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Comparing NEWS2, TRISS, and RTS in predicting mortality rate in trauma patients based on prehospital data set: a diagnostic study

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Abstract

Background In the recent years, National Early Warning Score2 (NEWS2) is utilized to predict early on, the worsening of clinical status in patients. To this date the predictive accuracy of National Early Warning Score (NEWS2), Revised Trauma Score (RTS), and Trauma and injury severity score (TRISS) regarding the trauma patients' mortality rate have not been compared. Therefore, the objective of this study is comparing NEWS2, TRISS, and RTS in predicting mortality rate in trauma patients based on prehospital data set.

Methods This cross-sectional retrospective diagnostic study performed on 6905 trauma patients, of which 4191 were found eligible, referred to the largest trauma center in southern Iran, Shiraz, during 2022–2023 based on their prehospital data set in order to compare the prognostic power of NEWS2, RTS, and TRISS in predicting in-hospital mortality rate. Patients are divided into deceased and survived groups. Demographic data, vital signs, and GCS were obtained from the patients and scoring systems were calculated and compared between the two groups. TRISS and ISS are calculated with in-hospital data set; others are based on prehospital data set.

Results A total of 129 patients have deceased. Age, cause of injury, length of hospital stay, SBP, RR, HR, temperature, SpO2, and GCS were associated with mortality (p-value < 0.001). TRISS and RTS had the highest sensitivity and specificity respectively (77.52, CI 95% [69.3–84.4] and 93.99, CI 95% [93.2–94.7]). TRISS had the highest area under the ROC curve (0.934) followed by NEWS2 (0.879), GCS (0.815), RTS (0.812), and ISS (0.774). TRISS and NEWS were superior to RTS, GCS, and ISS (p-value < 0.0001).

Conclusion This novel study compares the accuracy of NEWS2, TRISS, and RTS scoring systems in predicting mortality rate based on prehospital data. The findings suggest that all the scoring systems can predict mortality, with TRISS being the most accurate of them, followed by NEWS2. Considering the time consumption and ease of use, NEWS2 seems to be accurate and quick in predicting mortality based on prehospital data set.

Keywords Mortality rate, Prehospital vital signs, Trauma, Scoring system

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Introduction

Trauma is one of the most important causes of mortality and morbidity, worldwide [1, 2]. It is projected that around 10% of the burden of disease in adults is because of traumatic injuries [3]. Trauma can result in severe consequences including disabilities in patients, psychosocial burdens, and mortality in the active workforce of the society [4–6]. Cardiopulmonary arrest, unplanned admission to intensive care units, and nosocomial infections are some of the complications of trauma patients who are admitted to trauma centers [7–9]. However, the mortality rate of hospitalized trauma patients is estimated to be 11% [10]. In-hospital mortality rate in trauma patients undergoing cardiopulmonary resuscitation (CPR) is 92.7 [8]. Mortality and morbidity resulting from trauma are related to intensity of the injury, diagnosis delay, and timing to reach a medical establishment [8]. Consequences of trauma can additionally affect the psychological status of the family and efficiency of the society [11]. Hence, prompt evaluation, proper post-trauma care, and proper triage can reduce the long-term mortality and morbidity among trauma patients, among which swift assessment of trauma severity is crucial for primary triage of multiple trauma patients [12].

Trauma scoring systems can be used to promptly assess the severity of the injury and the prognosis of patient's condition. Using these scoring systems improve the overall organization of triaging trauma patients, optimization of resources, and immediate assessment of trauma complications [13, 14]. Several scoring systems have been introduced for this purpose. The most accurate trauma scoring system is the trauma and injury severity score (TRISS). However, the calculation of the score is complicated and time-consuming and it is usually utilized for research instead of clinical purposes [15–17]. Considering the downfalls of scoring systems, new ones are introduced, including Modified Early Warning Score (MEWS), Worthing Physiological Scoring System (WPSS), National Early Warning Score (NEWS2), Rapid Emergency Medicine Score (REMS), Glasgow Coma Score (GCS), Injury Severity Score (ISS), Revised Trauma Score (RTS), Circulation, Respiration, Abdomen, Motor, and Speech (CRAMS), Glasgow coma score, age, and systolic blood pressure, and mechanism of injury (MGAP) [18–21].

In recent years, NEWS2 has been utilized to promptly diagnose patients whose clinical status tends to take a turn for the worse [22]. In 2022, a cohort study indicated that NEWS2 can be associated with mortality rate of hospitalized patients in general wards [22]. Another study conducted in 2022 aimed at comparing the ability of the MEWS, WPSS, NEWS2, and REMS to predict in-hospital mortality in multiple trauma patients showed that REMS and MEWS have better accuracy than the other ones [19]. Studies have also shown that vital signs obtained in prehospital setting can predict patient's clinical status and vital signs in-hospitals and emergency departments [23, 24].

In this study, the authors hypothesize that NEWS2 can effectively and precisely predict the chance of in-hospital mortality in the injured patients based on their prehospital data set. This will be helpful in providing a fast and precise method for predicting patients' clinical course, consequently, offering better care for trauma patients and decreasing the overall burdensome mortality and morbidity rates among them. Therefore, we aimed to investigate whether the NEWS2 obtained from prehospital data set can predict in-hospital mortality in trauma patients. We are inclined to compare the prognostic power of NEWS2, RTS, and in-hospital TRISS scoring systems.

Methods

This cross-sectional retrospective diagnostic study was designed according to standards for reporting diagnostic accuracy studies (STARD) [25] in order to compare the prognostic power of NEWS2, RTS, and in hospital TRISS in predicting the in-hospital mortality rate of trauma patients referred to the largest trauma center in southern Iran, Shiraz, during 2022–2023 based on their prehospital data set.

In the first step, all trauma patients admitted to a tertiary referral trauma center in southwestern Iran from 2022 to 2023 who were hospitalized for at least 24 h were enrolled in the study using convenience sampling method. Afterwards, patients who activated emergency protocols by calling an ambulance and were brought to the hospital with emergency staff and who had recorded vital signs and other required prehospital data were included in the study, while patients who came to trauma center by themselves, who did not have a documented vital sign and other prehospital evaluations, who were under 18 years of age, who had incomplete or incorrectly documented prehospital data (missing data), who suffered from drowning, who were burn patients whose predominant injury was burn, and who were declared deceased before arriving at the hospital were excluded from the study. Overall, a total of 6905 patients initially had the potential to be enrolled in the study; after excluding ineligible patients, 4191 patients were enrolled in the study (Fig. 1).

A data sheet is used to gather information from patients which included demographic data (age and gender), mechanism of the injury, vital signs (systolic blood pressure, heart rate, respiratory rate, and temperature), blood oxygen saturation using pulse-oximeter, GCS, type of trauma (blunt or penetrating), injury severity score (ISS) in the emergency room, and outcome of the patient (deceased or survived). These data sheets are filled by the emergency staff who responded to the accident. NEWS2, RTS, ISS, and TRISS are then calculated and documented. Due to the retrospective nature of the

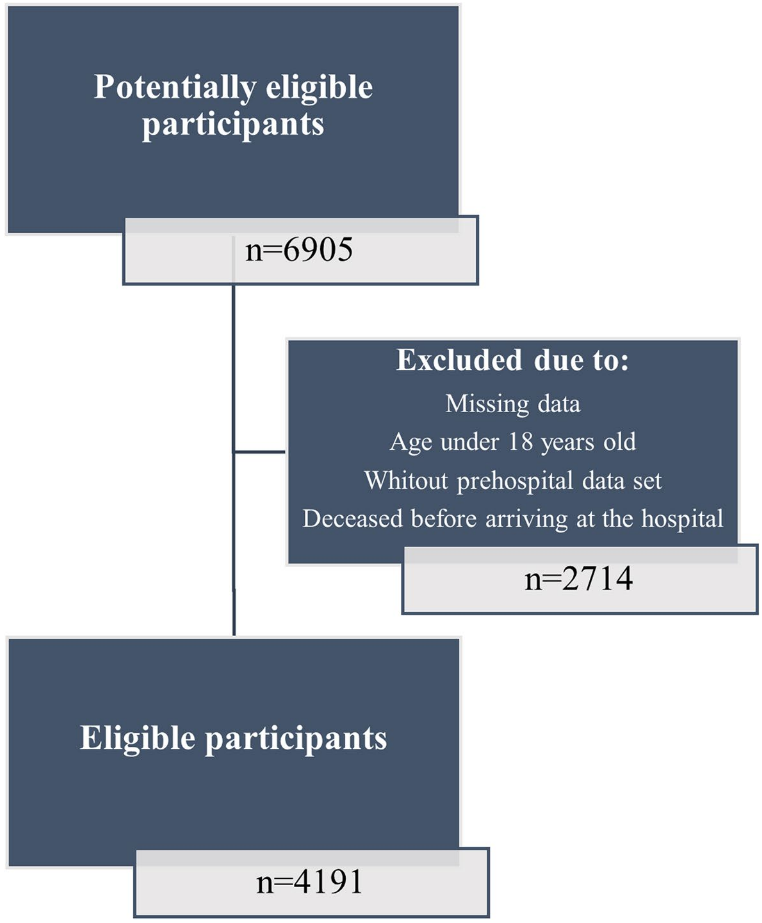

Fig. 1 Flow diagram of participants through the study

study and complete concealment of the patients' personal information, with the authorization of the ethic committee if the shiraz university of medical sciences (IR.SUMS.REC.1401.337), no consent forms were obtained from the patients prior to data collection. NEWS2 is calculated using the scoring chart shown in Fig. 2, and the score is then interpreted using the charts in Fig. 3 [26].

RTS is calculated and interpreted using the values and formula indicated in Table 1. It includes values from 0 to 7.8408 with the latter having the highest survival probability. The interpretation of the RTS scoring system is presented in Table 2 [27, 28]. TRISS were also obtained from the data gathered in hospitalized setting. It is calculated using in-hospital ISS and RTS score with two different formulas for blunt and penetrating injuries (Table 3) [29]. It is notable that the RTS utilized in calculating TRISS is obtained from in-hospital data set of the patients.

The means, and standard deviations are reported as crude numbers and percentages. The continuous variables normally distributed were compared using *t*-test. The chi-square test was used to compare categorical variables for bivariate analysis, while Kruskal-Wallis test will be utilized for comparing two or more independent variables. Binary logistic regression was used to control the confounding variable and evaluate the accuracy of the scales, sensitivity, specificity. In addition, the area under the receiver operating characteristic curve (ROC) will be reported. SPSS version 27.0 and MedCalc version 22.021 were used for statistical analysis. A two-sided *p*-value of less than 0.05 was considered to be statistically significant.

Results

In total, 4191 patients were enrolled in the study, 129 (3.1%) of whom died in the first 72 h after arrival at the emergency room on average. The mean age of the patients was 41.06 ± 20.56 years with the majority of them being male (79.1%). There was a significant difference in age between survived and deceased patients, with deceased patients being older than those who survived (p-value < 0.001). Most patients suffered from

NEW score	Clinical risk	Response
Aggregate score 0–4	Low	Ward-based response
Red score Score of 3 in any individual parameter	Low–medium	Urgent ward-based response*
Aggregate score 5–6	Medium	Key threshold for urgent response*
Aggregate score 7 or more	High	Urgent or emergency response**

* Response by a clinician or team with competence in the assessment and treatment of acutely ill patients and in recognising when the escalation of care to a critical care team is appropriate.

**The response team must also include staff with critical care skills, including airway management.

Fig. 2 National early warning score (NEWS2), royal college of physicians 2018

National Early Warning Score (NEWS2)

Physiological parameter	Score 3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO_2 Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO_2 Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

Royal College of Physicians

Fig. 3 NEWS thresholds and triggers, royal college of physicians 2017

traffic accidents included either vehicle or pedestrian accidents (61.4%). This was also the leading cause of injury in both survived and deceased groups (61.1% and 71.3%, respectively). The cause of injury was significantly different between the two groups with patients who had endured traffic accidents having worse outcomes

Table 1 RTS values and formula

GCS	Value	SBP	Value	RR	Value
13–15	4	> 89	4	10–29	4
9–12	3	76–89	3	> 29	3
6–8	2	50–75	2	6–9	2
4–5	1	1–49	1	1–5	1
3	0	0	0	0	0

RTS = (0.9368 × GCS value) + (0.7326 × SBP value) + (0.2908 × RR value)

GCS Glasgow coma scale, *SPB* Systolic blood pressure, *RR* Respiratory rate, *RTS* Revised trauma score

(*p*-value = 0.002). Patients who have expired had longer hospital stay in comparison with the ones who survived. A statistically significant difference was observed in the duration of the hospital stay (*p*-value < 0.001) (Table 4).

SBP was significantly higher among survived patients than the deceased group (129.38 ± 18.25 vs. 112.81 ± 31.9, $P < 0.001$) (). Heart rate and respiratory rate were also higher among survived patients compared to deceased ones (87.69 ± 16.64 vs. 86.49 ± 28.72 and 16.59 ± 3 vs. 14.9 ± 5.05, respectively), both of which were statistically significant ($P < 0.001$). Expired patients had significantly lower O2 saturation (86.24 ± 18.2 vs.

Table 2 Interpretation of RTS

RTS	0	1	2	3	4	5	6	7	7.8408
Survival probability, %	2.7	7.1	17.2	36.1	60.5	80.7	91.9	96.9	98.8

RTS Revised trauma score

Table 3 TRISS calculation value and formula

Blunt	x = -1.1270 + [RTS × 0.9544] + [ISS × -0.0768] + [age point × -1.9052]	
Penetrating	x = -0.6029 + [RTS × 1.1430] + [ISS × -0.1516] + [age point × -0.6029]	
age points	≤ 55	0
	> 55	1
Probability of survival = 1 ÷ (1 + e^{-x})		

RTS Revised trauma score, *ISS* Injury severity score, *e* Euler's number

Table 4 Demographic data of the study population and general properties of the trauma

Characteristics[a]	Survived (*N* = 4062)	Deceased (*N* = 129)	Total (*N* = 4191)	*p*-value
Age, years				< 0.001
< 45, N (%)	2643 (65.1)	51 (39.5)	2694 (64.3)	
45–55, N (%)	444 (10.9)	15 (11.6)	459 (11)	
56–65, N (%)	493 (9.7)	19 (14.7)	412 (9.8)	
> 65, N (%)	582 (14.3)	44 (34.1)	626 (14.9)	
Mean ± SD	40.66 ± 20.3	53.63 ± 24.41	41.06 ± 20.56	
Gender				0.265
Male, N (%)	3219 (79.2)	97 (75.2)	3316 (79.1)	
Female, N (%)	843 (20.8)	32 (24.8)	875 (20.9)	
Cause of Injury				0.002
Traffic accidents, N (%)	2483 (61.1)	92 (71.3)	2575 (61.4)	
Falling, N (%)	1036 (25.5)	33 (25.6)	1069 (25.5)	
Human or animal assault, N (%)	1 (< 0.1)	1 (0.8)	2 (< 0.1)	
Firearms, N (%)	28 (0.7)	1 (0.8)	29 (0.7)	
Others, N (%)	514(12.7)	2 (1.6)	516 (12.3)	
Length of hospital stay[b], Days ± SD	2.51 ± 1.06	2.86 ± 1.44	5.66 ± 7.98	< 0.001

SD Standard deviation

[a] The percentage in the table is reported within the survival status of the patients.

[b] From arrival to the emergency room until either death or recovery (discharged from hospital).

Table 5 Prehospital clinical characteristics of the patients

Characteristics[a]	Survived (*N* = 4062)	Deceased (*N* = 129)	Total (*N* = 4191)	*p*-value
SBP, mean mmHg ± SD	129.38 ± 18.25	112.81 ± 31.9	128.87 ± 19.03	< 0.001
HR, mean bpm ± SD	87.69 ± 16.64	86.49 ± 28.72	87.65 ± 17.13	< 0.001
RR, mean bpm ± SD	16.59 ± 3	14.9 ± 5.05	16.53 ± 3.1	< 0.001
SpO_2, mean % ± SD	94.27 ± 5.73	86.24 ± 18.2	94.02 ± 6.62	< 0.001
Temperature, mean °C ± SD	36.78 ± 0.38	36.46 ± 0.48	36.77 ± 0.39	< 0.001
GCS, mean ± SD	14.63 ± 1.63	9.19 ± 4.77	14.46 ± 2.03	< 0.001
3, N (%)	24 (0.6)	27 (20.9)	51 (1.2)	
4–5, N (%)	9 (0.2)	8 (6.2)	17 (0.4)	
6–8, N (%)	68 (1.7)	31 (24)	99 (2.4)	
9–12, N (%)	106 (2.6)	19 (14.7)	125 (3)	
13–15, N (%)	3855 (94.9)	44 (34.1)	3899 (93)	

SD Standard deviation, *SBP* Systolic blood pressure, *HR* Heart rate, *RR* Respiratory rate, *GCS* Glasgow comma scale, *bpm* bits/breaths per minute

[a] The percentage in the table is reported within the survival status of the patients.

94.27 ± 5.73, $P < 0.001$) and lower temperature than survived patients (36.46 ± 0.48 vs. 36.78 ± 0.38, $P < 0.001$). GCS of the deceased patients was significantly lower in their prehospital data with 27 (20.9%) having a GCS equal to 3, while 24 (0.6%) of the survived patients had a GCS equal to 3 and 3855 (94.9%) had a GCS above 13. Thereby, data analysis revealed that survived patients had a higher prehospital GCS than deceased ones (14.63 ± 1.63 vs. 9.19 ± 4.77, $P < 0.001$) (Table 5).

ISS and NEWS2 had significantly higher values among deceased patients in comparison to survived group (20.8 ± 14.67 vs. 8.13 ± 6.84, $P < 0.001$ and 8.6 ± 5.12 vs. 2.02 ± 2.37, $P < 0.001$, respectively). In accordance with that, RTS (6.07 ± 1.87 vs. 7.75 ± 0.44, $P < 0.001$) and TRISS (77.57 ± 26.93 vs. 98.65 ± 4.3, $P < 0.001$) had lower values in deceased group compared to the survived ones (Table 6).

The areas under the ROCs of ISS, GCS, RTS, NEWS2, and TRISS were 0.774, 0.815, 0.812, 0.879, and 0.934, respectively. The associations of all the scoring systems with the prediction of in-hospital mortality were statistically significant (*p*-value < 0.0001). TRISS had the

Table 6 Descriptive data of ISS, RTS, NEWS2, and TRISS

Characteristics[a]	Survived (*N* = 4062)	Deceased (*N* = 129)	Total (*N* = 4191)	*p*-value
ISS, mean ± SD[b]	8.13 ± 6.84	20.8 ± 14.67	8.52 ± 7.53	< 0.001
RTS, mean ± SD	7.75 ± 0.44	6.07 ± 1.87	7.69 ± 0.62	< 0.001
2.7% SP, N (%)	0 (0)	4 (3.1)	4 (0.1)	
7.1% SP, N (%)	0 (0)	0 (0)	0 (0)	
17.2% SP, N (%)	1 (< 0.1)	4 (3.1)	5 (0.1)	
36.1% SP, N (%)	4 (0.1)	3 (2.3)	7 (0.2)	
60.5% SP, N (%)	22 (0.5)	20 (15.5)	42 (1)	
80.7% SP, N (%)	74 (1.8)	35 (27.1)	109 (2.6)	
91.9% SP, N (%)	113 (2.8)	19 (14.7)	132 (3.1)	
96.9% SP, N (%)	30 (0.7)	1 (0.8)	31 (0.7)	
98.8% SP, N (%)	3818 (94)	43 (33.3)	3861 (92.1)	
NEWS2, mean ± SD	2.02 ± 2.37	8.6 ± 5.12	2.22 ± 2.74	< 0.001
Low, N (%)	3508 (86.4)	32 (24.8)	3540 (84.5)	
Low to medium, N (%)	152 (3.7)	1 (0.8)	153 (3.7)	
Medium, N (%)	176 (4.3)	12 (9.3)	188 (4.5)	
High, N (%)	226 (5.6)	84 (65.1)	310 (7.4)	
TRISS, mean ± SD[b]	98.65 ± 4.3	77.57 ± 26.93	98 ± 7.3	< 0.001

ISS Injury severity score, *RTS* Revised trauma score, *NEWS2* National early warning score, *TRISS* Trauma and injury severity score, *SP* Survival probability

[a] The percentage in the table is reported within the survival status of the patients.

[b] These variables are calculated based on in-hospital data sets

Table 7 Receiver operator characteristics of ISS, GCS, RTS, NEWS2, and TRISS in predicting in-hospital mortality rate

Indicator	ISS[a]	GCS	RTS	NEWS2	TRISS[*]
cutoff	> 12	≤ 14	≤ 7	> 4	≤ 97.01
Sensitivity (95% CI)	65.12 (56.2–73.3)	67.44 (58.6–75.4)	66.67 (57.8–74.7)	74.42 (66-81.7)	77.52 (69.3–84.4)
Specificity (95% CI)	81.83 (80.6–83)	93.45 (92.6–94.2)	93.99 (93.2–94.7)	90.1 (89.1–91)	92.83 (92-93.6)
PLR (95% CI)	3.58 (3.11–4.13)	10.3 (8.72–12.17)	11.1 (9.34–13.19)	7.52 (6.56–8.63)	10.81 (9.36–12.5)
NLR (95% CI)	0.43 (0.34–0.54)	0.35 (0.27–0.45)	0.35 (0.28–0.45)	0.28 (0.21–0.38)	0.24 (0.18–0.33)
AUC (95% CI)	0.774	0.815	0.812	0.879	0.934
p-value	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

ISS Injury severity score, *RTS* Revised trauma score, *NEWS2* National early warning score, *TRISS* Trauma and injury severity score, *PLR* Positive likelihood ratio, *NLR* Negative likelihood ratio, *AUC* Area under the curve, *CI* Confidence interval

[a] These variables are calculated based on in-hospital data sets

highest sensitivity and RTS had the highest specificity in predicting in-hospital mortality based on prehospital data set. The sensitivities of the ISS, GCS, RTS, NEWS2, and TRISS were 65.12, 67.44, 66.67, 74.42, and 77.52, respectively. The specificities of the mentioned scoring systems were 81.83, 93.45, 93.99, 90.1, and 92.83, respectively. Other receiver operator characteristics of the scoring systems are summarized in Table 7.

Furthermore, comparison of the ROCs of the scoring systems revealed that TRISS is significantly superior to the others in predicting in-hospital mortality rate based on prehospital data set, followed by NEWS2, GCS, RTS, and ISS (Fig. 4). Both NEWS2 and TRISS were found to be significantly superior to GCS, RTS, and ISS (p-value < 0.05). TRISS was superior to NEWS 2 in its prognostic accuracy (p-value = 0.0026). Nonetheless,

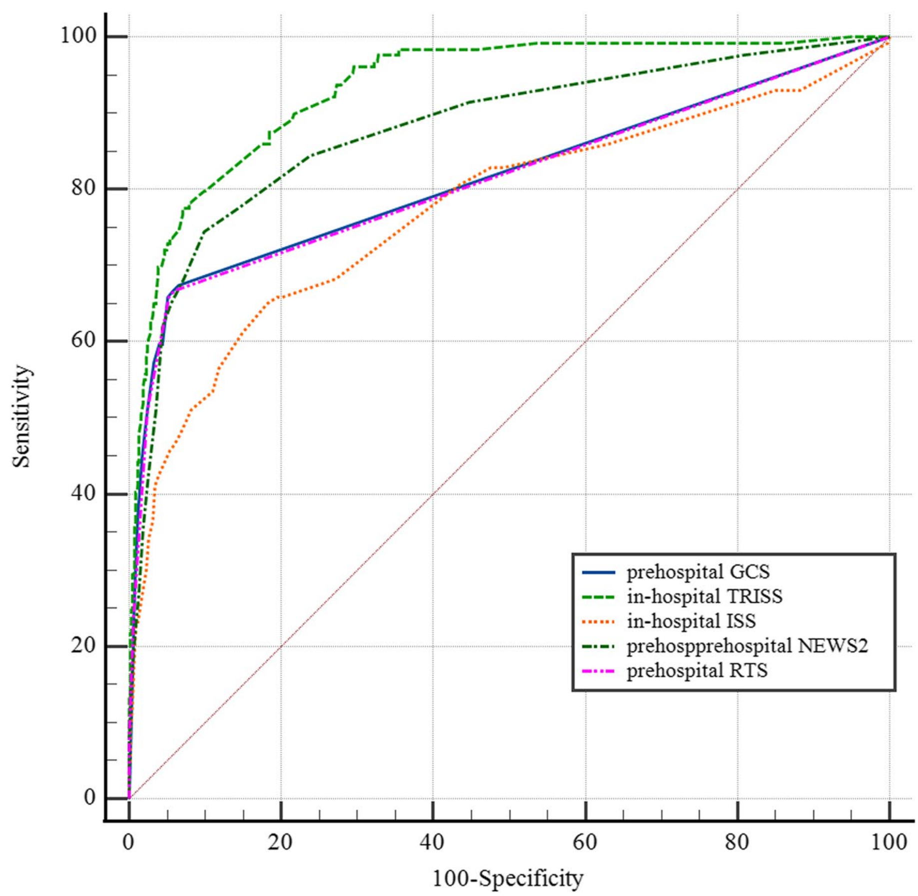

Fig. 4 Receiver operator curves of in-hospital ISS, prehospital GCS, prehospital RTS, prehospital NEWS2, and in-hospital TRISS

Table 8 Pairwise comparison of the ROS properties of the scoring systems

Scoring system	AUC of ROCs	p-value	95% CI
NEWS2 ~ TRISS[a]	0.879 ~ 0.934	0.0026	0.0190 to 0.0901
NEWS2 ~ RTS	0.879 ~ 0.812	< 0.0001	0.0353 to 0.0985
NEWS2 ~ GCS	0.879 ~ 0.815	0.0001	0.0326 to 0.0949
NEWS2 ~ ISS[a]	0.879 ~ 0.774	0.0007	0.114 to 0.206
TRISS* ~ RTS	0.934 ~ 0.812	< 0.0001	0.0825 to 0.160
TRISS* ~ GCS	0.934 ~ 0.815	< 0.0001	0.0796 to 0.157
TRISS* ~ ISS[a]	0.934 ~ 0.774	< 0.0001	0.0908 to 0.173
RTS ~ GCS	0.812 ~ 0.815	0.6246	-0.00942 to 0.0157
RTS ~ ISS[a]	0.812 ~ 0.774	0.2223	-0.0235 to 0.101
GCS ~ ISS	0.815 ~ 0.774	0.1847	-0.0200 to 0.104

ISS Injury severity score, *RTS* Revised trauma score, *NEWS2* National early warning score, *TRISS* Trauma and injury severity score, *PLR* Positive likelihood ratio, *NLR* Negative likelihood ratio, *AUC* Area under the curve, *ROC* Receiver operator curves, *CI* Confidence interval

[a]These variables are calculated based on in-hospital data sets

GCS, ISS, and RTS had insignificant differences in predicting in-hospital mortality based on prehospital data set (p-value > 0.05) (Table 8).

Discussion

In recent years, several scoring systems have been introduced for predicting the outcome of trauma patients based on their vital signs, mental status, site and severity of the injury, and other risk factors. The accuracy and swiftness of these tests in predicting in-hospital mortality in patients are major issues. In this study, we attempted to compare the prognostic power of TRISS, NEWS2, and RTS scoring systems in predicting mortality in trauma patients based on their prehospital data set. As indicated in previous studies, prehospital vital signs are closely correlated with initial in-hospital vital signs [23]. Therefore, in this novel study, we hypothesized that trauma scoring systems could predict in-hospital mortality based on prehospital data set. Thus, prompt arrangements can be utilized based on mortality risk and increased the overall outcome of the patients. Among the scoring systems, we selected TRISS, NEWS2, and RTS because of their accurate prognostic power and/or ease of use. Subsequently, we compared them with each other and more basic scoring systems such as ISS and GCS. Our results showed that all these scoring systems could effectively predict mortality rate of patients. TRISS and RTS have the highest sensitivity and specificity, respectively. TRISS had the highest area under the ROC curve followed by NEWS2, RTS, GCS, and ISS.

Age of the patients was associated with their mortality rate. The older the patients, the lower their survival rate. This is in alignment with a previous study in which, age was significantly corelated with mortality rate and deceased patients had higher median age [30]. As a conclusion, older patients require more precise and prompter evaluation and closer observation after trauma. Gender, on the other hand, remains a controversial issue in its correlation with survivability chances after trauma. Some studies indicated that females have higher chances of survival [31] and others showed no correlation between gender and mortality rate [32]. In our study gender did not show any significant difference among deceased and survived patients. To the best of the authors knowledge, no physiological explanation was given for the survival benefit of one gender compared the other. Road traffic accidents victims had significantly higher mortality rate compared to other causes of injuries. Road traffic injuries remain a major threat to public health and inflict many mortalities and morbidities annually. Studies suggest that this type of injury has tripled in our region (Iran) in a 23-years period. Length of hospital stay was associated with increased in-hospital mortality rate in our study, which is supported by previous studies [33, 34].

Deceased patients had overall worse prehospital vital signs status compared to survived ones. Systolic blood pressure, heart rate, respiratory rate, temperature, GCS and SpO_2 was significantly associated with in-hospital mortality in this research. Multiple studies have indicated that these easily obtained measurements can in fact predict in-hospital mortality [35–37]. As mentioned, prehospital vital signs are associated with emergency room vital sign measurements [23] and can be used as a rapid and reliable predictor of mortality in the patients.

All the scoring systems can predict mortality rates among trauma patients. TRISS have the highest sensitivity and area under the ROC curve among all the evaluated scoring systems. However, it is noteworthy that TRISS is only calculable with in-hospital data set. This finding is in line with previous studies, in which TRISS was the most successful predicator of mortality in trauma patients compared to other scoring systems [38, 39]. Nevertheless, calculating TRISS score is found to be an intensive task that includes calculating two other scoring systems beforehand [40, 41]. Hence, undermining the point of this study to provide a swift evaluation tool for predicting trauma patients' outcomes. RTS had lower sensitivity and AUC of ROC in our study compared to previous ones [38, 42]. NEWS2 had higher sensitivity and specificity in comparison to a previous study [43]. These differences can be due to data gathering setting (prehospital vs. in-hospital), demographic and regional varieties, and study populations.

The comparison of scoring systems revealed that NEWS2 is the second most accurate scoring system. It is debatable that the benefits of the NEWS2 system exceeds the ones of TRISS, in that the former takes approximately 3 min and 35 s for medical staff to calculate [44] and contains only the common vital signs and primary evaluations, whereas the later includes calculating two other scoring systems. NEWS2 had also a decent sensitivity (only second to TRISS) and specificity (higher than TRISS) in predicting in-hospital mortality among trauma patients based on their prehospital data set. In our study, the cutoff point of the NEWS2 was more than 4, which corelates to medium and high thresholds introduced by the royal college of physicians [26]. This point is the recommended "key threshold for urgent response", which is in line with our findings. Other scoring systems (ISS, RTS, GCS) did not show any significant difference in accuracy of predicting mortality compared to each other, although all of them are capable of that purpose.

In recent years, regarding the advancements in monitoring technologies, wearable devices are utilized for constant monitoring of patients [45, 46]. Using devices which can evaluate and report NEWS2 in prehospital setting might effectively increase the patients' survivability. Nonetheless, the feasibility and clinical validation of these devices for this purpose is yet to be evaluated.

Strengths and limitations

Our study is a novel one in that it compares the accuracy of several sophisticated scoring systems in predicting mortality based on the prehospital data set of a proper study population. The data is collected in the largest trauma center in southern Iran and professional staff had documented these data in a systematic manner. Reporting the time consumed to calculate each scoring systems, which our study lacked, could greatly aid the endeavor of finding an accurate and swift trauma scoring system. The retrospective nature of the study had also caused a number of cases to be excluded due to their missing data. Moreover, other available scoring systems are to be evaluated and compared in order to sum up an accurate conclusion.

Conclusion

This pioneer study investigates and compares the accuracy of NEWS2, TRISS, and RTS scoring systems in predicting mortality rate based on prehospital data set in the largest trauma center in southern Iran. The results suggest that all the scoring systems are well capable of predicting mortality, with TRISS being the most accurate of them, followed by NEWS2. TRISS and NEWS2 showed no significant difference in accuracy. Considering the time consumption and ease of use, NEWS2 seems to be an accurate and swift scoring system in predicting mortality based on prehospital data set. Further meta-analysis and population-based studies are required to choose a superior scoring system and reduce the mortality rate of the trauma patients.

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Authors' contributions

SP designed the original intellectual content of the study. MRY, MK, and SP have designed the concepts of the study. MRY and MK did the literature search. MRY and MK did data analysis, statistical analysis. MRY, MK, and SP prepared, reviewed, and edited the manuscript. MK is the corresponding author of the study.

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Availability of data and materials

data available request for corresponding authors.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of the Shiraz University of Medical Science (Approval ID: IR.SUMS.REC.1401.337). Due to the retrospective nature of the study, the ethics committee of Shiraz university of medical sciences have waived the necessity of informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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