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Original Article

External Validation of the Trauma Injury Severity Score (TRISS) in Patients with Major Injuries at a Tertiary Care Public Hospital in Thailand

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Abstract

Objective: To externally validate TRISS's probability of survival in a tertiary care hospital in northeastern Thailand.

Materials and Methods: A retrospective cohort prognostic study included patients with significant injuries (ISS > 15) admitted to the hospital from 2011 to 2022 from the Khon Kaen trauma registry. Baseline characteristics were identified. AuROC presented the accuracy of the model. The age group was used as a subgroup analysis. The primary outcome was in-hospital mortality.

Results: This retrospective cohort study was conducted at a tertiary care public hospital in northeastern Thailand. A total of 20,867 patients were included. Missing primary outcome data were excluded. Most patients were male (75.23%). The mean age was 38.19 ± 19.65 years. The mean ISS was 20.17 ± 5.28. The mortality rate was 15.33%. AuROC was 0.8388. Subgroup analysis by age group showed a statistically significant reduction in AuROC by increasing age.

Conclusion: The accuracy of the TRISS model in a tertiary care hospital in Thailand was excellent, as close as MTOS. The accuracy was decreased by age. The TRISS model is applied to trauma quality improvement programs in Thailand.

Keywords: TRISS, Major trauma, External validation, Prediction model

Introduction

Unintentional injuries were the leading cause of death worldwide, especially in young adults.[1] It caused a significant loss in gross domestic product (GDP) and workforce that drove the country. There have been attempts to reduce such mortality and morbidity from the injuries. Benchmarking, by comparing preventable death rates within and among the hospitals, served as one tool among many in the trauma quality improvement program.[2] Reduction in deaths may reflect better prevention and management policies. A trauma registry collecting data on the probability of survival (PS) was used for the criteria. Deaths among patients with a PS greater than 0.5 were considered preventable,[2] including Thailand. The next step would be a Morbidity and mortality (M&M) conference, where the committee would analyze what occurred and devise strategies to prevent such deaths from happening again.

One of the most widely used PS models in trauma patients was the trauma injury severity score (TRISS), developed from a Major Trauma Outcome Study (MTOS) in the United States.[3,4] It combines anatomic, physiologic, and comorbidity survival criteria. Injury severity score (ISS), revised trauma score (RTS), age, and the mechanism of injury were used to develop the model using logistic regression. Although there were some

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modifications and validations of the model in low-to-middle-income countries,[5-11] the standard for comparative evaluation remained the original model. There has been no external validation of the TRISS model in Thailand, which has one of the highest rates of road traffic injuries (RTIs),[12] and differs significantly in injury epidemiology from the data used to develop the original model; this divergence might affect the model's accuracy.

The objective of this study is to externally validate the TRISS model in Khon Kaen Hospital, a tertiary care hospital and referring trauma center in northeastern Thailand.

Materials and Methods

Study design and collection

A retrospective, prognostic cohort study was conducted using the trauma registry of a trauma center in our hospital. The institutional ethics committee approved the proposal. The data were collected by an online trauma center injury surveillance (IS) officer from 1st January 2011 to 31st December 2022. All patients admitted during this period, whether to the trauma ward or other departments, were included in this study. Due to the comprehensive inclusion, the study size was not calculated. A trauma center IS online officer conducted data entry in real time to reduce recall bias.

Participants

The eligibility criteria include all the patients with significant trauma defined by ISS as more important than 15,[13] admitted to our hospital. The exclusion criterion was patients declared dead before arrival. The follow-up period extended up to discharge status, either survived or dead.

Variables and outcomes

The predictors in this study were the parameters in the TRISS probability of survival (PS) model: age, mechanism of injury, injury severity score (ISS), revised trauma score (RTS), and Glasgow coma scale (GCS) score. Sex was also included as a predictor.

No potential confounders or effect modifiers were identified, as each predictor served as a prognostic factor. The trauma center IS officer would assign the Abbreviated Injury Scale (AIS) for each injury and automatically calculate the ISS. The 1998 version of the AIS was used for AIS coding in all patients. RTS was derived from systolic blood pressure (SBP), respiratory rate (RR), and GCS score collected from the trauma registry and automatically calculated. The primary outcome was in-hospital mortality.

TRISS calculation model

The TRISS model was first developed and used in North America to predict mortality and has been accepted as one of the best models for estimating trauma survival. It is a combined scoring system consisting of ISS as the anatomical criterion, RTS as the physiological criterion, and age as the comorbidity criterion. The scores are calculated using coefficients derived from logistic regression, which are separated by the mechanism of injury.[3]

The ISS ranges from 0 to 75 and is calculated from the AIS score. Age is categorized into 0 and 1, with patients aged 18 to 54 categorized as 0 and those aged 55 and over as 1. The RTS is determined by three parameters: SBP, RR, and GCS score. These parameters are combined into a coefficient as follows:

For blunt mechanism trauma,

$$b = (-0.4499) + (0.8085)(RTS) + (-0.0835)(ISS) + (-1.7430)(Age)$$

For penetrating mechanism trauma,

$$b = (-2.5355) + (0.9934)(RTS) + (-0.0651)(ISS) + (-1.1360)(Age)$$

For PS calculation, the equation is $PS = 1/(1- e^{b})$

PS values range from 0 to 1.

Statistical analysis

Categorical data were described using frequency and percentage and tested using Fisher's exact probability test. Normally distributed continuous data were described using means and standard deviations and were tested using independent t-tests. Non-normally distributed continuous data were described using the medians and interquartile ranges. Statistical uncertainties were expressed as 95% two-sided confidence intervals in all analyses. A p-value less than 0.05 was considered statistically significant. No multivariable adjustment was used in the analyses. The primary outcome others were shown as missing data, presented as counts (n) and percentages (%). All statistical analyses were performed with STATA version 16 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC). The area under the receiver operating characteristic (AuROC) curve was plotted between survival and PS.

Results

The data were collected from January 2011 to December 2022 from all significant trauma victims admitted to the hospital. None of the patients were excluded. A total of 20,867 patients were included. The missing primary outcome data numbered 2,362 (11.32%). Most patients were male (75.23%). The mean age was 38.19 ± 19.65 years. The main mechanism of injury was blunt (92.96%). The in-hospital mortality was 15.33%. Physiologic characteristics are shown in Table 1. All of the results from Table 1 were statistically significant between survivors and those deceased.

Table 1 Baseline characteristics of major trauma patients

Baseline characteristics	Missing data, n (%)	all, n = 20,867	Survivors, n = 15,669 (84.67%)	Dead, n = 2,836 (15.33%)	*p*-value
Male, n (%)	1,640 (7.86)	12,954 (75.23)	10,798 (74.25)	2,156 (80.54)	0.000
Age, years (mean ± SD)	8 (0.04)	38.19 ± 19.65	37.15 ± 19.47	43.93 ± 19.69	0.000
Mechanism: blunt (%)	2,795 (13.39)	16,799 (92.96)	12,449 (92.72)	2,609 (97.35)	0.000
SBP at ER, mmHg (mean ± SD)	132 (0.63)	126.34 ± 35.88	127.72 ± 31.96	118.68 ± 51.89	0.000
RR at ER, bpm [median, IQR]	54 (0.26)	20 [0, 20] 2	20 [0, 20]	0 [0, 18]	0.000
eGCS at ER [median, IQR]	82 (0.39)	4 [1, 4]	4 [3, 4]	1 [1, 3]	0.000
vGCS at ER [median, IQR]	70 (0.34)	5 [1, 5]	5 [1, 5]	1 [1, 1]	0.000
mGCS at ER [median, IQR]	97 (0.46)	6 [5, 6]	6 [5, 6]	4 [1, 5]	0.000
GCS at ER [median, IQR]	100 (0.48)	15 [7, 15]	15 [10, 15]	6 [3, 9]	0.000
ISS (mean ± SD)	5,905 (28.30)	20.17 ± 5.28	19.43 ± 4.39	23.63 ± 4.35	0.000
RTS (mean ± SD)	183 (0.88)	6.48 ± 1.83	6.85 ± 1.51	4.41 ± 2.08	0.000
TRISS - PS (mean ± SD)	5,998 (28.74)	0.84 ± 0.24	0.90 ± 0.18	0.58 ± 0.31	0.000

SD = standard deviation; SBP = systolic blood pressure; ER = emergency room; RR = respiratory rate; bpm = beat per minute; IQR = interquartile range; eGCS = eye response in Glasgow coma scale; vGCS = verbal response in Glasgow coma scale; mGCS = motor response in Glasgow coma scale; ISS = injury severity score; RTS = revised trauma score; TRISS – PS = trauma injury severity score probability of survival

The AuROC curve tested the accuracy of the TRISS in major trauma patients. The area under the curve was 0.8400. Figure 1 shows the AuROC curve of the TRISS model.

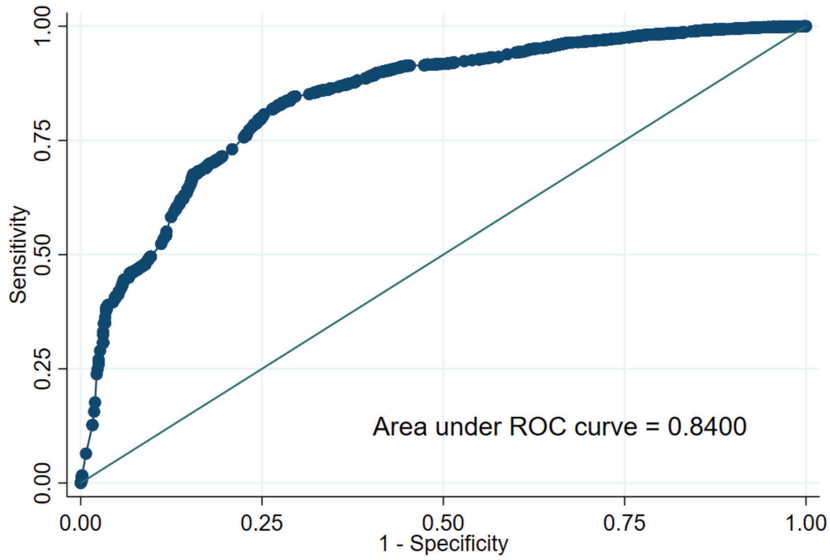

Figure 1 Area under receiver operating characteristic (AuROC) curve

In a subgroup analysis by age presented in Table 2, there was a decrease in AuROC as age increased. The difference between age groups was statistically significant (p-value < 0.001)

Table 2 Subgroup analysis by age

Age group (years)	Observation	AuROC	95% CI
0 - 20	2,881	0.8999	0.88260, 0.91715
21 - 40	4,663	0.8626	0.84713, 0.87803
41 - 60	4,623	0.8126	0.79678, 0.82840
61 - 80	2,315	0.7843	0.76122, 0.80742
> 80	294	0.8109	0.75597, 0.86585

AuROC = area under receiver operating characteristic; CI = confidence interval

In comparing AuROC curves among TRISS, RTS, and ISS, the TRISS model showed the best performance, which was statistically significant (Table 3).

Table 3 Comparison of TRISS, RTS, ISS

Models	Observation	AuROC	95% CI	
TRISS	14,780	0.84	0.83156	0.84854
RTS	14,780	0.804	0.79408	0.81382
ISS	14,914	0.6609	0.64790	0.67383

p-value < 0.001
AuROC = area under receiver operating characteristic; CI = confidence interval; TRISS = trauma injury severity score; RTS = revised trauma score; ISS = injury severity score

Discussion

There were more than 50 prediction models for trauma patients.[14] TRISS was among the most popular due to the nature of the combination scoring system and its accuracy. Through several external validations in various countries and settings, including low-to-middle-income countries and RTIs,[11,15-17] most used a small sample size. The TRISS model also had limitations,[18] such as the inability to account for multiple severe injuries in a single body part, an inability to predict a low mechanism of injury, and a lack of accuracy in interhospital comparisons.

RTIs were the leading cause of death among trauma patients in Thailand, an upper-middle-income country,[19] ranking 20th countries with RTI deaths. This injury epidemiology differed from the MTOS study, which raised questions about the applicability of the TRISS model in the country.

The accuracy of the TRISS model in this study was consistent with the MTOS and Malaysian National Trauma Data Bank (NTrD) studies.[10] The AuROC curve of the TRISS from Khon Kaen Hospital's trauma registry showed excellent prediction, implying generalizability in countries with various road infrastructures, traffic laws, and RTI prevention policies.

On the other hand, subgroup analysis by age group showed a decline in the AuROC curve with increasing age groups. The applicability in the elderly population may be questionable, highlighting the limitation of the TRISS model as comorbidity scores were only binary and too rough to distinguish the difference.

The TRISS model also exhibited the best performance among other scoring systems. According to the TRISS scoring system, which was the combined model, this is straightforward; RTS is a physiologic score, and ISS is an anatomical score.

This study is a pioneer in external validation of the TRISS model in a tertiary care public hospital in Thailand, a level 1 trauma center, and a referral center with a provincial trauma registry. This databank is well-known for its completeness, large scale, and systematic data collection, increasing the generalizability of the results due to various parameters.

There are several limitations to this study. Firstly, it was a retrospective study with inherent information bias. Choosing the study design, including appropriate data-collecting protocols, was a primary strategy to reduce this bias. Additionally, the main data collector was not involved in the analytical component. Secondly, a high number of missing survival outcomes led to selection bias. Missing values were declared to aid decision-making. The author did not include patients with arrest-on-arrival status in the study because this group was not admitted to the hospital, leading to another selection bias. Lastly, this was a single-center study with a high mortality rate at a tertiary care referral center. The applicability to other levels of trauma centers, including community hospital benchmarking, remains unknown.

Conclusion

TRISS model exhibits excellent performance among primary trauma victims treated by a tertiary care trauma center in northeastern Thailand. Although it is the best model for predicting the probability of survival, its performance declines with the patient's age increases.

Conflicts of Interest

There is nothing to declare.

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