64.65%, sensitivity of 97.60% and specificity of 62.50%. In outcome evaluation based on TRISS by Hadisaputra et al they obtained a sensitivity of 81.8% and specificity of 97.6% with a cut-off point of 33.3%.<sup>12</sup> In accordance with research by Gunawan et al the sensitivity was 84.6% and specificity was 81.8% using an intersection point  $< 90.5\%$ .<sup>6</sup> The results as obtained by these studies were similar to result obtained by us showing TRISS has high sensitivity and specificity and thus can be used as a good predictor of survival and outcome in patients of polytrauma. We also applied logistic regression analysis to see TRISS as a predictor of survival in patients of polytrauma and we found out that TRISS above cut off value of 64.50% was associated with higher odds of survival.

Study conducted by Gaikwad et al reported that according to TRISS, the expected deaths were predicted to be 11.03%, but in actual the deaths were 23.52% showing a negative correlation with TRISS.<sup>10</sup> Similar results were seen by Murlidhar et al where mortality rate predicted using TRISS was 10.89%, but actual mortality rate was 21.26%.<sup>13</sup>

It was seen that TRISS methodology when applied to these setups predicted fewer deaths as compared to the actual deaths and also did not accurately predict the survival in the trauma patients. Rathore et al observed that 41.1% deaths couldn't be explained by using TRISS and it was found less reliable in severely injured patients.

TRISS also has some limitations as the score was not able to calculate multiple injuries in the same body region. It also doesn't include patient systemic comorbidities which may play a contributing factor in patient prognosis. TRISS was also not able to evaluate intubated patients because score was dependent to patients' respiratory rate.

It has to be noted that the outcome of polytrauma patients depends on many factors including severity of trauma, comorbidities, emergency personnel and trauma management system. Lack of adequate resources including inadequate manpower or equipment for patient monitoring can also play a factor for suboptimal care and high mortality. Improvement of health sector with proper and judicious funding for equipment and training of health personnel is needed to improve outcomes.

## CONCLUSION

It was observed that TRISS can predict the survival and mortality in patients of polytrauma with strong factor to predict prognosis, analysed using ROC model (AUC=0.926; CI 95% 0.868-0.985). TRISS also has high sensitivity and specificity value at a cut off of 64.65% and hence it can be used to evaluate quality of service and treatment on patients with polytrauma. TRISS was the best predictor of survival when compared to other scores like RTS and ISS.

TRISS can be utilized to evaluate trauma care and compare trauma care in hospitals as well as to improve and organize trauma care system on a larger scale. TRISS thus can lead to good trauma care which is associated with better prognosis and lesser mortality. However, our study is a single centre study with limited participants due to time bound nature of the study. Multi centre studies with more number of participants are required for further evaluation of effectiveness of TRISS in survival prediction in patients of polytrauma.

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