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Research paper

Comparison between RISC II and TRISS in predicting 30-day mortality in primary trauma patients admitted at a university hospital in northeastern Thailand

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INTRODUCTION

Injuries remain one of the leading causes of death in low-to-middle-income countries.[1,2] There is an attempt to develop a trauma system to improve the victims' survival and measure the outcomes.[3] Over 50 clinical prediction models, broadly called trauma and injury scoring systems[4–6] have been developed to predict the probability of survival (PS) of the victims suffering from injuries and to reflect the outcomes of trauma care, for example, the Trauma Injury Severity Score (TRISS), Abbreviated Injury Score (AIS), Injury Severity Score (ISS), Revised Trauma Score (RTS), Glasgow Coma Scale (GCS), and A Severity Characterization of Trauma (ASCOT).[7] These statistical methods allow a hospital to compare its norms against others.[8] As usual, none of the clinical scoring systems fits all the patients. Despite the worldwide acceptance, TRISS has some limitations, mainly when applied to specific subgroup populations such as the elderly and patients with predictors such as systolic blood pressure (SBP), GCS, and Head AIS.[9] In 2009, Lefering[10] developed the Revised Injury Severity Classification score (RISC). In 2014, he updated it to version II (RISC II).[11] RISC II was claimed to be superior to TRISS in predicting 30-day mortality rates in primary blunt trauma patients in Hong Kong[12] and used to predict mortality rates in Resuscitative endovascular occlusion of the aorta (REBOA) managed severe trauma patients.[13,14] In low-to-middle-income countries, especially in Southeast Asia, there is a lack of relevant studies on RISC II predicting mortality. This study compares RISC II and TRISS in predicting 30-day mortality rates in primary trauma patients admitted to a university hospital in northeastern Thailand.

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MATERIALS AND METHODS

The institutional ethics committee approved this retrospective diagnostic study protocol: HE641476. Surgical residents collected the data from the inpatient trauma registry between October 2019 and October 2021. All patients were admitted to the trauma unit of a university hospital in Thailand.

Study Size Estimation

Vergouwe et al. 2005[15] suggested a thumb rule to estimate the study size. They recommended a minimum of 100 events and 100 non-events for external validation samples.

Participants

The inclusion criteria for participants comprised major trauma patients with ISS > 11,[16] who were consulted by the trauma team for clinical management. The study excluded the patients who were poisoned, drowned, and died before arrival. All the parameters to calculate the PS for RISC II and TRISS were shown in Table 1 and retrieved retrospectively. The Abbreviated Injury Scale (AIS) version 2015 was used for AIS coding in all patients. The primary outcome of this study was 30-day mortality.

Table 1. Baseline characteristics of patients who died or survived during 30 days.

Demographic data	Missing value, *n* (%)	All (*n* = 627) *n* (%)	Survived (*n* = 530) *n* (%)	Dead (*n* = 97) *n* (%)	*p*-Value
Male	0 (0.0)	459 (73.2)	386 (72.8)	73 (75.3)	0.709
Age, mean (±SD), year	0 (0.0)	41.1 (±20.7)	40.2 (±20.6)	46.1 (±20.7)	0.010
Pre-injury ASA	5 (0.8)				<0.001
I		397 (63.8)	347 (65.8)	50 (52.6)	
II		121 (19.5)	111 (21.1)	10 (10.5)	
III or above		104 (16.7)	69 (13.1)	35 (36.8)	
Mechanism of injury	0				
Blunt		609 (97.1)	515 (97.2)	94 (96.9)	0.749
Penetration		18 (2.9)	15 (2.8)	3 (3.1)	
SBP, mean (±SD), mmHg*	1 (0.2)	131.3 (±25.8)	131.6 (±24.2)	128.8 (±24.2)	0.421
RR (median, IQR), /min*	0	21.1 (±4.5)	20.8 (±3.9)	23.7 (±7.5)	<0.001
GCS (median, IQR)	0	14 (9,15)	15 (11,15)	3 (3,9)	<0.001
mGCS (median, IQR)	0	6 (5,6)	6 (5,6)	1 (1,5)	<0.001
Head/neck AIS	0				<0.001
0		75 (12)	59 (11.1)	16 (16.5)	
1		14 (2.2)	12 (2.3)	2 (2.1)	
2		173 (27.6)	167 (31.5)	6 (6.2)	
3		93 (14.8)	83 (15.7)	10 (10.3)	
4		165 (26.3)	148 (27.9)	17 (17.5)	
5		106 (16.9)	61 (11.5)	45 (46.4)	
6		1 (0.2)	0 (0.0)	1 (1.0)	
1, 2		365 (58.2)	238 (44.9%)	24 (24.7%)	<0.001
3+		262 (41.8)	292 (55.1%)	73 (75.3%)	
ISS, mean (±SD)	0	22.8 (±10.0)	20.6 (±7.6)	34.5 (±12.8)	<0.001
INR, (median, IQR)	64 (10.2)	1.07 (1.00, 1.17)	1.06 (1.00, 1.15)	1.19 (1.08, 1.39)	<0.001
Base deficit, median (IQR), mEq/L	19 (3.0)	6.2 (3.9, 8.9)	5.7 (3.8, 8.2)	10.4 (7.2, 14.8)	<0.001
Hb, mean (±SD), mg/dL	28 (4.5)	11.7 (±2.4)	11.8 (±2.4)	11.01 (±2.4)	0.005
Prehospital CPR	0	585 (93.3)	61 (62.9)	524 (98.9)	<0.001

Abbreviations: IQR, Interquartile range; ASA, American Society of Anesthesiologist; SBP, Systolic Blood Pressure; RR, Respiratory Rate; GCS, Glasgow Coma Scale; mGCS, motor response in GCS; AIS, Abbreviated Injury Scale; ISS, Injury Severity Score; INR, international Normalized Ratio; Hb, Hemoglobin; CPR, Cardiopulmonary Resuscitation. [According to the low missing rate, the authors decide not to imputation. However, we exclude cardiopulmonary resuscitation at the scene in the estimation of systolic blood pressure and respiratory rate, but not included in the missing values].

Statistical Analysis

In this study, categorical data were described with frequency and percentage and were tested by Fisher's exact probability test. Typically, distributed continuous data were described with mean and standard deviation and were tested by independent t-test. Non-normally distributed continuous data were described using median and interquartile, and statistical uncertainty data were expressed using 95% two-sided confidence intervals in all analyses. A *p*-value < 0.05 will indicate statistical significance, and no multivariable adjustment was used. All analyses were performed with STATA version 16 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC). In this study, we compared the area under receiving operating characteristic (AUROC) between the RISC II and the TRISS models in predicting 30-day mortality. The subgroup analyses used various cut-off values, including severe traumatic brain injury (GCS ≤ 8 vs. GCS 9–15), age (aged ≤ 65 vs.> 65), hypotension (SBP < 90 mmHg vs.≥ 90 mmHg), ISS (ISS: ≤ 20 vs.> 20), and severity of AIS head injury (head AIS 0–2 vs. 3–6).

RESULTS

A total of 628 trauma patients were included in the study. However, one patient was excluded due to their pure burn conditions. Finally, a total of 627 patients were included (Figure 1). All TRISS calculations were performed with no missing values, while some missing values on the RISC II calculation were not excluded from the analyses. The missing values were mainly from laboratory results, with the maximum percentage of missing values detected for INR (10.2%) (Table 1). The 30-day mortality rate in the study was 15.5%.

Table 1 shows the baseline characteristics of the patients. The median age was 41.1, and 73.2% of the patients were male. Blunt trauma was the most common mechanism of injury among the patients (97.1%). Most of the parameters were significantly different between the two groups. The deceased patients showed worse ASA classification, lower blood pressure after admission, lower

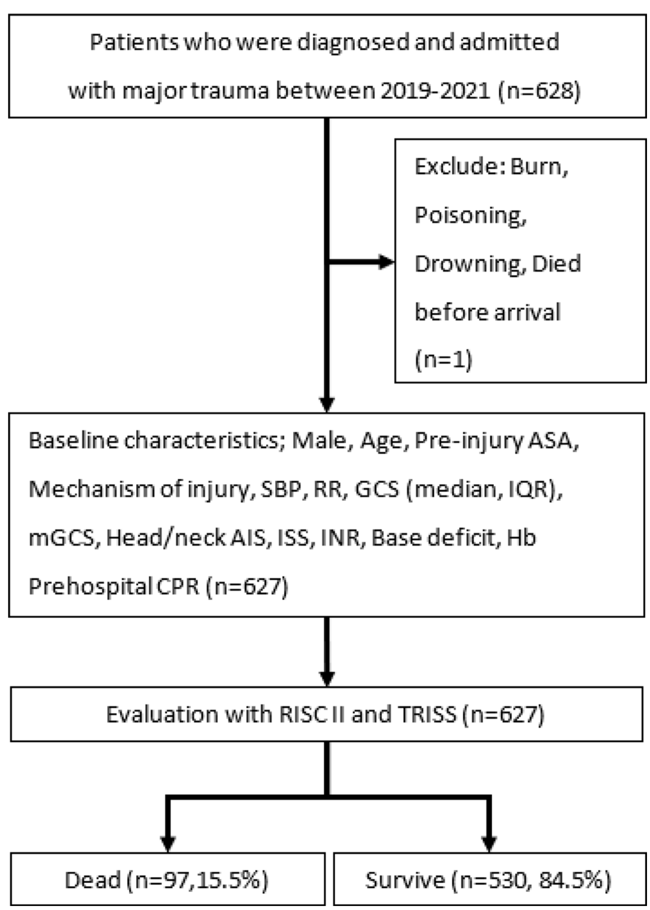

Figure 1. Study flow diagram.

respiratory rate, more severe GCS scores including motor function, worse ISS, and poor laboratory results. Additionally, the deceased patients had a significantly higher rate of CPR at the scene.

Table 2 and Figure 2 show both prediction models' discrimination and calibration. The AUROC values for RISC II and TRISS were 0.953 and 0.934, respectively. These values indicated that RISC II is statistically superior to TRISS in predicting 30-day mortality. However, subgroup analyses showed that RISC II and TRISS performed worse for head injuries with a defined head AIS score of 3–6. However, RISC II performed statistically better for patients with SBP < 90 mmHg but worse for patients with ISS > 20.

DISCUSSION

The use of good prognostic scores has helped us to improve the quality of trauma care by accurately predicting mortality, evaluating the unexpected death identified by the scores, compare the study results with the national or international database to measure our hospital's performance with that of standard ones, and are easy to use.

Table 2. Discrimination and calibration of the RISC II and the TRISS models for the subgroups.

Parameter	RISC II	TRISS	*p*-Value
AUROC (95%CI)	0.953 (0.931–0.975)	0.934 (0.910–0.959)	0.024
Subgroup AUROC			
GCS ≤ 8	0.941 (0.903–0.978)	0.895 (0.845–0.945)	0.032
GCS 9–15	0.901 (0.846–0.955)	0.880 (0.826–0.933)	0.336
Age ≤ 65	0.958 (0.935–0.980)	0.939 (0.914–0.964)	0.029
Age > 65	0.939 (0.886–0.991)	0.920 (0.845–0.994)	0.425
SBP < 90 mmHg	0.990 (0.971–1.000)	0.972 (0.932–1.000)	0.139
SBP ≥ 90 mmHg	0.923 (0.888–0.958)	0.892 (0.856–0.930)	0.025
ISS ≤ 20	0.973 (0.943–1.000)	0.951 (0.901–1.000)	0.201
ISS > 20	0.920 (0.883–0.957)	0.888 (0.847–0.930)	0.027
Head AIS 0–2	0.982 (0.951–1.000)	0.968 (0.934–1.000)	0.039
Head AIS 3–6	0.926 (0.891–0.960)	0.903 (0.865–0.940)	0.081

Abbreviations: RISC II, Revised Injury Severity Classification, version II; TRISS, Trauma and Injury Severity Score; AUROC, Area Under Receiver Operating Characteristics curve; GCS, Glasgow Coma Scale; SBP, Systolic Blood Pressure; AIS, Abbreviated Injury Scale; ISS, Injury Severity Score.

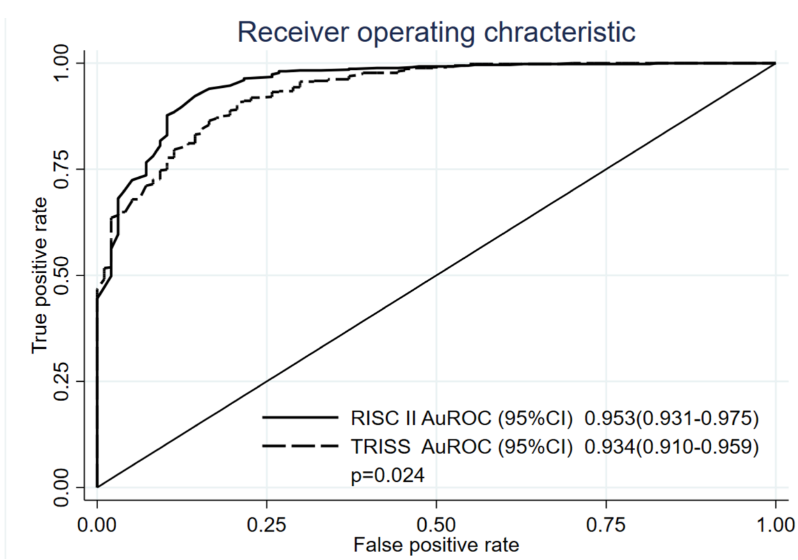

Figure 2. The receiver operating characteristic curve shows the comparison between the RISC II model and the TRISS model.

The scores could be based on anatomical injury (anatomical scores), physiological status (physiological scores), preexisting comorbidities, and combined scores. However, the most widely used combined score was the TRISS model. It is composed of the anatomical score (ISS), physiological score (RTS), and comorbidity (age), all with coefficients by the mechanism of injury.[8,17]. However, these measures were clinical and subjective and were difficult to perform. Therefore, to overcome these issues, we required more objective scores. RISC II was the one we were looking for due to reasonable laboratory parameters, which could represent accurate physiological scores.

This study aimed to assess discrimination and calibration of RISC II and TRISS models predicting mortality in a university hospital in a low-to-middle-income country. From Table 2, most parameters of the patients in the survived group showed statistically better values than those in the dead group, except for the AIS head injury. This could be due to the defect when collecting the data. This means more severe injuries were found in the deceased victims. Still, the trauma team focused on managing the severe issues such as airway, breathing, and shock, before paying attention to the patients with head injuries.

Our study was the first to propose that RISC II was statistically superior to TRISS in predicting 30-day mortality in major trauma patients. It also showed better prediction in the younger age group, patients with lower ISS value, hypotension, and mild to moderate AIS head injury. This might tell us that RISC II showed the highest performance in patients with significant trauma who did not have severe injuries based on anatomical scores. The argumentations were why RISC II performed better in severe traumatic brain injury (GCS ≤ 8) and hypotension (SBP < 90 mmHg) patients. This effect could be from small sample size and physiologic scores in nature.

Although the outstanding AUROC, RISC II performed better in predicting mortality than the initial validation.[11] This effect could be a small percentage of missing values (10%) than the original one (up to 50%). However, there were also some limitations in this study. Similar to TRISS, there were challenges using the RISC II due to multiple variables and different coefficients. However, both models were not designed for triage or front desk workers. Since both the scores were utilized for benchmarking the quality of trauma care, it was necessary for both to be very accurate rather than to be recallable. Furthermore, if we merged the collecting programs, objective variables such as hemoglobin, base deficit, and INR could be automatically extracted from the existing database.

Furthermore, the sample size used in our study was small and reflected only the quality of the trauma center of the university hospital, which may not reflect the whole country with various capacities. As it was also a retrospective study, there could be a variation in the accuracy of the recorded data.

Lastly, we studied only major trauma patients with ISS score >11. The application with non-major trauma patients needs further study. It should be noted that the minor trauma patients were not to die unexpectedly. Therefore, the calculation of PS for minor trauma patients was not necessary based on the nature of the disease.

CONCLUSION

In low-to-middle-income countries, particularly Thailand, RISC II was superior to TRISS in predicting the 30-day mortality of major trauma patients in a university hospital. The best performance for RISC II was trauma victims with an ISS score of 12–20. Future studies should emphasize the improvement in predicting mortality in low-to-middle-income countries with limited resources, all levels of injury severity, and various types of injuries.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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