

# Accuracy of Trauma Injury Severity Score (TRISS) in Khon Kaen Hospital

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## Abstract

**Objective:** To validate the accuracy of the Trauma Injury Severity Score (TRISS) in predicting the probability of survival (Ps) for trauma patients admitted to Khon Kaen Hospital, compared with actual in-hospital mortality.

**Materials and Methods:** This cross-sectional diagnostic study used trauma patient data from the Khon Kaen Trauma Registry, between January 2017 to December 2019. Ps was calculated using the national standard formula and compared to actual mortality. ROC curve analysis was used to determine the optimal Ps cut-off value based on sensitivity and specificity. Data were analyzed using SPSS v25.

**Results:** Data from 44,120 trauma patients were included. Most patients were male (71.1%) with a mean age of 39.6 years, and 86.8% sustained blunt trauma. The mean Revised Trauma Score (RTS) was 7.6, and the mean Injury Severity Score (ISS) was 7.8. A Ps cut-off of >95.0% yielded the highest accuracy (94.65%) for TRISS, with sensitivity and specificity of 79.0% and 93.9%, respectively.

**Conclusion:** The TRISS methodology accurately predicted survival for trauma patients at Khon Kaen Hospital, with improved accuracy achieved by adjusting the Ps cut-off value.

**Keywords:** Trauma Injury Severity Score (TRISS), Revised Trauma Score (RTS), Injury Severity Score (ISS)

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## Introduction

Traumatic injuries are a significant burden to our healthcare system especially in the lower income countries [1]. A lack of modernized public transportation, lack of road traffic law enforcement, and wide geographical landscape lead to a poorer outcome in the majority of traumatic cases. Therefore, by setting up a trauma unit within a tertiary hospital may improve the outcomes of traumatic injuries [2].

Trauma is an important health problem and a major cause of death in the world particularly in young adults and adolescents [3]. The mortality from trauma are the 3<sup>rd</sup> ranking cause of death in Thailand and Road Traffic Injury (RTI) is the major cause of death (Thai Roads Foundation). There were more than 20,000 deaths per year from RTI (Global status report on road safety 2018).

According to the severity of trauma patients, can be divided into mild, moderate and severe by using organ injury and/or physiologic status of the patients to assessment. There are several trauma-scoring systems have been developed over the past 50 years for predict the probability of survival (Ps). However, we still have not found the ideal scoring system available yet. TRISS was first described in 1981 and it has been widely used for a long time. TRISS combines both anatomical and physiological grading of injury severity (Injury Severity Score-ISS and Revised Trauma Score-RTS, respectively) with patient age to predict survival from trauma. TRISS determines the probability of survival (Ps) of a patient from the ISS and RTS.

The purpose of this study to validate the accuracy of the TRISS score to predict probability of survival (Ps) of admitted trauma patients in Khon Kaen Hospital compared with the actual mortality (in-hospital mortality) during 3-years period.

## Materials and Methods

### Study design and populations

This is a cross-sectional analytic study. The data was collected from all trauma patients with any ages who admitted to the division of Trauma Surgery between January 2017 and December 2019. All data was Collected from Trauma

Registry of Khon Khan Hospital. The data collection included baseline demographic data, RTS, ISS, TRISS score and actual mortality of trauma patients (in-hospital mortality).

TRISS determined the probability of survival (Ps) of patient from the ISS and RTS Using the following formula:

$$Ps = 1/(1+e^{-b})$$

$$e = 2.718282$$

Where 'b' was calculated from:

$$b = b_0 + b_1(\text{RTS}) + b_2(\text{ISS}) + b_3(\text{age index}) [4,5]$$

The coefficients b<sub>0</sub>-b<sub>3</sub> were derived from multiple regression analysis of the Major Trauma Outcome Study (MTOS) database. Age Index was 0 if the patient was below 54 years of age or 1 if 55 years and over. b<sub>0</sub> to b<sub>3</sub> were coefficients, which were different for blunt and penetrating trauma. If the patient was less than 15, the blunt coefficients were used regardless of mechanism.

Blunt injury: b<sub>0</sub> = -1.2470, b<sub>1</sub> = 0.9544, b<sub>2</sub> = -0.0768, b<sub>3</sub> = -1.9052

Penetrating injury: b<sub>0</sub> = -0.6029, b<sub>1</sub> = 1.1430, b<sub>2</sub> = -0.1516, b<sub>3</sub> = -2.6676

This study was approved by the Research Ethics Committee of the Khon Khan hospital (KEXP65036).

### **Statistical analysis**

Statistical data was analyzed by statistical package for the social sciences (SPSS) for Window Version 25.0. The outcome measurements were used for predicting the survival of admitted trauma patients at Khon Khan hospital and were compared with the actual mortality. The area under the receiver operating characteristic (ROC) curve of sensitivity versus 1-specificity between observed and expected risk of mortality was used to find the cut-off value for Ps that was the most accurate level of TRISS.

## Results

### Demographic characteristics

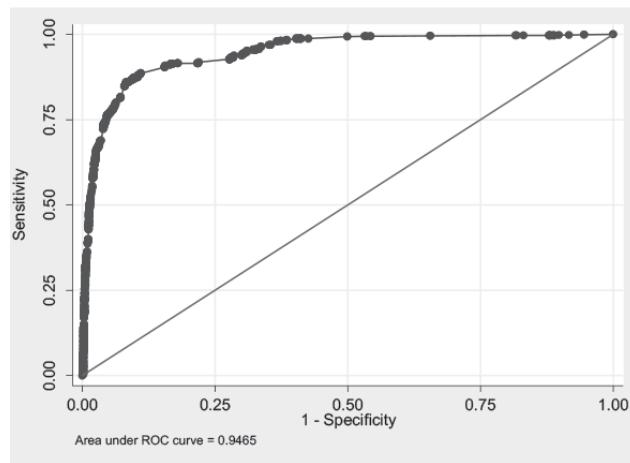
We reviewed 44,120 admitted trauma patient's data in Khon Khan hospital between January 2017 and December 2019. The majority patients were male (71.1%), Mean age 39.6, 86.8% were blunt injuries. The mean Revised Trauma Score (RTS) was 7.6 and the mean Injury Severity Score (ISS) was 7.8. The demographic and clinical characteristics were shown in the **Table 1**.

**Table 1** Demographic and clinical characteristics of Trauma patients (n=44,120)

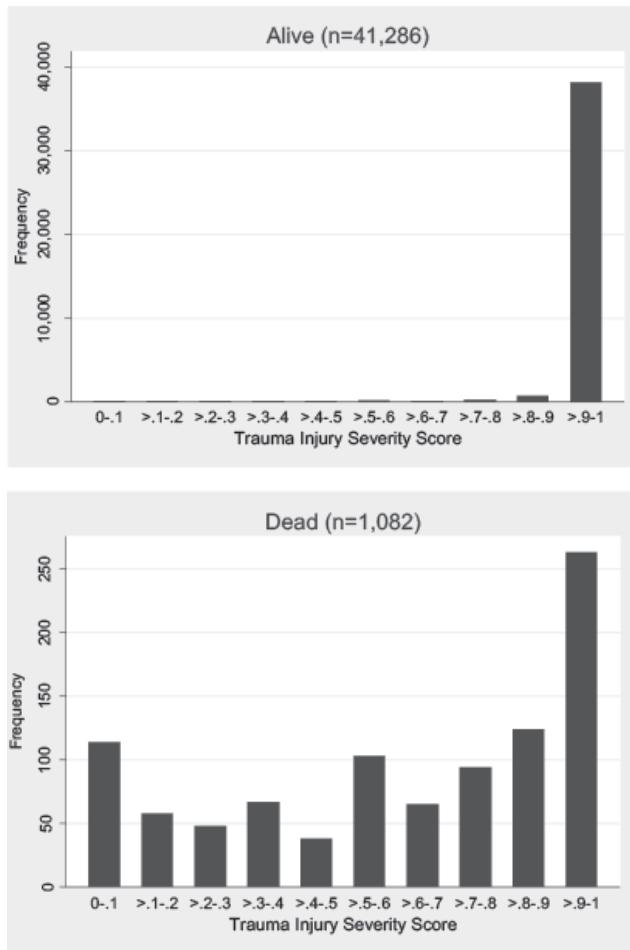
	Total (n=44,120)	
	N	%
Gender: Male	31,444	71.1%
Age: Mean $\pm$ SD (years)	39.6	$\pm$ 21.1
Injury type		
Blunt injury	38,297	86.8%
Penetrating injury	5823	13.2%
Injury Severity Score (ISS)	7.8	$\pm$ 6.5
Revised Trauma Score (RTS)	7.6	$\pm$ 1.0
Death	1,082	2.6%

### The probability of survival in Khon Khan hospital

The receiver operating characteristic (ROC) curve for TRISS was showed in **Figures 1**. The Area under the ROC curves of TRISS in Khon Khan hospital were 0.9465. Figures 2 displayed histograms of probability of survival using TRISS methodology among patients who were either death or alive. The cut-off value for  $Ps >95.0\%$  was the most accurate level of TRISS of which the sensitivity and specificity of TRISS were 79.0% and 93.9% respectively. The detail of sensitivity and specificity for different cut point of  $Ps$  are show in **Table 2**.



**Figure 1** The receiver operating characteristic (ROC) curve for TRISS



**Figure 2** histograms of probability of survival using TRISS methodology among patients who were either death or alive.

**Table 2** Sensitivity and Specificity of different cut point for probability of survival from TRISS.

probability	Sensitivity	specificity	PPV	NPV
5	6.9	99.8	48.9	97.8
10	11.7	99.8	57.9	97.9
15	14	99.8	58.9	97.9
20	17.8	99.7	58.1	98
25	20.2	99.7	58.8	97.9
30	22.6	99.6	59.8	98.1
35	26.3	99.5	56.9	98.2
40	29.5	99.5	57.2	98.3
45	32	99.4	56.5	98.4
50	33.4	99.3	53.2	98.4
55	36.3	99.1	49.7	98.5
60	43.9	98.8	47.9	98.6
65	47.9	98.7	48.1	98.7
70	50.6	98.6	46.3	98.8
75	53.4	98.3	43.8	98.9
80	60.3	97.9	41	99
85	65.6	97.4	38.3	99.1
90	73	96	31	99.3
95	79	93.9	24.2	99.5

### The probability of survival and associated factors

The factors associated with probability of survival are presented in **Table 3**. The result showed that the significant were RTS ( $p < 0.001$ ), ISS ( $p < 0.001$ ), Age index ( $p < 0.001$ ) and mechanism of injury ( $p < 0.001$ ) Adjusted OR and 95% CI of factors associated with probability of survival were shown in the **Table 4**.

**Table 3** Variables that associate with probability of survival

	Mean(SD) or Number(%)		p-value
	Alive (N=41,201)	Dead (N=1,082)	
Mechanism of injury			< 0.001*
Blunt	35,990 (97.4)	979 (2.6)	
Penetrating	5,206 (98.1)	103 (1.9)	
Age index			< 0.001*
< or = 54	30,637(98.0)	641 (2.0)	
➤ 54	10,643 (96.0)	441 (4.0)	
RTS	7.6 (0.8)	4.7 (2.3)	< 0.001*
ISS	7.4 (6.1)	20.7 (9.6)	< 0.001*

**Table 4** showed the adjusted OR and 95% CI of factors associated probability of survival. The result showed that risk factors for probability of survival were RTS (OR =0.42; 95% CI 0.40 – 0.44), ISS (OR = 1.11; 95% CI 1.10 – 1.12), Age index > 54 (OR 3.30 ;95%CI 2.79, 3.90) and Mechanism of injury not significant to probability of survival (OR 0.93 ;95%CI 0.60, 1.46)

**Table 4** Multivariate Logistic Regression analysis of factors associated with probability of survival

Factors	Adj OR	95% CI		p-value
RTS	0.42	0.40	0.44	<0.001 *
ISS	1.11	1.10	1.12	<0.001 *
Age index > 54	3.30	2.79	3.39	<0.001 *
Mechanism of injury : Blunt(Ref.) = 1	0.93	0.60	1.46	
Penetrating injury				

## Discussion

A trauma scoring system is an important step to identify patients at high risk of death. It allows accurate triaging of severely injured patients. Several score systems have been developed to assess the severity of injury. The TRISS score is widely used to predict the trauma outcome. The objective of the study was to determine the accuracy of the TRISS score to predict survival of admitted trauma patients in Khon Kaen Hospital.

Accuracy of TRISS score for prediction from ROC curve was good diagnostic tool. (The Area under the ROC curves were 0.9465) then improving by adjusting the cut-off value. The most accurate level of TRISS is 79% sensitivity and 93.9% specificity and the cut-off value of  $Ps > 0.95$ . Therefore, it could be used as a description of overall injury severity for injured patients and to compare the results between alternative treatments to improve the quality of trauma system at Khon Khan Hospital

Regarding the literature review, Similar to this study. Preecha Siritongtaworn et. al [6] study the TRISS score in Trauma patients in Siriraj hospital. That study show that TRISS Score is good diagnostic tool. (The sensitivity and specificity were 90.9% and 97.2% respectively.) by adjusting the cut-off value.  $Ps > 95.0\%$  was the most accurate level of TRISS same as this study. Shahrokh Yousefzadeh-Chabok et. al [9] study the valid of trauma score at Pour-Sina Hospital in Rasht-Iran. That study showed that the best diagnostic tool to predict the probability of survival was TRISS score prepare to RTS and ISS. (Sensitivity of 99%, 84%, and 95% and Specificity of 62%, 62%, and 72%, respectively.) Although Jih Huei Tan et. al [8] that study the validation of the trauma mortality prediction scores from a Malaysian population showed that the best diagnostic tool was NISS score, but the TRISS score also good diagnostic tool. (AUC for the NISS and TRISS were 0.878, and 0.848, respectively.)

From this study, although multiple factor associate to the of probability of survival was RTS ( $p < 0.001$ ), ISS ( $p < 0.001$ ), Age index ( $p < 0.001$ ) and mechanism of injury ( $p < 0.001$ ), but Mechanism of injury was not significant to probability of

survival by adjusted OR and 95% CI of factors (OR 0.93 ; 95% CI 0.60, 1.46) The most impact to probability of survival was age (OR 3.30 ; 95% CI 2.79, 3.90).

There are some limitations of the present study. The ISS was found in the TRISS, particularly the inability to account for multiple injuries to the same body region. Similar to the RTS, intubated patients were excluded from TRISS because respiratory rates and verbal responses were not obtainable. The specific conditions of the countries such as the epidemiology of trauma, the emergency medical services, referral system, and the medical care could not be overlooked. Finally, variations in trauma outcomes might be a result of a number of factors, including patient injury severity and co-morbidities, individual practitioner management of trauma, and center-specific systems management of trauma.

## **Conclusion**

Mortality in traumatic patients is high, and based on our results, TRISS is the most powerful predictor of mortality in these patients, which may be due to consideration of physiological and anatomical parameters. Thus, Authors find that the accuracy of TRISS methodology for prediction in Khon Khan Hospital is improved by adjusting the cut-off value. Therefore, it should be used as a more accurate description of overall injury severity

## **Conflict of interest**

The authors, hereby, declare no conflict of interest.

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