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Original Research Paper

Surgery

"PROGNOSTIC PERFORMANCE OF REVISED TRAUMA SCORE (RTS) AND MODIFIED RAPID EMERGENCY MEDICINE SCORE (mREMS) AT NIMS HOSPITAL EMERGENCY MEDICINE DEPARTMENT"

Vishwa Reddy Gankidi*	Assistant Professor(Former) – Emergency Medicine Department Nizam's Institute of Medical Sciences ,Hyderabad ,Telangana –500082. *Corresponding Author
Ashima Sharma	Professor - Department of Emergency Medicine Nizam's Institute of Medical Sciences ,Hyderabad ,Telangana –500082.
Suneel Kumar G	Professor and HOD - Department of Emergency Medicine Nizam's Institute of Medical Sciences ,Hyderabad ,Telangana –500082.
Laxmi Bhaskar Nori	Additional Professor - Department of Hospital Administration Nizam's Institute of Medical Sciences ,Hyderabad ,Telangana –500082.
Naveen Kumar Boiraju	Statistician , Scientist-C : Indian Council of Medical Research National Institute of Nutrition,Hyderabad,Telangana-500007.

ABSTRACT

Background: Application of outcome prediction models in the form of scoring systems helps in the recognition of illness severity. Early diagnosis and timely intervention are cost-effective and aid in the improvement of patient outcomes. Scoring systems assist in clinical decision making by injury description, prediction of mortality outcome, allocation of resources, triage, quality assurance, and research in trauma care. So there is a definitive need to study the utility of existing scoring systems in the ED. This study tries to analyze the conceptual and statistical background of the commonly used scoring systems m REMS and RTS, helps to understand the trauma severity assessment thereby addressing new ideas and trends in trauma scoring in both surgical and medical group of the study population.

Objectives: To evaluate the accuracy of m REMS and compare it with RTS in predicting the outcome of patients with mortality being the primary outcome. It also aims to optimize a common scoring system for all patients presenting to the emergency department

Methods: This is a prospective randomized double-blinded study. A total of 2535 patients were included in the study, The study was conducted over 2 years in the triage population of the NIMS emergency department. For all entries to the ED- blood pressure, respiratory rate, pulse rate, Glasgow coma scale, peripheral capillary oxygen saturation, and patients age were noted, following that REMS and RTS scores were calculated for each patient at measured intervals. The statistical associations between two scoring systems and in-hospital mortality were studied and the statistical analysis was done using SPSS software.

Results: In the triage population, mREMS score area under curve for Medical group(AUC: 86.6, 95% CI: (93.8) – (79.4)); Surgical (AUC : 66.4, 95% CI:75.7 - 57.1) is superior to RTS score Surgical group(AUC:44.8, 95% CI: 59.2 – 30.2), Medical (AUC- 29.4, 95% CI: 39.4 - 19.4) in predicting in hospital mortality. Higher mREMS score is associated with increased mortality. In the non-survival group mean mREMS score is 7.85 and the RTS score is 7.31 and in the survival group means mREMS score is 5.08 and the RTS score is 7.46, mean age of patients in the survival group is 51.55 in the non-survival group is 57.68. RTS area under the curve for surgical (AUC:44.8,95% CI:59.2 -30.2) group is superior to (AUC – 29.4, 95% CI: 39.4 –19.4) group in the prediction of mortality.

Conclusions: In the triage population m REMS is a simple and reliable score for prediction of in-hospital mortality for the medical and surgical group of patients. m REMS score has a higher prognostic value in mortality prediction compared to the RTS model. Both m REMS and RTS models have good performance and are applicable for the prediction of poor outcome.

KEYWORDS : Mortality prediction, Triage, MAP - Mean arterial pressure , ISS – Injury Severity Score, WPSS - Worthing physiological scoring system.

INTRODUCTION :

Scoring systems help in the quick assessment of injury severity, outcome prediction, and decrease mortality rates. Development of scoring systems common to all adult patients, helps in appropriate triage, objective measurement, improving prognostic accuracy, quality of patient care, resource allocation, and prehospital therapeutic efficacy.[25] A scoring system has two parts: a score range -which is a number assigned to the severity of the disease, a probability model - which is an equation measuring the probability of in-patient death. An accurate model system is usually known for its high predictive value, should be well-validated, calibrated, and discriminated before its implementation.[(5,7)]

A logistic score which is true is usually calculated as per the established and well -known formulae designed for its purpose. Each scoring system has different variables included in them, involving complicated calculations. Validity and accuracy of each scoring system has to be assessed in the varied clinical settings for better applicability.[(,5,6)]

Traditionally scoring systems classified into anatomic, physiologic, and combined varieties.

The examples include:

Anatomic Scoring Systems: Abbreviated Injury Score -AIS, Injury Severity Score -ISS, New Injury Severity Score – NISS, Anatomy Profile – AP, Penetrating Abdominal Trauma Index -PATI, ICD -based Injury Severity Score -ICISS, Trauma Mortality Prediction Model TMPM-ICD9, Trauma-Induced Severity Score -TRISS, A Severity Characterization of Trauma-ASCOT, International Classification of Diseases Injury Severity Score - ICISS

Physiologic Scoring Systems: Emergency Trauma Score, Revised Trauma Score- RTS, Quick Sequential Organ Failure Assessment Score – q SOFA, Systemic Inflammatory Response Syndrome – SIRS, Acute Physiology, and Chronic Health Evaluation - APACHE.

Combined Models: International Classification of Diseases Injury Severity Score –ICISS, Polytrauma - Schussel, A

Severity Characterization of Trauma - ASCOT, Trauma-Induced Severity Score - TRISS, Trauma Index Scores based on combined models including age and premorbid conditions would likely help in the better prediction of outcome.[1,6]

Trauma is the leading cause of mortality for all individuals in the elderly age group, application of scoring systems for prediction of mortality is limited to populations in which they were originally designed, RTS – for trauma patients and REMS – for Medical patients Rapid Emergency Medicine Score (REMS) is a modified version of APACHE II scoring system. REMS is a scoring model consisting of Glasgow coma scale, Respiratory Rate, oxygen saturation, mean arterial pressure, and age with a score range of (0 -26) and patients with a higher score have a poor prognosis. This score was also applied to trauma patients except for that variable GCS in the score was underweighted and age was overweighted. mREMS is an improvised version of REMS which incorporates the mechanism of injury and systolic BP in place of MAP. There have been many studies reporting accurate predictive validity of this score among non- surgical patients, the usability verification of REMS and m REMS in the trauma population is yet to be tested.[4,5]

Table 1: mREMS Scoring

Variables	Score						
	0	+1	+2	+3	+4	+5	+5
Age (years)	≤44	45-64		65-74	>74		
Systolic Blood Pressure (SBP)	110-159	160-199	>200		≤74		
		90-109	80-89				
Heart Rate (HR-beats/min)	70-109		110-139	140-179	>179		
			55-69	40-54	≤39		
Respiratory Rate (RR-breaths/min)	12-24	25-34	6-9	35-49	>49		
		10-11			≤5		
Oxygen Saturation (%)	>89	86-89		75-85	<75		
Glasgow Coma Scale	14 or 15		8-13			5-7	3 or 4

RTS is one of the commonly used scoring systems, based on the initial vital signs which include RR, GCS, and Systolic BP. The Triage RTS score range (0–12), a lower score indicates a higher degree of injury, and can also be used in prehospital triage. RTS score is widely used for prediction of mortality in trauma patients but has yet to be tested in non-surgical patients (Table 1 and 2).

Table 2:

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			

Our present study aims to evaluate the accuracy of mREMS and compare it with RTS in predicting in -hospital mortality in both surgical and medical groups of patients, to optimize a common scoring system for all patients, it also endeavours to look into the areas of improvement in the triage scoring systems.

Objectives :

- To evaluate modified Rapid Emergency Medicine Score (mREMS) as a risk stratification tool for prediction of in - hospital mortality in triage population
- To compare m REMS score accuracy to Revised Trauma Score (RTS) in predicting mortality .

Materials And Methods:

A total of 2535 patients were included in the study. All patients presenting to the emergency department age 18 years and older, fulfilling the inclusion criteria were recruited in the study. Patients who die within 6 hours of presentation and pregnant patients were excluded from the study, also patients with inadequate data for calculation of scores are excluded from the study.

Study Design and Data Collection: This is a prospective randomized study. After obtaining permission from the Institutional ethics committee, all patients fulfilling the inclusion criteria were enrolled in the study, For all entries to the ED, blood pressure, respiratory rate, pulse rate and glasgow coma scale, peripheral oxygen saturation and patients age at 0hrs, 6hrs, 12hrs, and 24hrs were noted. The m REMs is composed of patients age and routinely acquired vital signs which include, systolic BP, HR, RR, peripheral capillary oxygen saturation, GCS, The mREMS score is calculated with each variable being assigned a score of 0 –4, with exception of GCS which has a range of 0-6, with an overall maximum mREMS score of 26.[14] RTS score consists of three continuous measurements, GCS, Systolic BP, and RR. Based on the input, each variable is scored from 0–4, these are then added and weighed by using the formulae:

$$RTS = 0.9368(GCS) + 0.7326(SBP) + 0.2908(RR)$$

When summed up values can range from 0 to 7.84.

The individual scores– mREMS and RTS were calculated for each patient at measured intervals. Mean plus standard deviation for all the variables of both the scores were calculated at different intervals. The statistical associations between the two scoring systems and in-hospital mortality were examined.

STATISTICAL ANALYSIS:

Data is stored in a computer system under password protection maintaining confidentiality, Statistical analysis is done using SPSS software-version 21. Continuous variables are measured using mean plus standard deviation and categorical variables with frequency and percentage, p values of less than 0.5 will be used to measure statistically significant association. A comparison between different groups is done using parametric tests, Chi-square test for categorical variables and t-test for continuous variables.

The discriminant power of different scoring systems is compared by using ROC curves, and similarly sensitivity and specificity.

RESULTS:

In the present study, out of 2535 patients, -1863 were medical cases and 672 were surgical (trauma and non- trauma). Survival group constitutes 2098 cases and Non-survival group 437 cases- surgical -136 and medical - 301. There were 1772 were males and 763 were females. The mean age distribution in the non-survival group is 57.68 and in the survival group is 51.55. Mean mREMS and RTS Scores in the non-survival group is 7.85 and 7.31 and in the survival, the group is 5.08 and 7.46 respectively. (Table 3)

Table 3: Distribution of patients by age and gender

Age Groups (Years)	Female	Male	Total
0 - 20	46	113	158
20 - 40	206	559	765
40 - 60	289	638	927
60 - 80	198	416	614
80 - 100	24	47	71
Total	**763**	**1773**	**2535**

An ideal predictor variable needs to be simple to record, potentially independent of other useful variables, and should possess a strong association with mortality. It is also worth mentioning that there is a definitive need to understand the difference between avoidable and unavoidable mortality in the triage.[5]

The study of the distribution of scores and their variables in the mortality group showed that the majority of patients had mREMS score in the range of 16-20, and higher m REMS was associated with increased mortality, patients who died had a lower GCS compared to the survival group, patients with higher mREMs score who survived had lower mean age and higher GCS compared to the non-survival group.

The Majority of patients had RTS scores in the range (3- 10), lower RTS was associated with increased mortality. As per univariate analysis Systolic BP (p = 0.000), GCS (p = 0.000), HR (p= 0.000) in RTS and m REMs scores had higher predictive value, RR (p = 0.510) , Spo2 (p = 0.624) had lower prognostic value in outcome prediction. Mechanism of injury and age if included would contribute to higher prognostic significance of scores. There were varying rates of missing data in the variables such as temp and MAP, initially included in REMs score calculated for only a few patients as later systolic BP was used as per mREMS.

Table 4: mREMS and RTS Score characteristics and association with Mortality

mREMS SCORE	Score Range	Surgical n =137	%	Medical n = 301	%
	0-5	5	3.64	24	7.9
	6-10	15	10.9	45	14.9
	11-15	28	20.4	88	29.2
	16-20	48	35	95	31.5
	21-26	41	29.9	135	44.8
Total		137	100	301	100
RTS SCORE	**Score Range**	**Surgical n = 137**	**%**	**Medical n = 301**	**%**
	0-3	27	19.7	85	28.2
	3-10	103	75.1	169	56.1
	11-12	7	5.1	47	15.6
Total		137	100	301	100

Table 5: Multiple Logistic Regression analysis of variables of mREMS and RTS scores of surgical group

Variables	Dead (n=137) Mean (SD)	Alive (n = 536) Mean (SD)	95% CI	P Value
Age	51 ± 20	37 ± 18		
Systolic BP	118± 20	110 ± 18	(9.8) – (-13.5)	0.744
Diastolic BP	74 ± 11	76 ± 9	(7.4) – (-4.2)	0.572
Heart Rate-HR	94.5 ± 17	96 ± 14	(11.9) – (-4.5)	0.357
Respiratory Rate-RR	16 ± 7	20 ± 3	(2.0) – (- 3.1)	0.419
Oxygen Saturation - SpO2	96 ± 3	96 ± 9	(2.5) – (-2.6)	0.966
Glasgow Coma SCALE - GCS	10 ± 3	12 ± 4	(2.4) –(-1.6)	0.696
Score	**Dead Mean (SD)**	**Alive Mean (SD)**	**95% CI**	**p value**
REMS	7.3 ± 2.9	6.3 ± 1.8	(-0.63) – (-2.7)	0.004
RTS	7.0 ± 1.2	7.6 ± 0.33	(-0.40) – (-2.99)	0.173

Multivariate analysis of the surgical group showed that mREMs (AROCC -66.4), 95% CI (0.63) – (-2.7) is superior to RTS in predicting mortality, among the variables, HR (p-value – 0.357) (95 % CI – 11.9 – 4.5) has a higher prognostic value in trauma and non-trauma patients. (Table 5)

Table 6: Multiple Logistic Regression analysis of variables of mREMS and RTS scores of medical group

Variables	Dead (n=301) Mean (SD)	Alive (n=1562) Mean (SD)	95% CI	P Value
Age	68 ± 12	60 ± 16	(14.6) – (-4.6)	
Systolic BP	120 ± 15	120 ± 22	(10.4) – (-12.2)	0.673
Diastolic BP	78 ± 10	76 ± 12	(8.9) – (1.0)	0.016
Mean Arterial Pressure - MAP		90.6		
Heart Rate-HR	87 ± 13	96 ± 18	(0.50) – (-11.10)	0.070
Respiratory Rate-RR	23 ± 4	21 ± 5	(3.38) – (-1.52)	0.529
Oxygen Saturation - Sp02	95 ± 3.5	97 ± 3.7	(1.9) – (4.4)	0.405
Glasgow Coma SCALE -GCS	12 ± 3.8	15 ± 0	(3.2) – (2.07)	0.000
Score	**Dead Mean (SD)**	**Alive Mean (SD)**	**95% CI**	**p value**
mREMS	6 ± 3	2 ± 2	(-2.7) – (-5.1)	0.001
RTS	6.9 ± 1.3	7.2 ± 0.87	(0.878) – (-0.195)	0.201

Multivariate analysis of the medical group showed that mREMs (AROCC -86.6%), 95% CI (-2.7) - (-5.1) is superior to RTS in predicting mortality. Among all the variables GCS (p-value - 0.000), 95 % CI - (3.2)- (2.07) and age an independent variable has higher prognostic value for outcome prediction in the medical group of patients. (Table 6)

REMS (95% CI — (-2.7) – (- 5.1) (Medical), (-0.63) – (-2.7) (Surgical)) was superior to RTS (95% CI — (- 0.878) – (- 0.195) (Medical), (-0.40) – (-2.99)(Surgical) in predicting mortality in both the groups. (Table 7and 8)

Table 7: Multivariate analysis of the medical group

Medical Group (n = 1863)		
Score	**95% CI**	**Area under Curve**
REMS	(-2.7) – (-5.1)	86.6 %
RTS	(-0.878) – (- 0.195)	29.4 %

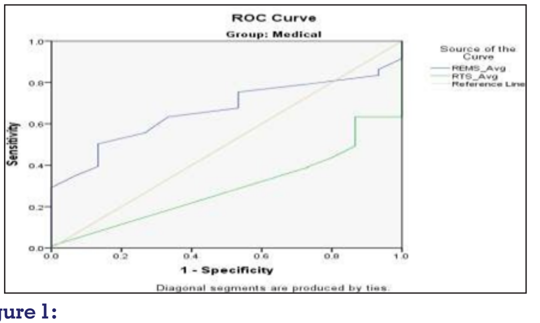

Figure 1:

Table 6: Multivariate analysis of the surgical group

Surgical Group (n = 673)		
Score	**95% CI**	**Area under Curve**
REMS	(-0.63) – (-2.7)	66.4 %
RTS	(-0.40) – (-2.99)	44.8 %

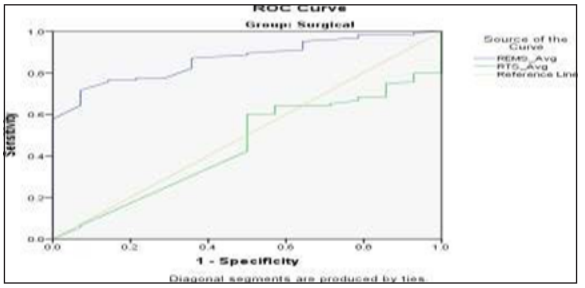

Figure 2:

DISCUSSION

Quantification of injury severity remains a neglected area with imperfect tools and model systems. Characterization of injury severity is crucial for the assessment and grading of the trauma. Historically emergency systems used physiological responses assessed by revised trauma score -RTS which include respiratory rate, arterial pressure and gas, in which the selection of variables was influenced by the ease of measurement, but later due to its complex calculated measurements, it has been less widely used in practice. Abbreviated injury severity scale -AIS formulated by the researchers in the past has become the basis for the development of Injury severity score -ISS. It has been widely used in clinical practice to measure the severity of trauma.[(7,15)]

Many scoring systems have evolved which includes Trauma injury severity score - TRISS, Worthing physiological scoring system- WPSS, Rapid acute physiology score -RAPS, Emergency Trauma Score- EMTRAS, Rapid emergency medicine score - REMS, Revised Trauma Score -RTS, used for outcome prediction of emergency department admissions.[4,5] Quick sequential organ function assessment score- qSOFA, Acute Physiology and Chronic Health evaluation score- APACHE II, National Early warning score -NEWS are used for risk assessment of patients with suspected sepsis. APACHE II is a commonly used scoring system for ED patients admitted to the intensive care unit.[(5)]

Emergency Trauma score- EMTRAS which was developed to provide mortality prediction in trauma patients includes 4 variables: age, GCS, base excess (BE) and prothrombin time (PT).[(6)]

Each scoring system has its own advantages and limitations . An ideal scoring system accurately predicts mortality and morbidity, it also aids in the reliable description of injuries. Among these Injury severity scores is one of the oldest trauma score models, Trauma injury severity score incorporates the severity of injury mechanism to ISS. MGAP is a trauma score that incorporates the injury mechanism and age in addition to other common variables. Rapid acute physiology score and Worthing physiological scoring system and Emergency trauma score are some of the commonly used trauma scoring systems for prediction of mortality in emergency department admissions.[(5,10)]

The present study compared two scoring systems mREMS and RTS for predicting in-hospital mortality in two groups of patients medical and surgical (trauma and non-trauma) presenting to the emergency department with the primary outcome under investigation being mortality. mREMs when compared with RTS, had a discriminant power with AUCs of 86.6% and 66.4% for medical and surgical groups, RTS score had a discriminant power with AUCs of 29.4% and 44.8% for medical and surgical groups respectively.[(7)]

Olson et al. used different methods to derive REMS and evaluate the predictive power of RTS, their study proved that REMS is a better predictor of in-hospital mortality than RAPS. Their estimate of the AUC for RAPS was (0.65) and REMS was (0.74). In this study we compared mREMS and RTS in two groups of patients- medical and surgical separately and found that mREMs- AUC (86.6, 66.4) was superior to RTS – AUC (29.4,44.8) in predicting outcome.[(4)]

REMS was derived within the Olson study, and risk stratification tools generally perform better in the population in which they are originally derived. Olson found that all six variables of REMS were associated with in-hospital mortality, but the association between mean arterial pressure and mortality was not significant on multivariate analysis. In this study as per m REMs we used systolic BP instead of MAP, this conversion may explain why blood pressure is a key mention as a predictor of mortality in our study, but GCS and HR have higher significance and are independent predictors of mortality.[(10)]

Unlike other studies, respiratory rate and oxygen saturation did not show association with mortality on multivariate analysis in both medical and surgical groups.

Goodcare et al. found that REMs is an effective predictor of mortality among medical patients, our study proved that mREMs score is a strong predictor of mortality in the trauma population also. RTS uses only a subset of mREMs variables, although simple and applicable in triaging the patients, underperformed mREMs in mortality prediction of both groups of patients.[(11)]

Lee et al. compared REMS and EMTRAS score for predicting mortality in nonsurgical ED patients and found that both the scores have similar predictive validity, Mangini et al. also showed that EMTRAS score has a significant association with mortality.[(5,6)]

Imhoff et al. proved that higher REMS score was associated with increased mortality in trauma patients. In their study, REMs performed similarly to RTS and outperformed other trauma scoring systems ISS and Shock Index. In our study mREMS outperformed RTS in both group of patients and has proved that RTS has moderate predictive validity in the surgical group of patients. Mild differences in the prediction of in-hospital mortality by RTS and REMS scoring systems are observed in both the studies.[(7,8)]

Injury Severity Score is one of the commonly used scoring systems to evaluate injury severity worldwide, but it is a retrospective model and the score can only be determined after diagnosis. ISS and TRISS are therefore better suited for risk prediction and comparison between patient groups or trauma centers but not practically useful as real-time triage tools, RTS and APACHE scores are less accurate in predicting in-hospital mortality.[(10,15)]

Our study confirms that the initial measurement of variables GCS and HR of mREMS are reliable indicators of mortality in the study population, these findings are different from the previous studies like Imhoff et al which suggest that heart rate is not a reliable indicator of mortality prediction . MAP,Spo2, has predictive value for mortality in agreement with the previous studies, physiological variables like respiratory rate - RR in comparison to other variables did not outperform in the mortality prediction of both the study groups.[(8)]

To conclude the development of a risk stratification tool or a score for all emergency department admissions recalls the need for further studies to identify potentially useful variables and their independent association with mortality and requires validation in different groups of populations.

CONCLUSION

mREMS score is a simple and accurate predictor of in - hospital mortality.

The mREMS score has superior predictive value to the RTS model in the medical group and has moderate applicability similar to the RTS model in the surgical group of patients.

The mREMS score has the prospective applicability for in-hospital clinical decision making and scene- triage of trauma patients.

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