Validation of revised trauma score in the emergency department of Kasr Al Ainy

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Background
High-flow trauma centers face a huge variety of injury patterns and severity warranting an objective measure to reflect injury severity and consequently the intensity of care required in a resource-limited environment. The revised trauma score (RTS) is a physiological triage system based upon Glasgow coma scale, systolic blood pressure, and respiratory rate that can be used as a prognostic tool in trauma patients.

Patients and methods
During the initial assessment of 200 blunt trauma victims presenting to Kasr Al Ainy emergency department between October 2015 and February 2016, the RTS was calculated and correlated with injury severity, discharge from the emergency room after initial assessment, ICU admission, length of hospital stay, and mortality. A cut-off RTS was thought to guide the decision-making process and anticipation of the required resources.

Results
An overall 78.5% of male individuals and 21.5% of female individuals with a mean age of 31.2 years with blunt abdominal trauma presented with a mean RTS of 11.41. No patient with an RTS of 10 or less could be discharged home from the emergency department. There was a statistically significant correlation between RTS and ICU admission and mortality ($P<0.001$ for both). A cut-off RTS of less than 11 (RTS=10 or less) predicts mortality with a sensitivity of 92.9% and specificity of 81.8%, with area under the curve=0.929. Correlation between RTS and length of hospital stay did not reveal statistical significance ($P=0.310$).

Conclusion
RTS can support the discharge decision process and reflect injury severity by predicting the need for ICU and mortality.

Keywords:
blunt trauma, ICU admission, mortality, revised trauma score

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Background

Trauma-related mortality, especially in young individuals, and resource consumption continue to pose a significant burden on health care [1–6]. High-flow trauma centers face a huge variety of injury patterns and severity warranting an objective measure to reflect injury severity and, consequently, the intensity of care required in a resource-limited environment. For that purpose, several physiological and anatomical triage scoring systems have been devised [7]. The revised trauma score (RTS) is a physiological triage system based upon Glasgow coma scale (GCS), systolic blood pressure (SBP) and respiratory rate (RR). Each parameter is assigned a coded value from 0 to 4 [7,8]. Its parameters can easily be determined. It does not require any sophisticated technology. Since its introduction by Champion *et al.* [9], several studies evaluated the RTS as a prognostic tool in trauma patients.

Patients and methods

This study is a prospective cohort study performed at Kasr Al Ainy (Cairo University Hospitals) on 200 patients presenting to the emergency room with a blunt mode of trauma between October 2015 and February 2016. This study has been approved by the preliminary ethical committee of the Faculty of Medicine, Cairo University Hospitals.

Patients aged less than 12 years, having pre-existing significant comorbidity, penetrating trauma patients and those pronounced dead on arrival were excluded from his study.

All trauma patients were initially assessed and managed according to the principles of the Advanced Trauma Life support (ATLS, Chicago, IL, USA).

Immediately after arrival, during their primary survey, the RTS was calculated by assessing GCS, SBP, and RR.

The findings of the primary and secondary survey dictated the appropriate multidisciplinary team management of all patients in concordance with the hospital's trauma management protocol.

The data were prospectively collected and recorded in a specially designed sheet including RTS on presentation, mode of trauma, demographics, resuscitation details, initial treatment, hospital stay, need for ICU admission, morbidity and mortality.

The data were analyzed to determine the degree of correlation between the RTS and injury severity reflected as safety of discharge from the emergency department after initial assessment and management, ICU admission, mortality, and length of hospital stay (Table 1).

The Statistical Package of the Social Science software program (SPSS), version 23 was used for statistical analysis. Quantitative variables were summarized using mean, SD, median, and first and third quartiles and compared using the Mann–Whitney test for not normally distributed variables. Qualitative variables were represented as frequencies and percentages and compared using the χ^2 test. Receiver operator characteristic (ROC) was used to determine the best cut off RTS and its validity. A *P* value less than 0.05 was considered of statistical significance.

Table 1 Method of revised trauma score calculation

Glasgow coma scale	Systolic blood pressure (mmHg)	Respiratory rate	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

Table 2 Summary of age of patients

Total number	200
Minimum age (years)	12
Maximum age (years)	80
Mean age (years)	31
SD of age (years)	14.2
Median age (years)	27

Results

The demographic data of the 200 patients are summarized in Tables 2 and 3 and the exact mode of blunt trauma in Table 4.

The RTS of the 200 patients shows that the majority of patients presented with an RTS of 12. The frequency and percentage of each RTS category is illustrated in Table 5.

After initial assessment and management of all patients 77 (39%) patients were discharged home from the emergency room, 104 (52%) were admitted to the hospital, 10 (5%) were referred to another hospital due to unavailability of beds and nine (5%) asked for discharge against medical advice. Interestingly, all 77 patients who could be discharged home from the emergency room (ER) belonged to the RTS category of 12 and 11. The percentage of patients who were discharged home from the ER in each RTS category compared with the total number of patients in this category is depicted in Fig. 1.

Evidently, no patient with an RTS of 10 or less could be discharged home. In fact, RTS less than or equal to 10 showed a statistically significant *P* value as regards the ability to discharge the patient from the ER safely (Table 6).

Table 3 Gender distribution

Gender	*n*	%
Male	157	78.5
Female	43	21.5

Table 4 Mode of blunt trauma

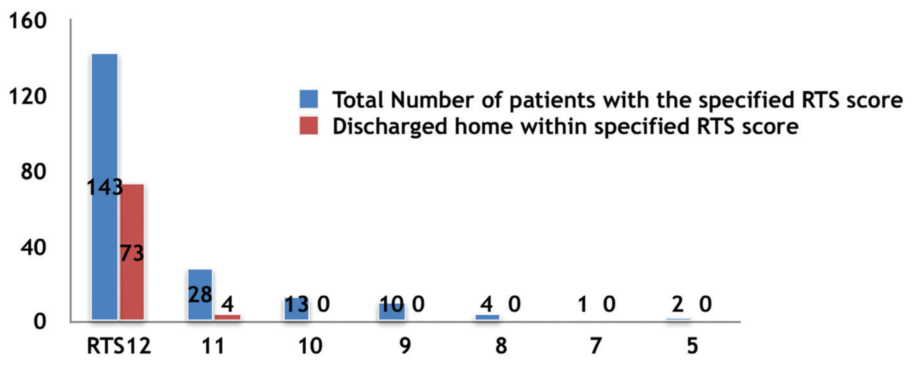
Mode of trauma	*n*	%
Motor vehicle collision	133	66.5
Fall from height	35	17.5
Isolated head trauma	19	9.5
Fall down on stairs	6	3.0
Blunt trauma to abdomen	2	1.0
Blunt trauma to chest	1	0.5
Blunt trauma to face	2	1.0
Assault	2	1.0

Table 5 Revised trauma score of 200 patients

RTS	*n*	%
12	143	71
11	27	14
10	13	6
9	10	5
8	4	2
7	1	1
5	2	1

RTS, revised trauma score.

Figure 1



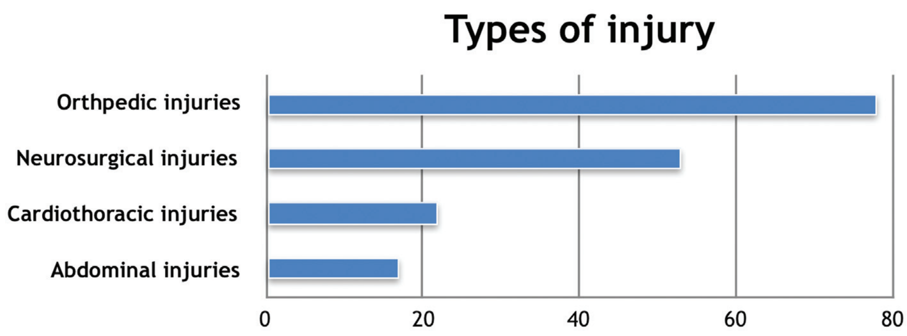
Number of patients discharged home in each category compared with the total number of patients in this category. *Others includes admission, referred patients, and discharge against medical advice.

Table 6 Discharge from the ER in the different revised trauma score categories

RTS	Discharge from the ER [*n* (%)]	Other Disposition [*n* (%)]	Total [*n* (%)]	*P* value
10 or less	0 (0)	30 (24.4)	30 (15)	$<$0.001
$>$10	77 (100)	93 (74.6)	170 (85)	

RTS, revised trauma score.

Figure 2



Types of injury.

Among the 200 patients, 128 patients were identified as positive for injuries. Seventy-eight suffered orthopedic injuries, 53 neurosurgical, 22 cardiothoracic, and 17 patients had abdominal injuries (Fig. 2).

After excluding the patients who were referred to other hospitals and the discharges against medical advice, 181 patients remained. There were 16 (8.8%) mortalities among them. One death occurred in the RTS 12 category, two deaths in the RTS 11, four deaths in the RTS 10, five deaths in the RTS 9, three deaths in the RTS 8, and one death in the RTS 5 category. The percentage of patients who passed away in each RTS category as a proportion of this category is shown in Fig. 3.

As expected, there was a steady increase in the mortality with decreasing RTS. All patients in the RTS category of eight or less and 56% with an RTS of nine passed away. In fact, data analysis identified a cut-off point at an RTS of 10 starting from which there was a statistically significant increase in mortality (Table 7).

In spite of the fact that RTS categories 10 or less constitute only 13.8% of the total study population, they make up for a major proportion of the mortality (81.3%).

One further important aspect that we investigated was the need for ICU admission in correlation with the different RTSs. A total of 28 patients needed ICU admission. Their distribution among the different RTS categories is displayed in Table 8.

Again, dividing the 200 patients into two main categories at a cut-off point of RTS 10 or less results in a statistically significant difference between patients with regard to the need for ICU admission (Table 9).

Analysis of the length of hospital stay in correlation to the different RTS categories revealed no statistically significant difference (Table 10).

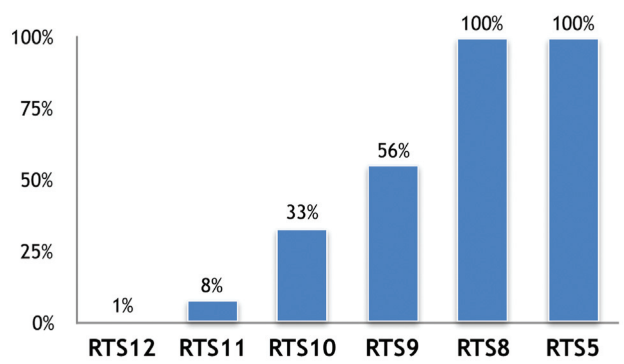
Table 11 and Figure 4 demonstrate the best cut-off RTS for the prediction of survival, as determined by ROC, which plots sensitivity against specificity (i.e. the false-positive rate). Cut-off values for the diagnostic test vary along the length of the blue curve, reflecting the interchange between sensitivity and specificity. The area under the ROC curve represents the accuracy of the test. A test that performs no better than chance would be represented by a straight line (green line) with an area under the ROC of 0.5. A near perfect test would have a rectangular configuration (blue line) with an area under the ROC approaching 1.00. The statistically determined cut-off RTS is 10, with a sensitivity of 92.9% and specificity of 81.8% with an area under the curve=0.929.

Discussion

Triage of trauma victims is the process of their rapid and accurate evaluation to determine their injury severity and hence the required level of medical service [10]. An ideal tool should be simple, consistent, that is, with high inter-rater reliability, and valid, that is, accurately reflecting the severity of injury pattern. No consensus as regards a single best scoring system exists. The various scoring systems are selected on the basis of the most prevalent type of trauma, personnel, available resources, and the personal preference of emergency service providers. Cross-national comparative studies evaluating different scoring systems might determine an optimal system [11]. Most physiologic triage tools incorporate simple assessments of neurologic, respiratory, and circulatory function [12]. An example is the RTS. RTS parameters are the GCS, the SBP and the RR. Therefore, RTS is a very simple bedside calculation, readily available soon after trauma admission [13]. In our study, we aimed at evaluating and validating the RTS in Kasr Al Ainy emergency department in the prediction of mortality, morbidity, need for ICU admission and as an aiding factor to discharge patients safely from the emergency department.

Data of 200 patients who presented to Kasr Al Ainy emergency department with blunt injuries revealed that a normal RTS of 12 in the absence of any clear indications for hospital admissions supports the decision of discharge of the trauma patient from the emergency department. In fact, all the 77 patients who were safely discharged home belonged to the RTS of 12 or 11 categories. There were no readmissions due to missed injuries or deterioration of a patient's status. Not a single patient with an RTS of 10 or less could be discharged. This finding is in concordance with the findings of Orhon *et al.* [14] whose study included 633 trauma patients. They found that the RTS helped them in the prediction of hospitalization requirements, as the RTS was higher in patients who were discharged from the emergency department in comparison with those who required hospitalization (P=0.004). In their study, 255 (40.3%) patients could be discharged after their initial assessment and management in the emergency department.

Figure 3



Percentage of mortality in each RTS category. RTS, revised trauma score.

Table 8 Number and proportion of patients requiring ICU admission in each category

RTS	
12	3 (2)
11	6 (22)
10	6 (46)
9	6 (60)
8	4 (100)
7	1 (100)
5	2 (100)

RTS, revised trauma score.

Table 7 Mortality at cut-off point of revised trauma score 10 or less

RTS	Nonsurvivors (*N*=16) [*n* (%)]	Survivors (*N*=165) [*n* (%)]	Total (*N*=181) [*n* (%)]	*P* value
10 or less	13 (81.3)	12 (7.3)	25 (13.8)	$<$0.001
$>$10	3 (18.8)	153 (92.7)	156 (86.2)	

RTS, revised trauma score.

Table 9 ICU admission at cut-off point of revised trauma score 10 or less

RTS	Need for ICU (*N*=28) [*n* (%)]	No Need for ICU (*N*=172) [*n* (%)]	Total (*N*=200) [*n* (%)]	*P* value
10 or less	19 (67.9)	11 (6.4)	30 (15.0)	<0.001
>10	9 (32.1)	161 (93.6)	156 (85.0)	

RTS, revised trauma score.

Table 10 Mean hospital stay in each revised trauma score category

RTS	*N*	Mean±SD of length of hospital stay	Median (IQR) of length of hospital stay	Minimum	Maximum	*P* value
5	1	2.0	2.0 (2.0 : 2.0)	2	2	0.310
8	3	2.7±1.2	2.0 (2.0 : 4.0)	2	4	
9	9	3.9±3.3	3.0 (1.0 : 6.5)	1	10	
10	13	9.9±12.7	4.0 (1.0 : 14.0)	0	40	
11	21	8.3±8.0	5.0 (3.5 : 10.5)	1	30	
12	58	6.7±6.9	5.0 (2.0 : 7.25)	1	36	

RTS, revised trauma score.

Table 11 Receiver operator characteristic determined sensitivity, specificity and area under the curve at a cut-off revised trauma score of 10

	Sensitivity	Specificity
Cut-off RTS of 10	92.9	81.8%
Area under the curve	0.929 $P \leq 0.001$	

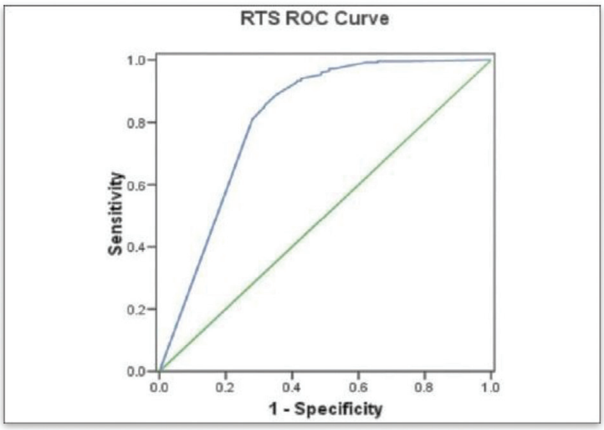
AUC, area under the curve; RTS, revised trauma score.

As expected, our results confirm a significant correlation between mortality and RTSs. Thirteen of the 16 mortalities belonged to the RTS category 10 or less. Several other studies designated decreasing RTSs as independent predictors of mortality [15,16].

In fact, as clearly depicted in our results, an RTS of 10 or less could clearly be correlated to a statistically significant higher mortality ($P \leq 0.001$). At a cut-off point of RTS 10 or less, RTS can identify 81.3% of mortality with a sensitivity of 92.9% and a specificity of 81.8%. This is in keeping with other studies that assessed the ability of the RTS to forecast subsequent mortality. At a higher cut-off RTS of 11, they identified 97% of deaths [7].

ICU admission requirement also correlated significantly with the RTS. Anticipating ICU need is a very important aspect in our institution. Being a high-flow emergency department, shortage of ICU beds constitutes a chronic problem apart from being an important consideration in resource allocation. Early identification of these patients minimizes waiting time in the emergency department until a place is prepared in our hospital or transfer arrangements to another hospital are instituted. Of the 200 trauma victims, 28 (14%) patients needed ICU admission. Actually, all patients in our study with an RTS of 8, 7, or 5 needed ICU admission. All had severe neurological and/or cardiothoracic injuries. The four patients admitted to our hospital passed away; the other three were referred to other hospitals, as there were no available ICU beds. Orhon and colleagues found in their study that ICU patients had a lower RTS than those who were not in the ICU (P=0.001).

Figure 4



The receiver operating characteristic (ROC) curve to determine the best cut-off RTS for mortality. RTS, revised trauma score.

Length of hospital stay is another significant aspect of resource allocation [14]. RTSs could not predict length of stay in hospital in our study. Watts *et al.* [17] also found that RTS had limited correlation with length of hospital stay in trauma patients. Li *et al.* [18] who evaluated RTS in the prediction of trauma patient outcome on 3233 patients also concluded that length of hospital stay was dependent on the recovery of anatomical injuries rather than physiological parameters.

In a high-flow, resource-limited emergency department, as in our institution, trauma victims are primarily evaluated by residents who have to manage multiple patients with a huge diversity of injury patterns and severity simultaneously. Standardizing performance under these challenging circumstances can definitely be fostered by a simple triage tool such as the RTS, which provides some objective guidance in the discharge decision process. Even though the injury severity score (ISS), which is an anatomical trauma scoring system, has been found by some authors to correlate more accurately with ICU requirement and length of hospital stay [8,16,18], the RTS has demonstrated a higher correlation with mortality [16,18]. This finding seems plausible as the degree of physiological derangement accounts for mortality more than the anatomical injuries. In contrast, the restoration of anatomical injuries is labor-intensive and, therefore, more indicative of the length of hospital stay. Yet, an important drawback of the ISS is that it cannot be accurately determined before full investigation or even operation, precluding its use in the challenging working environment as a decision support tool.

To overcome the shortcoming of either a purely physiological scoring system or/and a purely anatomical system, the trauma ISS has been devised, which combines RTS and ISS parameters with age. It was repeatedly found to be superior to either RTS or ISS alone in the prediction of mortality [6,7,11,13–16,19]. Again, the complexity of its calculation and the need for an accurate and comprehensive determination of all anatomical injuries limit its practicality in a high-volume, resource-limited setting like ours.

A documented RTS of 12 should be considered a prerequisite for safe discharge. Any variation from an RTS of 12 should warrant documented clearance for discharge by a more senior physician. In contrast, an RTS of 10 or less should be viewed as an early alert to the seriousness of physiologic derangement with consequent high probability of ICU need and significant mortality.

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Conflicts of interest
None declared.

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