The Use of Trauma Score-Injury Severity Score (TRISS) at Siriraj Hospital: How Accurate Is It?

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Objective: *Trauma Score-Injury Severity Score (TRISS) is one of the most universally deployed scores. It is based on both the physiologic Revised Trauma Score (RTS) and anatomic Injury Severity Score (ISS).The purpose of the present study was to validate the accuracy of the TRISS methodology to predict survival of admitted trauma patients at Siriraj Hospital when compared with the actual mortality (discharged or dead) during 1-year period.*

Material and Method: *One thousand four hundred eighty seven trauma patients were admitted to the Division of Trauma Surgery, Department of Surgery, Faculty of Medicine, Siriraj Hospital between October 1, 2004 and September 30, 2005. The probability of survival (Ps) was calculated for each patient according to the TRISS method. It was used to assess injury severity and to compare with the actual outcome in injured patients. The data was analyzed by SPSS version 12.*

Results: *The majority of the patients were men (77.1%), mean age 38.7 $\pm$ 19.8 years; 75.0% were blunt injuries. The mean Revised Trauma Score (RTS) was 7.6 $\pm$ 0.8 and the mean Injury Severity Score (ISS) was 10.2 $\pm$ 8.3. The cut-off value for Ps > 95.0% was the most accurate level of TRISS of which the sensitivity and specificity of the TRISS methodology were 90.9% and 97.2% respectively.*

Conclusion: *Accuracy of TRISS methodology for prediction of survival of the patients in Siriraj Hospital was confirmed, and improved by adjusting the cut-off value.*

Keywords: *Trauma score-injury severity score (TRISS), Revised trauma score (RTS), Injury severity score (ISS), Probability of survival (Ps)*

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Trauma is an important health problem and a leading cause of death particularly in young adults and adolescents[1]. The resulting mortality accounts for a higher number of life years lost. The severity and the resulting disability is higher than in any other disease. Several trauma-scoring systems have been developed over the past 30 years, but it now seems that there is no ideal scoring system available[2]. TRISS was first described in 1981 and it has been proved popular over time. Champion and Boyd have demonstrated that the predictive capacity of any model is increased by the inclusion of additional relevant information in the development of the TRISS[3-5]. This method combines both anatomical and physiological grading of injury severity (Injury Severity Score-ISS and Revised Trauma Score-RTS, respectively) with patient age in order to predict survival from trauma. TRISS determines the probability of survival (Ps) of a patient from the ISS and RTS[6] and has served as the standard for outcome prediction in trauma for the last 20 years[7]. Several published examples employing TRISS methodology in systems outcome analysis exist, yet little has been written regarding its current utility and application to an individual trauma center's quality-monitoring program[8]. Siriraj Trauma Registry in the years 1996 to 2002 reported all trauma patients were about 25,000 cases/year with more than 1,500 inpatients each year. In 2003, more than 2,000 trauma cases were admitted to Siriraj Hospital. The number of trauma patients continued to rise [9].

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The purpose of the present study was to validate the accuracy of the TRISS methodology to predict survival of admitted trauma patients at Siriraj Hospital compared with the actual mortality (survival to discharge or dead) during 1-year period. If accurate, it can be used as a description of overall injury severity for an individual patient or a population of injured patients. Furthermore, if the expected probability of death can be accurately assessed, meaningful comparisons of results between alternative treatments, institutions, and trauma systems will be possible[2,10-14].

Material and Method

The research design was a diagnostic test study. All 1,487 traumatic patients were admitted to the Division of Trauma Surgery, Department of Surgery, Faculty of Medicine, Siriraj Hospital between October 1, 2004 and September 30, 2005. Siriraj Hospital served as a tertiary care and referral hospital (level I designated trauma center) and was available 24 hours for trauma management.

TRISS determined the probability of survival (Ps) of a patient from the ISS and RTS using the following formulae:

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

$e = 2.718282$

Where 'b' was calculated from:

$b = b_0 + b_1 (RTS) + b_2 (ISS) + b_3 (age\ index)$[15,16]

The coefficients b0-b3 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. b0 to b3 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:
b0 = -1.2470, b1 = 0.9544, b2 = -0.0768, b3 = -1.9052
Penetrating injury:
b0 = -0.6029, b1 = 1.1430, b2 = -0.1516, b3 = -2.6676

Data collection and analysis

The study group was all trauma patients aged 15 years or older who were transported to our trauma center alive. These patients were resuscitated and investigated. Both the patients who were declared dead in the emergency department and admitted to Siriraj Hospital were included in the present study. Eighty-eight patients were excluded due to incomplete data. The Revised Trauma Score (RTS)[17] was recorded in Trauma Score record form (Fig. 1) by general surgery resident at the time of registration. RTS comprised of three different variables via weighting score *i.e.*, Glasgow Coma Scale score, systolic blood pressure, and respiratory rate (Table 1)[18]. After the patients were stabilized, investigated (roentgenogram or CT scan), and an intra-operative finding was obtained, the ISS (summing the square of the Abbreviated Injury Scale <AIS> in the three most severely injured body regions) was recorded. Calculation of RTS, ISS, and TRISS were validated by a computerized trauma registry.

Outcome measurements were used for predicting the survival of admitted trauma patients at Siriraj Hospital and were compared with the actual

SIRIRAJ TRAUMA SCORE RECORD

Name ..... Surname ..... Age ..... yr
HN ..... AN ..... Ward .....

on admission __/__/__ on discharge __/__/__

Mechanism of injury ..... BLUNT / PENETRATING

REVISED TRAUMA SCORE (RTS)

Clinical parameter	Category	Score
Respiratory rate (Breaths per minute)	10-29	4
	➢ 29	3
	6-9	2
	1-5	1
	0	0
Systolic blood pressure (mmHg)	➢ 89	4
	76-89	3
	50-75	2
	1-49	1
	0	0
Glasgow Coma Scale	13-15	4
	9-12	3
	6-8	2
	4-5	1
	3	0

Sum _____

Injury Severity Score (ISS)

ISS BODY REGION	AIS SCORE	SQUARED
HEAD /NECK	.....	.....
FACE	.....	.....
THORAX	.....	.....
ABD /PELVIC CONTENTS	.....	.....
EXTREMITIES /PELVIC GIRDLE	.....	.....
EXTERNAL	.....	.....

ISS (sum of squares of 3 most severe only) _____

Fig. 1 Siriraj Trauma Score Record

Table 1. Variables and weights for RTS calculation[18]

Glasgow coma scale (GCS)	Systolic blood pressure (SBP)	Respiratory rate (RR)	Coded value
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

RTS = 0.9368 GCS + 0.7326 SBP + 0.2908 RR

Table 2. Characteristics of 1487 trauma patients admitted during 1-year period

Variables	Mean ± SD or number (%)
Gender	
Male	1146 (77.1%)
Female	341 (22.9%)
Age (yrs)	38.70 ± 19.75
Injury type	
Blunt	1118 (75.2%)
Penetrating	369 (24.8%)
Injury Severity Score (ISS)	10.17 ± 8.34
Revised Trauma Score (RTS)	7.62 ± 0.75
Death	66 (4.40%)

mortality (survival to discharge or dead). Both 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. Data management was performed using SPSS® statistical software version 12.0

Results

The present study consisted of 1,487 trauma patients admitted to the Division of Trauma Surgery, Department of Surgery, Faculty of Medicine, Siriraj Hospital between October 1, 2004 and September 30, 2005. The results are illustrated in Table 2. The patients' age ranged from 15-97 years old. The majority of the patients were men (77.1%) and 75% were blunt injuries. Fig. 2 displayed histograms of probability of survival using TRISS methodology among patients who were either dead or alive. Plot of sensitivity against 1-specificity in receiver operating characteristic (ROC) curve is shown in Fig. 3. Details of sensitivity

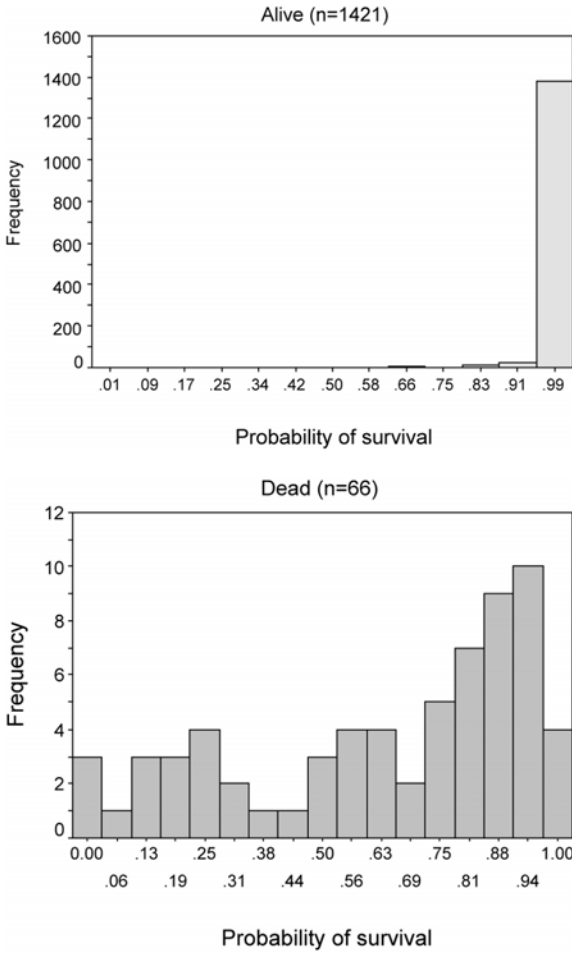

Fig. 2 Histograms of probability of survival among deaths and survivors

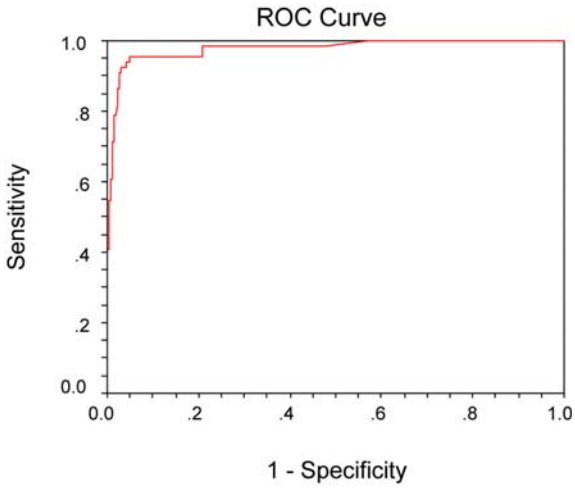

Fig. 3 Receiver operating characteristic (ROC) curve for TRISS

Table 3. Sensitivity and specificity of different cut point for probability of survival from TRISS

Probability	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
20	13.6	99.9	90.0	96.1
25	19.7	99.9	92.9	96.4
30	21.2	99.9	93.3	96.5
40	25.8	99.9	89.5	96.7
50	30.3	99.9	90.9	96.9
60	39.4	99.9	92.9	97.3
70	45.5	99.6	83.3	97.5
75	51.5	99.5	82.9	97.8
80	57.6	99.2	76.0	98.1
90	75.8	98.5	70.4	98.9
95	90.9	97.2	60.0	99.6

NPV = negative predictive value
PPV = positive predictive value

Table 4. Analysis of factors affecting survival

	Mean ± SD or number (%)		p-value
	Alive (n = 1421)	Dead (n = 66)	
RTS	7.73 ± 0.45	5.21 ± 1.53	<0.001
ISS	9.13 ± 6.54	32.53 ± 11.28	<0.001
Age index			
≤ 54	1145 (80.6%)	52 (78.8%)	0.720
> 54	276 (19.4%)	14 (21.2%)	
Mechanism			
Penetrating	364 (25.6%)	5 (7.6%)	0.001
Blunt	1057 (74.4%)	61 (92.4%)	

and specificity for different cut point of Ps are illustrated in Table 3. Table 4 displays analysis of factors affecting survival. RTS, ISS, and the mechanism of injuries significantly affect to survival. Table 5 reveals the sensitivity and specificity of different cut points for probability of survival from TRISS after excluding 264 neurological trauma cases. The accuracy of TRISS remained the same. Table 6 displays sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of ISS and RTS. A cut-off point of ISS greater than 14 gave the highest sensitivity of 98.5% and a specificity of 86.3%, respectively. With regard to RTS, the use of a cut-off point of less than 7 provided a sensitivity of 90.9% and a specificity of 93.7%.

Table 5. Sensitivity and specificity of different cut-off points for probability of survival from TRISS after excluding 264 neurological trauma cases

Probability	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
20	13.0	100.0	100.0	98.4
25	17.4	100.0	100.0	98.4
30	21.7	100.0	100.0	98.5
40	34.8	100.0	100.0	98.8
50	43.5	99.9	90.9	98.9
60	43.5	99.9	90.9	98.9
70	52.2	99.7	80.0	99.1
75	52.2	99.7	75.0	99.1
80	60.9	99.6	73.7	99.3
90	73.9	99.2	63.0	99.5
95	91.3	98.7	58.3	99.8

NPV = negative predictive value
PPV = positive predictive value

Table 6. Sensitivity and specificity of ISS and RTS

(a) ISS

ISS	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
> 14	98.5	86.3	25.0	99.9
> 13	98.5	84.2	22.4	99.9
> 12	98.5	82.1	20.3	99.9

(b) RTS

RTS	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
< 5	40.9	99.4	97.3	75.0
< 6	69.7	97.6	98.6	57.5
< 7	90.9	93.7	99.6	40.3

Discussion

Several score systems have been developed to assess the severity of injury. Even though the TRISS methodology is widely used to predict the trauma outcome, it has potential limitations. A recent study documented that methods to improve the TRISS methodology, including the addition of co-morbidities and stratification of age by 10-year intervals, were associated with improved predictive performance of TRISS in trauma outcomes[15]. Most recently, data from

the National Trauma Data Bank with records of 72,517 trauma patients (62,103 blunt, 10,414 penetrating) were used to examine the use of different methods of TRISS calculation. Multiple logistic regressions were used to recalculate the TRISS coefficients in models using both the original TRISS covariates and in models that also included variables for co-morbidities that could potentially affect survival[17].

The presented study confirmed that the traditional TRISS had limited ability to predict survival after trauma. Accuracy of prediction was improved by recalculating the TRISS coefficients, but additional improvements were not seen with models that included information about co-morbidities.

There are some limitations of the present study. The authors' first concern when analyzing the data was the large number of admitted patients but small measured dead cases. In addition, the problem associated with the ISS was found in the TRISS[19], 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[20]. 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.

Accuracy of TRISS methodology for prediction in Siriraj Hospital was improved by adjusting the cut-off value. The most accurate level of TRISS is 97% sensitivity and 91% specificity, at 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 Siriraj Hospital.

Conclusion

The predictive ability of TRISS, a trauma score that combines anatomic and physiologic measures, is superior to anatomic-based models such as ISS, but comparable with other physiologic-based models such as RTS. The authors find that the accuracy of TRISS methodology for prediction in Siriraj Hospital is improved by adjusting the cut-off value. Therefore, it should be used as a more accurate description of overall injury severity for injured patients and compared with the results between alternative treatments to improve the trauma system at Siriraj Hospital.

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ความแม่นยำของ Trauma Score-Injury Severity Score (TRISS) เมื่อนำมาใช้ในโรงพยาบาลศิริราช

ปรีชา ศิริทองถาวร, สุภาพร โอภาสานนท์

การประเมินความรุนแรงการบาดเจ็บในผู้ป่วยอุบัติเหตุมีอยู่ด้วยกันหลายระบบ Trauma Score-Injury Severity Score (TRISS) เป็นการประเมินความรุนแรงการบาดเจ็บทั้งด้านกายภาพ และสรีรวิทยาของผู้ป่วยอุบัติเหตุซึ่งมีความแม่นยำสูง และเป็นที่นิยมใช้อย่างแพร่หลายทั่วโลก การศึกษานี้มีจุดประสงค์เพื่อหาความแม่นยำของ TRISS ในการประเมินโอกาสรอดชีวิตของผู้ป่วยอุบัติเหตุโดยเปรียบเทียบกับการมีชีวิตรอดจริง การศึกษาทำในผู้ป่วยอุบัติเหตุ 1,487 คนที่รับไว้รักษาตัวในโรงพยาบาลศิริราชระหว่าง 1 ตุลาคม พ.ศ. 2547 ถึง 30 กันยายน พ.ศ. 2548 ผู้ป่วยส่วนใหญ่เป็นเพศชาย (ร้อยละ 77.1) และบาดเจ็บจากแรงกระแทก (ร้อยละ 75.0) อายุเฉลี่ย 38.7 ± 19.8 ปี Revised Trauma Score (RTS) เฉลี่ยเท่ากับ 7.6 ± 0.8 และ Injury Severity Score (ISS) เฉลี่ยเท่ากับ 10.2 ± 8.3

ผลการศึกษาพบว่า TRISS มีความแม่นยำในการทำนายโอกาสการมีชีวิตรอดของผู้ป่วยอุบัติเหตุในโรงพยาบาลศิริราช โดยจะมีความแม่นยำมากที่สุดเมื่อคำนวณคะแนนบาดเจ็บของผู้ป่วยอุบัติเหตุ และคิดเป็นโอกาสการมีชีวิตรอดมากกว่าร้อยละ 95.0 ซึ่งมี sensitivity และ specificity เท่ากับร้อยละ 90.9 และร้อยละ 97.2 ตามลำดับ