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Modified Rapid Emergency Medicine Score as a Predictor of Emergency Interventional Need for Trauma Patients Attending Suez Canal University Hospital

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ABSTRACT

Background: Validated trauma scoring systems can quickly assess injury severity and indicate prognosis. Several systems have been developed one of which is the modified rapid emergency medicine score (REMS) (2017), which is composed of patient age, and the routinely acquired vital signs systolic blood pressure (SBP), heart rate (HR), respiratory rate (RR), peripheral oxygen saturation, and Glasgow Coma Scale (GCS). Despite most of scores evaluated are used for measuring the severity of the injury and the mortality, less of them are used to predict the use of the emergency intervention and the predicted disposition of the patients.

Objective: This study aimed to assess the performance of modified rapid emergency medicine score (mREMS) in predicting the need of emergency interventions and mortality.

Patients and methods: This cross-sectional observational study was conducted at Suez Canal University Hospitals in Ismailia and involved 80 adult trauma patients attending to the emergency department. The focus was to appraise the predictive value of mREMS for the need for emergency interventions, emergency surgeries and mortality.

Results: mREMS score showed significant positive correlation with tranexamic–acid administration, pelvic binder application, the need for CPR and intubation, while showed no significant correlation with chest tube application. At cutoff value ≥3.5 mREMS score was statistically significant predictor of death, with AUC of 0.873, PPV of 23.5%, NPV of 98.4%, sensitivity of 86% and specificity of 82%.

Conclusion: mREMS can predict the need for certain emergency interventions in trauma patients and can predict mortality of the patients at score of more than 3.5.

Keyword: Modified rapid emergency score, Emergency interventions, Trauma.

INTRODUCTION

Injury stands as the foremost contributor to global mortality, imposing a considerable burden on individuals and society by contributing to disability, financial costs, and reduced productivity [1].

The management of injured patients should be promptly initiated in the prehospital environment to optimize recovery and prognosis [2]. Evidence supports that expeditious transfer of critically injured patients to a trauma center plays a crucial role in reducing mortality [3]. While, timely transfer is crucial for severe cases, avoidable referrals of less severely injured patients to trauma centers should be limited to optimize resource allocation [4].

Validated trauma scoring systems provide a rapid and reliable assessment of injury severity, while offering prognostic insights. Numerous scoring models have been established, including the Acute Physiology and Chronic Health Evaluation (APACHE), which incorporates multiple physiological and biochemical parameters. These include age, Glasgow Coma Scale (GCS), core body temperature, mean arterial pressure (MAP), heart rate (HR), respiratory rate (RR), blood oxygen saturation (PaO_2), arterial pH, as well as serum concentrations of sodium and potassium. Additionally, hematocrit levels, creatinine, and leukocyte count are integral components of this evaluation system [5]. The Revised Trauma Score (RTS) is specifically developed for use in prehospital trauma triage, enabling rapid assessment of injury severity. It incorporates three key physiological parameters: RR, systolic blood pressure (SBP), and the GCS. Each of these variables is assigned a distinct weight, and their cumulative score can reach a maximum of 12, aiding in the prioritization of trauma care and resource allocation [1].

As a straightforward physiological parameter, the Shock Index (SI)—calculated by the ratio of HR to SBP—has been traditionally employed to assess the severity of injuries [6]. The "mechanism of injury, GCS, age, and SBP" (MGAP) score is a trauma assessment tool utilized in prehospital settings. Unlike other scoring systems, MGAP incorporates the mechanism of injury—distinguishing between blunt and penetrating trauma—along with the GCS, patient age, and SBP, enabling a comprehensive evaluation of injury severity and prognosis [7].

The REMS, introduced in 2004, is a triage tool that has demonstrated strong predictive value for in-hospital mortality in non-trauma medical admissions. This scoring system incorporates multiple physiological parameters, including age, MAP, HR, RR, oxygen

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saturation (O_2 sat), and the GCS, facilitating early risk stratification and clinical decision-making (Table 1) [8].
Introduced in 2017, the Modified REMS score consists of patient age and routinely measured physiological parameters. Unlike the original REMS, it incorporates SBP instead of MAP, while retaining HR, RR, peripheral oxygen saturation, and GCS to enhance clinical evaluation**.** The mREMS score is determined by assigning a value between 0 and 4 to each parameter, except for the GCS, which ranges from 0 to 6, resulting in a maximum possible score of 26. This modified version substitutes MAP with SBP, as SBP is a widely recorded parameter and a well-established indicator of trauma severity. Additionally, the mechanism of injury—whether blunt or penetrating—has been incorporated into field triage tools for enhanced assessment **[9].**

Despite, all of these scores evaluated are used for measuring the severity of the injury and the mortality less of them are used to predict the use of the emergency intervention and the predicted disposition of the patients. The aim of this study was to use the modified REMS score as a predictor for the different emergency intervention among trauma patients.

PATIENTS AND METHODS

Study design and participants: This cross-sectional observational study was conducted on adult trauma patients presenting to the Emergency Room, Suez Canal University Hospitals in Ismailia. The study included all consecutive patients who met the inclusion criteria until the required sample size was achieved.

Inclusion criteria: Patients were eligible for the study if they were 18 years or older and had sustained trauma within the past 24 hours. The trauma mechanisms considered included polytrauma and isolated trauma. Polytrauma was defined according to the New Berlin definition, where patients had an Abbreviated Injury Scale (AIS) score of 3 or greater in two or more body regions. Additionally, at least one of the following physiological parameters had to be present: Hypotension defined as a SBP of 90 mmHg or lower, unconsciousness defined as a GCS score of 8 or lower, acidosis with a base excess of -6.0 or lower, coagulopathy with a partial thromboplastin time of 40 seconds or greater and an international normalized ratio of 1.4 or greater, or an age of 70 years or older [10]. The mechanisms leading to polytrauma included road traffic accidents, falls from height, and injuries sustained during quarrels or sliding accidents. Isolated trauma cases involved direct trauma or gunshot wounds affecting a single anatomical area. Only patients who arrived at the Emergency Department alive were included in the study.

Exclusion Criteria: Patients with incomplete or missing data. Those who left the Emergency Department before being assessed by a physician.

Procedure: Before inclusion in the study, a detailed history was obtained from the patient or when necessary from family members.

Clinical examination: Patients were assessed using the ABCDE approach. Airway patency was ensured to confirm an open airway. Breathing assessment included measuring oxygen saturation, calculating respiratory rate, performing percussion, and auscultating the chest. Circulatory assessment involved measuring blood pressure, calculating heart rate, and assessing capillary refill time. Disability assessment included evaluating the GCS, assessing pupil response, and measuring random blood sugar levels. Exposure was ensured by conducting a full-body examination to document all visible injuries. Vital signs, including SBP, HR, RR, oxygen saturation, and GCS score, were recorded. A detailed AMPLE history was obtained, covering allergies, medication use, past medical history, last meal, and the events leading to the injury.

Secondary Survey: A thorough head-to-toe examination was performed, including a full neurovascular assessment of the limbs and documentation of wounds. Patients underwent laboratory investigations including complete blood count, prothrombin time, international normalized ratio, and arterial blood gas analysis. Radiological investigations were conducted as needed, including chest X-ray, pelvis X-ray, Focused Assessment with Sonography for Trauma (FAST) scan, and additional X-rays or computed tomography scans when indicated.

Emergency interventions and surgeries:
The study documented all emergency interventions and surgical procedures required for each patient. Emergency interventions included the administration of tranexamic acid, blood or blood products, the use of pelvic binder or sheets, cardiopulmonary resuscitation, intubation, and the application of thoracic drainage. Emergency surgeries performed included laparotomy, reconstruction of depressed fractures, and evacuation of epidural hematoma. Non-emergency interventions included fracture stabilization using casts or splints and suturing of cut wounds.

Table (1): Calculation of the modified rapid emergency medicine score as the following

	score						
variable	0	1	2	3	4	5	6
Age in years	44 or less	45-64		65-74	More than 74		
Systolic Bp (mmHg)	110-159	160-199	200 or more		79 or less		
		90-109	80-89				
Heart rate (beat/min.)	70-109		110-139	140-179	More than 179		
			55-69	40-54	39 or less		
Respiratory rate	12-24	25-34	6-9	35-49	More than 49		
		10-11			5 or less		
Oxygen saturation	89 or more	86-89		75-85	Less than 75		
GCS	14 or 15		8-13			5-7	3-4

BP: Blood Pressure, GCS: Glasgow Coma Scale.

Ethical consideration: This study received ethical approval from the Institutional Review Board of Suez Canal University Faculty of Medicine. Before enrollment, all participants provided written informed consents, which explained the study's objectives and nature. The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, the established guidelines of the World Medical Association for studies involving human subjects.

Statistical analysis

Data were entered into the computer statistical software after being coded. Version 25 of the Statistical Package for Social Science (SPSS) was used for all statistical analyses. The quantitative variables were described using descriptive statistics in numerical form (mean, SD, or percentages). When applicable, the qualitative variables were described using tabular and diagrammatic formats. Tables and graphs were used to show the data. Quantitative data were displayed as mean ± SD, but qualitative data were displayed as numbers and percentages.

RESULTS

As shown in table (2), the mean age of studied group was 38.2 ± 14.9 and ranged from 18 to 75 years. As regards age groups, the most common population (57.5%) of patients aged from 18 to 40 years with mean 27.4 ± 7.3 years. 57 patients (71.2%) were males and 23 patients (28.8%) were females. Regarding mode of trauma, 50% had road traffic accident, 15% fell from high, 12.5% had a direct trauma, 8.75% were injured by quarrel, 6.25% were injured by shot, and 7.5% slipped. Extremity injuries were the most type of injury found in our study group as the following, 37.5% of patients had fractures in upper and lower limb, followed by brain injury found in 18.75% of patients, followed by chest injuries found in 16.25%. Abdominal injuries were in 13.75 % of the patients.

Table (2): Demographic data distribution among patients in studied group

	Studied group N=80	**Number (percent%)**
Age (years) **Mean± SD** **Range**	38.2±14.9 18-75	
Age groups		
18-40 years	27.4±7.3	46 (57.5%)
41-60 years	49.5±4.9	28 (35%)
61-75years	68.8±3.4	6 (7.5%)

N: Number, SD: Standard Deviation

As shown in figure (1) regarding mREMS, most of the patients (66.2%) of the patients had score of 0-2, 20% had score of 3-5, 6.3% had score of 6-8 and 7.5% had score of 9-13. Regarding the interventions in the Emergency Department, 26.25% of the patients needed emergency interventions, 50% needed non-emergency interventions and 23.75% didn't need any intervention**.** In our study, 26.25% needed emergency interventions as the following: 7.5% of the patients needed tranexamic acid, 6.25% needed PRBCs, 5% needed plasma, 5% needed CPR, 10% needed intubation and 7.5% needed chest tube. Regarding surgery, only 5% needed laparotomy, 1.25% needed reconstruction to the skull and 1.25% had evacuation to epidural hematoma**.** Regarding patients' outcome, 47.5% were discharge, 7.5% were transferred immediately to operation room, 11.25% needed OR transfer on non-emergent basis, 17.5% needed inpatient admission for conservative management, 10% were admitted to ICU and 6.25% died.

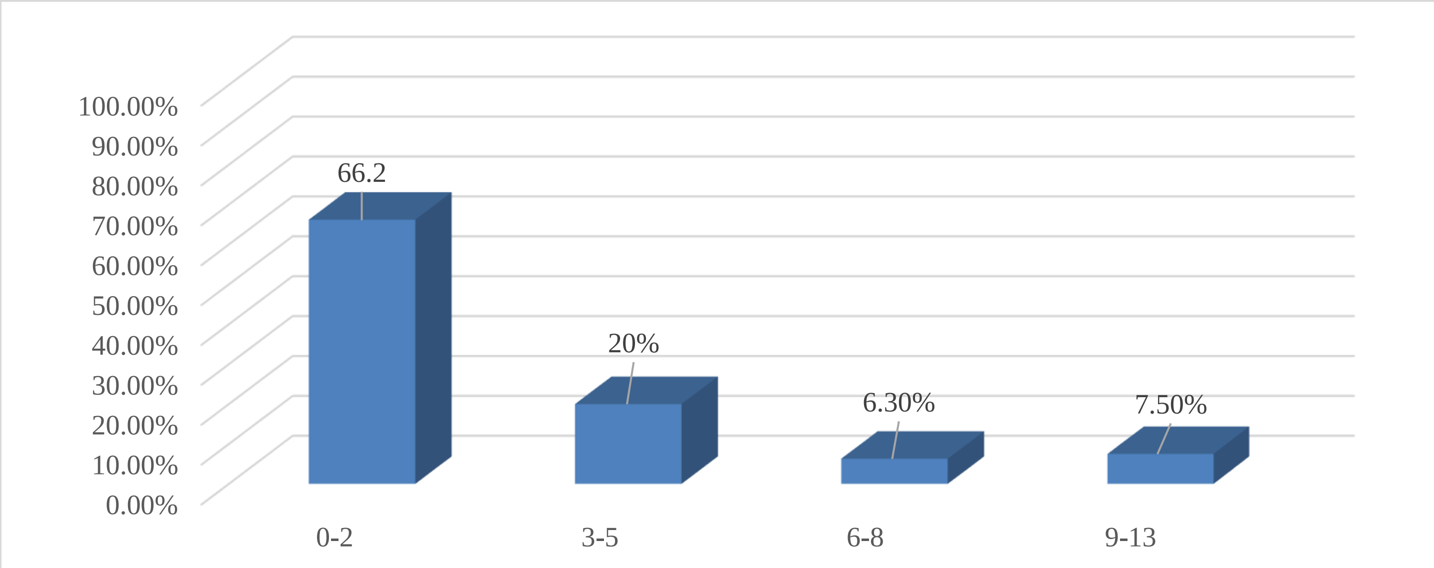

Figure (1): Modified Rapid Emergency Medicine score distribution among patients in studied group.

As shown in table (3), mREMS score showed significant positive correlation with tranexamic-cid, pelvic binder, CPR and Intubation, while showed no significant correlation with chest tube.

Table (3): Correlation between MREMS Score and the need for Emergency interventions

	mREMS score	
	r	**P value**
tranexamic -acid	.477**	0.001
Pelvic binder	.391**	0.001
CPR	.572**	0.001
Intubation	.817**	0.001
Chest Tube	-0.004	0.973

MREMS: Modified Rapid Emergency Medicine Score, CPR: Cardiopulmonary Resuscitation, r: Pearson Correlation, **: *Significant P-Value* (: $p \leq 0.05$).

At cutoff value ≥ 3.5 mREMS score was statistically significant predictor of death, with AUC of 0.873, PPV of 23.5%, NPV of 98.4%, sensitivity of 86% and specificity of 82% (Table 4 and figure 2).

Table (4): Roc curve for MREMS score of predicting mortality

	Cutoff	**AUC**	**Sig.**	**sensitivity**	**specificity**	**PPV**	**NPV**	**Accuracy**	**Lower bound**	**Upper bound**
MREMS score	≥3.5	0.873	0.005	86%	82%	23.5%	98.4%	87%	0.689	1

AUC: Area Under the Curve, Sig.: Significance, PPV: Positive Predictive Value, NPV: Negative Predictive Value, *Significant P-Value if* $p \leq 0.05$

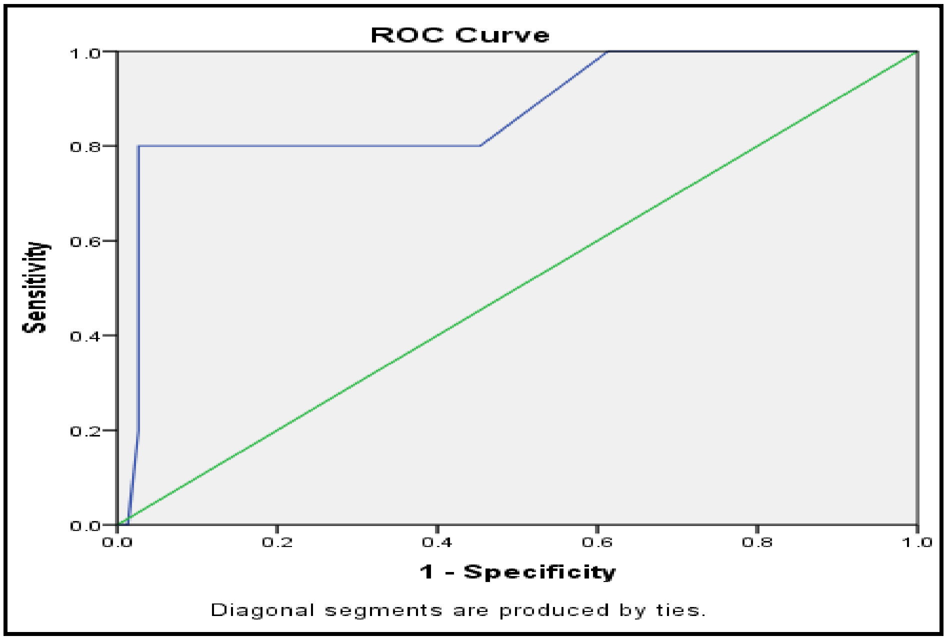

Figure (2): Roc curve for MREMS score of predicting mortality.

DISCUSSION

Injury remains the foremost cause of mortality worldwide, imposing a substantial human and societal burden through disability, financial strain, productivity loss, and increased fatality rates. This highlights the need for the development of simple yet more precise trauma scoring systems and triage models to enhance patient outcomes and reduce mortality [11]. Rapid and accurate evaluation of injury severity plays a vital role in trauma patient management. A simplified yet reliable prognostic scoring system is needed to facilitate decision-making for healthcare providers. However, many existing models, including APACHE, rely on extensive physiological data and prior medical history, limiting their applicability in urgent scenarios [12].

Validated trauma scoring systems provide a rapid and reliable assessment of injury severity and prognosis. Among these, the mREMS has been developed as an efficient alternative. Compared to more complex models like the Injury Severity Score (ISS), mREMS requires less time to compute while maintaining its predictive accuracy for mortality [9]. The aim of this study was to improve the outcome of the trauma patients through the proper triage and disposition by assessing the ability of this score to predict the emergency intervention in the trauma setting on primary assessment of the patients.

Our study results revealed that the mean age of the studied group was 38.2 ± 14.9 ranged from 18 to 75 years and most of the patients (57.5%) were from 18 to 40 years. This is similar to **Nakhjavan-Shahraki *et al.*** [13] who found that the mean age of trauma patients was 39.50 ± 17.27 years, and lower than **Miller *et al.*** [9] study in which the mean age of trauma patients was 50.3 ± 22.9 years. And **Bulut *et al.*** [14] in which the mean age of trauma patients was 61.41 ± 18.9 years as they included both general medical and surgical patients admitted to the ED not only the trauma patients.

In our study, 71.2% of patients were males, and 28.8% of patients were females. This is in agreement with **Nakhjavan-Shahraki *et al.*** [13] who found that 75.56% of trauma patients were males while 24.44% were females. **Miller *et al.*** [9] reported that 61.4% were males, and 38.6% were females. **Durantez-Fernández *et al.*** [15] reported that 64% were males, and 36% were females. In the study by **Bulut *et al.*** [14], the male population accounted for 51.95%, while females comprised 48.05%. Our findings align with existing epidemiological research on trauma exposure, which consistently indicated that males are more frequently subjected to traumatic events compared to females [16].

In the current study, regarding mode of trauma, 50% had road traffic accident (RTA), 15% fell from high, 12.5% had a direct trauma, 8.75% were injured by quarrel 6.25% were injured by shot, and 7.5% slipped. **Nakhjavan-Shahraki *et al.*** [13] reported that the mechanism of trauma was road traffic accidents in 69.23% of the patients and falling from height in16.44%. In an Indian study as well the mode of injury in 60.2% was RTA, 22.1% were fall from height, 12.3% were occupational machine injury, 4.2% came with assault, 0.5% came with burns, and 0.7% were due to various other reason [17].

Extremity injuries were the most type of injury found in our study group as the following: 37.5% of patients had fractures in upper and lower limb, followed by brain injury found in 18.75% of patients, followed by chest injuries in 16.25% of patients. This is in line with **Wijethung *et al.*** [18] where upper and lower limbs are the most commonly injured anatomical area 49% and 43% respectively, suggesting a high frequency of incidents affecting these areas, possibly due to their exposure and use in defensive actions or falls. Lower limb injuries are also common, indicating their vulnerability, possibly due to accidents, sports injuries, or falls. Followed by brain injuries in 21% of patients and 10% of the patients had chest injuries. Abdominal injuries were found in our study group in 13.75 % of the patients of whom 5% needed surgery. While in **Larsen *et al.*** [19] was 6.2%. This is explained by the inclusion of the abdominal trauma according to AIS score needing surgery in the latter study.

Regarding mREMS, most of the patients (66.2%) had score of 0-2, 20% had score of 3-5, 6.3% had score 9f 6-8 and 7.5% had score of 9-13.

Miller *et al.* [9] found that 51.9% of the patients had a score from 0-2, 32.5% had a score from 3-5, 11.9% had a score from 6-8, 3.11% had a score from 9-13 and 1.1% had a score more than 13. There were no patients had a score more than 13 in our study group due to small sample size, while in **Miller *et al.*** [9] they included 429,711 patients, which included variable types of injuries.

In our study, 26.25% needed emergency interventions as follows: 7.5% of the patients needed tranexamic-acid, 6.25% needed PRBCs, 5% needed plasma, 5% needed CPR, 10% needed intubation and 7.5% needed chest tube. Regarding surgery, only 5% needed laparotomy, 1.25% needed reconstruction to the skull and 1.25% had evacuation to epidural hematoma. A comparative analysis was conducted using prospectively collected data from a trauma center in Switzerland to evaluate the predictive performance of the MGAP, GAP, and RISC2 scoring systems in assessing trauma severity, hospital resource utilization, and early patient outcomes. The findings revealed that 26.1% of patients required emergency intervention, 9.8% needed blood transfusion or blood products, and 13.9% underwent intubation and cardiopulmonary resuscitation (CPR). Additionally, 32.4% of patients required surgical intervention [7]. The difference is in the need for surgical intervention because of our small sample size, which included 80 patients and the large sample size (2112 patients) in **Zeindler *et al.*** [7] and the selection of only severely injured patients according to their Triaging system.

Regarding patients' outcome, 47.5% of the patients in our study were discharged, 7.5% were transferred immediately to operation room, 11.25% needed OR transfer on non-emergent basis, 17.5% needed inpatient admission for conservative management, 10% were admitted to ICU and 6.25% died.

In **Zeindler *et al.*** [7] as the patients included were severely injured, 36.4% were discharged but without full recovery, 34.2% were admitted to ICU whether directly or after surgery and 8.3% died whether immediately or deceased in hospital. The difference in numbers is due to determining the outcome of the patients in our study was within 24 hours as our main target was to measure the patients' outcome and interventions on their presentation to ED, while in **Zeindler *et al.*** [7] was determined as the final fate of the patients.

In our study, mREMS score showed significant positive correlation with tranexamic-acid, pelvic binder, CPR and intubation, while showed no significant correlation with chest tube. This could be because the early simple pneumothorax doesn't significantly affect RR and SPO_2, which are present in mREMS. As the physical examination and vitals might be normal if the pneumothorax is small [20]. According to our knowledge this is the first study to correlate mREMS score with the emergency interventions and surgeries.

At cutoff value $\geq$ 3.5, mREMS score was statistically significant predictor of death, with AUC of 0.873, PPV of 23.5%, NPV of 98.4%, sensitivity of 86% and specificity of 82%. Our results are in agreement with **Miller *et al.*** [9]' study of validation of mREMS to quickly predict trauma in-hospital mortality. The study reported that the mREMS score demonstrated superior predictive accuracy for hospital mortality, with an AUC of 0.967, exceeding that of MGAP (AUC = 0.964) and RTS (AUC = 0.959). Additionally, mREMS outperformed ISS (AUC = 0.780) and SI (AUC = 0.670) in mortality prediction. When analyzed overall and stratified by the mechanism of injury—blunt or penetrating trauma—mREMS consistently exhibited the highest AUC, indicating its robustness as a prognostic tool.

Miller *et al.* [9] reported that the mREMS score demonstrated the highest predictive accuracy, with an AUC of 0.967, surpassing RTS, ISS, MGAP, and SI. Additionally, mREMS maintained superior performance when stratified by the mechanism of injury, whether blunt or penetrating trauma. Subgroup analyses further revealed that its predictive capability improved when the ISS exceeded 15, suggesting that mREMS may be particularly effective in assessing mortality risk among severely injured patients. In line with our results, **Phunghassaporn *et al.*** [21] found that at cutoff value $\geq$ 3, mREMS score is statistically significant predictor of death, with an AUC of 0.909, PPV of 13.6%, NPV of 99.2%, sensitivity of 86.1% and specificity of 76.3%. Nevertheless, substantially higher mortality than in the original mREMS study by **Miller *et al.*** [9].

Also, **Martín-Rodríguez *et al.*** [22] found that three and seven-days mortality, the mREMS with an AUC of 0.857, sensitivity of 69.2% and specificity of 86.8%, and AUC of 0.833, sensitivity of 64.9 and specificity of 87.8 respectively with all cases (p <0.001). Similarly, the study by **Durantez-Fernández *et al.*** [23] demonstrated that the mREMS scale exhibited consistent predictive accuracy for early mortality at two days, as well as at one week and one-month post-injury. Their findings highlighted that patients who did not survive were, on average, 20 years older than survivors, emphasizing the critical role of age as a key determinant in the prognostic assessments made by the mREMS score.

The mREMS scale, an evolution of the REMS demonstrated superior predictive accuracy for hospital mortality compared to the Rapid Acute Physiology Score (RAPS), from which it originates. By incorporating age and oxygen saturation—variables absent in RAPS—mREMS enhances real-time mortality risk assessment [9, 24]. Our findings corroborate those of **Miller *et al.*** [9], further validating that the refinements made to REMS significantly improve its ability to predict mortality in trauma patients.

In a meta-analysis by **Toloui *et al.*** [25], the predictive performance of various physiological scoring systems, including the Worthing Physiological Score (WPS), was assessed for mortality risk in critically ill patients. Based on 25 studies, the analysis revealed that the areas under the summary ROC curve were 0.83 for REMS, 0.89 for RAPS, 0.64 for mREMS, and 0.86 for WPS, illustrating variations in their prognostic value. The analysis demonstrated that in-hospital mortality was effectively predicted by all three models—RAPS, REMS, and WPS. Moreover, their predictive value was notably higher in trauma patients compared to other clinical scenarios. The findings also suggested that scoring systems such as the RAPS, REMS, and WPS exhibited greater accuracy in forecasting in-hospital mortality than mREMS, particularly when applied to trauma populations. The significance of this finding is underscored by the fact that mortality and morbidity rates are typically greater in acute non-traumatic conditions than in trauma-related cases. This can be attributed to the study composition, which included six studies on trauma patients, nine on sepsis or infection cases, five on a mixed population of acute conditions, and five centered on non-trauma patients.

Limitations include a small sample size and single-center design, which may limit generalizability. Additionally, mREMS did not predict all emergency interventions, such as chest tube placement, and long-term outcomes were not assessed. Larger, multicenter studies are needed to validate these findings and enhance mREMS applicability in trauma settings.

CONCLUSION

According to this study, revealed that mREMS can predict the need for certain emergency interventions in trauma patients and can predict mortality of the patients at score of more than 3.5. In busy emergency departments, the mREMS is simple to calculate and effective. Additionally, it could help doctors properly use medical resources and appropriately dispose of patients.

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