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Performance of REMS in Predicting Sepsis Mortality in a Tertiary Care Emergency Setting

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Abstract:

Background: Sepsis is a major cause of morbidity and mortality in emergency and critical care settings, particularly in resource-limited countries like India. Early identification of high-risk patients is crucial for timely intervention and optimal resource utilization. The Rapid Emergency Medicine Score (REMS) is a simple, bedside physiological scoring system that may help predict mortality at the time of emergency department presentation.

Methods: This was a prospective observational study conducted in a tertiary care emergency department. A total of 166 adult patients with sepsis were enrolled and followed until discharge or death. REMS was calculated at presentation using six clinical parameters: age, heart rate, respiratory rate, mean arterial pressure, Glasgow Coma Scale, and oxygen saturation. Patients were categorized into survivors and non-survivors. ROC curve analysis was performed to evaluate the predictive accuracy of REMS. Multivariate logistic regression was used to identify independent predictors of in-hospital mortality.

Results: Out of 166 patients, 108 (65.1%) survived and 58 (34.9%) died. Mean REMS score was significantly higher among non-survivors (11.1 ± 3.1) compared to survivors (6.4 ± 2.3), ($p < 0.001$). REMS demonstrated good predictive accuracy for in-hospital mortality with an AUC of 0.84 (95% CI: 0.77 – 0.89). At a cut-off of REMS ⩾10, sensitivity was 62.1%, specificity 88.9%, PPV 75.8%, NPV 81.4%, and overall accuracy 79.5%. On multivariate analysis, REMS (AOR: 1.39 per point increase, $p < 0.001$), septic shock at presentation (AOR: 3.46, $p < 0.001$), serum lactate (AOR: 1.57 per mmol/L, $p < 0.001$), and age (AOR: 1.31 per 10-year increase, $p = 0.003$) were independent predictors of mortality.

Conclusion: REMS is a simple, rapid, and reliable bedside tool for predicting in-hospital mortality in patients with sepsis. Its good discriminatory ability and ease of application make it particularly useful for triage and risk stratification in busy and resource-limited emergency departments. Early use of REMS may help prioritize critically ill patients for aggressive management and intensive care admission.

Keywords:

Sepsis; Rapid Emergency Medicine Score; Mortality prediction; Risk stratification; ROC curve

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Introduction

Sepsis is one of the leading causes of mortality among critically ill patients, with an estimated 49 million cases and 11 million deaths annually worldwide, accounting for nearly 20% of all global deaths [1]. In low- and middle-income countries, including India, the burden is disproportionately higher due to delayed presentation, limited intensive care facilities, and high prevalence of infectious diseases. Indian ICU-based studies have reported sepsis mortality rates ranging from 28% to 60%, particularly in patients presenting with septic shock [2].

Sepsis is currently defined as life-threatening organ dysfunction caused by a dysregulated host response to infection, with organ dysfunction identified by an increase of ≥2 points in the Sequential Organ Failure Assessment (SOFA) score [3]. While laboratory-based scoring systems such as SOFA, APACHE II, and SAPS II are widely used for prognostication, their application in emergency departments (EDs) remains challenging due to time constraints, dependency on laboratory investigations, and the need for repeated measurements [4]. This poses a significant limitation in resource-constrained emergency settings where rapid triage decisions play a critical role in patient outcomes [4].

Early risk stratification is essential in sepsis management, as studies have demonstrated that each hour of delay in appropriate antibiotic therapy increases mortality by 7–10%, especially in septic shock [5]. Therefore, a simple, rapid, bedside scoring system based exclusively on clinical and physiological parameters can be of immense value in identifying high-risk patients at the point of first contact in the ED [5].

The Rapid Emergency Medicine Score (REMS) was developed as a simplified alternative to APACHE II, specifically designed for use in emergency settings to predict short-term mortality [6]. It includes six readily obtainable variables: age, mean arterial pressure, heart rate, respiratory rate, Glasgow Coma Scale (GCS), and peripheral oxygen saturation (SpO_2). REMS has been shown to have good predictive accuracy for in-hospital mortality in various emergency conditions including trauma, community-acquired pneumonia, and undifferentiated critically ill patients [7].

Previous studies evaluating REMS in sepsis have shown promising results [8,9]. When compared with qSOFA, REMS showed superior sensitivity for early mortality prediction in several emergency cohorts [10]. Given the high patient burden and limited availability of ICU beds in government and tertiary care hospitals in India, a rapid clinical tool like REMS could help prioritize admissions, guide early aggressive interventions, and improve allocation of limited critical care resources. Therefore, this study was aimed to evaluate the utility of the Rapid Emergency Medicine Score in predicting in-hospital mortality among patients presenting with sepsis in a tertiary care emergency department, and to assess its potential role as a practical triage tool in resource-limited settings.

Material and methods

Study Design and Setting

This was a prospective observational study conducted in the Department of Tuberculosis and Respiratory Disease at JNMCH, AMU, Aligarh, Uttar Pradesh, India over a period of 18 months from January 2017 to June 2018. The study aimed to evaluate the ability of the Rapid Emergency Medicine Score (REMS) to predict in-hospital mortality among patients presenting with sepsis.

Study Population

All adult patients aged 18 years and above presenting to the emergency department with a diagnosis of sepsis were screened for inclusion. Sepsis was defined according to the Sepsis-3 criteria, as suspected or confirmed infection with evidence of

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organ dysfunction, indicated by an increase in SOFA score of ≥2 points from baseline or clinical signs of organ failure in the emergency setting. Patients were enrolled consecutively to minimize selection bias. Patients were excluded if they were transferred after more than 24 hours of treatment from another hospital, had incomplete clinical data required for calculating the REMS score, left against medical advice within 24 hours of admission, or had do-not-resuscitate (DNR) orders at presentation.

Sample Size and Sampling Technique

The sample size was calculated based on study by Wang et al., evaluating REMS in sepsis, considering an expected mortality rate of approximately 30–40% and an anticipated AUC of 0.75–0.80 for REMS in predicting mortality [10]. Using a confidence level of 95% and power of 80%, the minimum required sample size was estimated to be 166 patients. A consecutive sampling technique was used, and all eligible patients during the study period were included until the desired sample size was achieved.

Data Collection Procedure

After obtaining informed consent from the patient or their legally authorized representative, demographic and clinical data were recorded at the time of presentation using a predesigned and pretested case record form. Data collected included age, sex, presenting symptoms, comorbidities such as diabetes mellitus, hypertension, chronic kidney disease, chronic liver disease, or malignancy, and source of infection (respiratory, urinary, abdominal, skin/soft tissue, or others). Vital parameters including heart rate, respiratory rate, systolic and diastolic blood pressure, oxygen saturation on room air or supplemental oxygen, and Glasgow Coma Scale (GCS) score were measured at the time of arrival in the emergency department, prior to any major therapeutic interventions like intubation, vasopressor initiation, or sedative administration, wherever feasible.

Calculation of Rapid Emergency Medicine Score (REMS)

The Rapid Emergency Medicine Score was calculated for each patient at the time of presentation based on six physiological parameters: age, mean arterial pressure, heart rate, respiratory rate, Glasgow Coma Scale score, and peripheral oxygen saturation (SpO_2). Each parameter was assigned points as per the standard REMS scoring system described by Olsson et al., and the total score ranged from 0 to 26. For patients on supplemental oxygen, measured SpO_2 values were used directly without adjustment. REMS was calculated by the treating physician or trained research personnel who were blinded to patient outcomes at that time. Patients were stratified into risk categories based on their REMS score (e.g., low, moderate, and high risk) to analyze mortality trends across different score ranges.

Outcome Measures

The primary outcome measure was in-hospital mortality, defined as death occurring during the same hospital admission following presentation to the emergency department. Secondary outcomes included need for ICU admission, requirement of mechanical ventilation, and length of hospital stay. Patients were followed from admission until discharge or death.

Laboratory and Radiological Assessment

Routine laboratory investigations including complete blood count, serum electrolytes, renal and liver function tests, arterial blood gas analysis, serum lactate levels, blood cultures, and relevant imaging studies such as chest X-ray or ultrasonography were performed as per standard institutional protocols. These parameters were primarily used for diagnostic and treatment purposes, while REMS relied only on clinical variables and did not include laboratory values.

Ethical Considerations

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The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants or their legally authorized representatives prior to inclusion in the study. Confidentiality of patient data was strictly maintained throughout the study, and the study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 20.0 (IBM Corp, Armonk, NY). Continuous variables were expressed as mean ± standard deviation or median with interquartile range, depending on data distribution, while categorical variables were expressed as frequencies and percentages. The predictive ability of REMS for in-hospital mortality was assessed using receiver operating characteristic (ROC) curve analysis, and the area under the curve (AUC) was calculated along with 95% confidence intervals. The optimal cut-off value of REMS for predicting mortality was determined using the Youden Index. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated at this cut-off point. Comparisons between survivors and non-survivors were performed using the independent t-test or Mann–Whitney U test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Multivariate logistic regression analysis was conducted to determine whether REMS was an independent predictor of mortality after adjusting for potential confounders such as age, comorbidities, and source of infection. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 166 patients with sepsis were enrolled, of whom 108 (65.1%) survived and 58 (34.9%) died during hospitalization. The overall mean age was 56.2 ± 15.0 years, with non-survivors being significantly older than survivors (63.8 ± 12.9 vs 52.3 ± 14.2 years, $p < 0.001$). Males constituted 63.9% of the cohort, with no significant difference in gender distribution between survivors and non-survivors (p = 0.324). Among comorbid conditions, hypertension (41.0%) and diabetes mellitus (43.4%) were most common. Hypertension and chronic kidney disease were significantly more prevalent in non-survivors compared to survivors (51.7% vs 35.2%, p = 0.032 and 24.1% vs 9.3%, p = 0.011, respectively). Patients with ≥2 comorbidities had significantly higher mortality (37.9% vs 22.2%; p = 0.028), whereas the absence of any comorbidity was more common among survivors (37.0% vs 13.8%; p = 0.002) (Table 1).

Table 1. Comparison of baseline demographic characteristics and comorbidities between survivors and non-survivors among septic patients (n = 166).

Variable	Total (n=166)	Survivors (n=108)	Non-survivors (n=58)	p-value
	Frequency (%)/mean ± SD			
Age (years)	**56.2 ± 15.0**	**52.3 ± 14.2**	**63.8 ± 12.9**	**<0.001**
Gender				
Male	**106 (63.9)**	**66 (61.1)**	**40 (69.0)**	**0.324**
Female	**60 (36.1)**	**42 (38.9)**	**18 (31.0)**	
Comorbidity				
Diabetes mellitus	**72 (43.4)**	**41 (38.0)**	**31 (53.4)**	**0.062**
Hypertension	**68 (41.0)**	**38 (35.2)**	**30 (51.7)**	**0.032**

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Chronic kidney disease	**24 (14.5)**	**10 (9.3)**	**14 (24.1)**	**0.011**
Chronic liver disease	**18 (10.8)**	**8 (7.4)**	**10 (17.2)**	**0.063**
≥2 comorbidities	**46 (27.7)**	**24 (22.2)**	**22 (37.9)**	**0.028**
No comorbidity	**48 (28.9)**	**40 (37.0)**	**8 (13.8)**	**0.002**

Respiratory tract infection was the most common source of sepsis (41.0%) and was significantly more frequent among non-survivors (48.3% vs 37.0%; overall comparison $p = 0.041$). Central nervous system infections were also relatively more common in non-survivors (10.3% vs 3.7%). Urinary tract infections were more frequently seen in survivors (22.2% vs 10.3%). Non-survivors presented with significantly worse physiological parameters: higher heart rate (118.4 ± 21.5 vs 106.7 ± 18.8 bpm, $p < 0.001$), higher respiratory rate (28.7 ± 6.9 vs 24.8 ± 5.7 breaths/min, $p < 0.001$), and significantly lower mean arterial pressure (65.6 ± 11.5 vs 78.6 ± 12.4 mmHg, $p < 0.001$). They also had lower oxygen saturation (89.7 ± 6.1% vs 94.4 ± 4.3%, $p < 0.001$) and higher serum lactate levels (3.8 ± 1.5 vs 2.2 ± 0.8 mmol/L, $p < 0.001$). Septic shock at presentation was significantly more common among non-survivors (69.0%) compared to survivors (29.6%, $p < 0.001$) (Table 2).

Table 2. Source of infection and clinical parameters at presentation in survivors and non-survivors.

Variable	**Total (n=166)**	**Survivors (n=108)**	**Non-survivors (n=58)**	**p-value**
	Frequency (%)/mean ± SD			
Source of infection				
Respiratory	**68 (41.0)**	**40 (37.0)**	**28 (48.3)**	**0.041**
Abdominal (intra-abdominal sepsis)	**34 (20.5)**	**22 (20.4)**	**12 (20.7)**	
Urinary tract	**30 (18.1)**	**24 (22.2)**	**6 (10.3)**	
Skin / soft tissue	**12 (7.2)**	**8 (7.4)**	**4 (6.9)**	
Central nervous system	**10 (6.0)**	**4 (3.7)**	**6 (10.3)**	
Others / unknown	**12 (7.2)**	**10 (9.3)**	**2 (3.4)**	
Clinical and hemodynamic variables				
Heart rate (beats/min)	**110.2 ± 19.1**	**106.7 ± 18.8**	**118.4 ± 21.5**	**<0.001**
Respiratory rate (breaths/min)	**25.4 ± 5.8**	**24.8 ± 5.7**	**28.7 ± 6.9**	**<0.001**
Mean arterial pressure (mmHg)	**73.5 ± 12.4**	**78.6 ± 12.4**	**65.6 ± 11.5**	**<0.001**
Glasgow Coma Scale	**12.0 ± 3.0**	**13.1 ± 2.2**	**12.6 ± 3.4**	**<0.001**
SpO_2 (%) at presentation	**92.3 ± 5.6**	**94.4 ± 4.3**	**89.7 ± 6.1**	**<0.001**
Serum lactate (mmol/L)	**2.8 ± 1.3**	**2.2 ± 0.8**	**3.8 ± 1.5**	**<0.001**
Septic shock at presentation	**72 (43.4)**	**32 (29.6)**	**40 (69.0)**	**<0.001**

Based on the Rapid Emergency Medicine Score (REMS), 32.5% of patients were classified as low risk (0–5), 38.6% as moderate risk (6–9), and 28.9% as high risk (≥10). A clear trend of increasing mortality was observed with increasing REMS categories ($p < 0.001$). Among patients with REMS ≥10, 62.1% were non-survivors, whereas only 3.4% mortality was observed in patients with REMS ≤5. The mean REMS score was significantly higher in non-survivors compared to survivors (11.1 ± 3.1 vs 6.4 ± 2.3, $p < 0.001$) (Table 3).

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Table 3. Distribution of REMS categories and comparison of mean REMS scores between survivors and non-survivors.

Variable	Total (n=166)	Survivors (n=108)	Non-survivors (n=58)	p-value
	Frequency (%)/mean ± SD			
REMS category				
0–5	**54 (32.5)**	**52 (48.1)**	**2 (3.4)**	**<0.001**
6–9	**64 (38.6)**	**44 (40.7)**	**20 (34.5)**	
≥10	**48 (28.9)**	**12 (11.1)**	**36 (62.1)**	
REMS score	**8.0 ± 3.4**	**6.4 ± 2.3**	**11.1 ± 3.1**	**<0.001**

ROC curve analysis demonstrated that REMS had good discriminative ability for predicting in-hospital mortality, with an area under the curve (AUC) of 0.84 (95% CI: 0.77–0.89). At the optimal cut-off value (REMS ≥10), the score showed a sensitivity of 62.1%, specificity of 88.9%, positive predictive value of 75.8%, and negative predictive value of 81.4%. The overall diagnostic accuracy of REMS was 79.5%, indicating good reliability as a bedside prognostic tool in septic patients (Figure 1 and Table 4).

Table 4. Diagnostic performance of REMS for prediction of in-hospital mortality using ROC curve analysis.

REMS	Parameter
AUC (95% CI)	**0.84 (0.77–0.89)**
Sensitivity (%)	**62.1**
Specificity (%)	**88.9**
PPV (%)	**75.8**
NPV (%)	**81.4**
Accuracy (%)	**79.5**

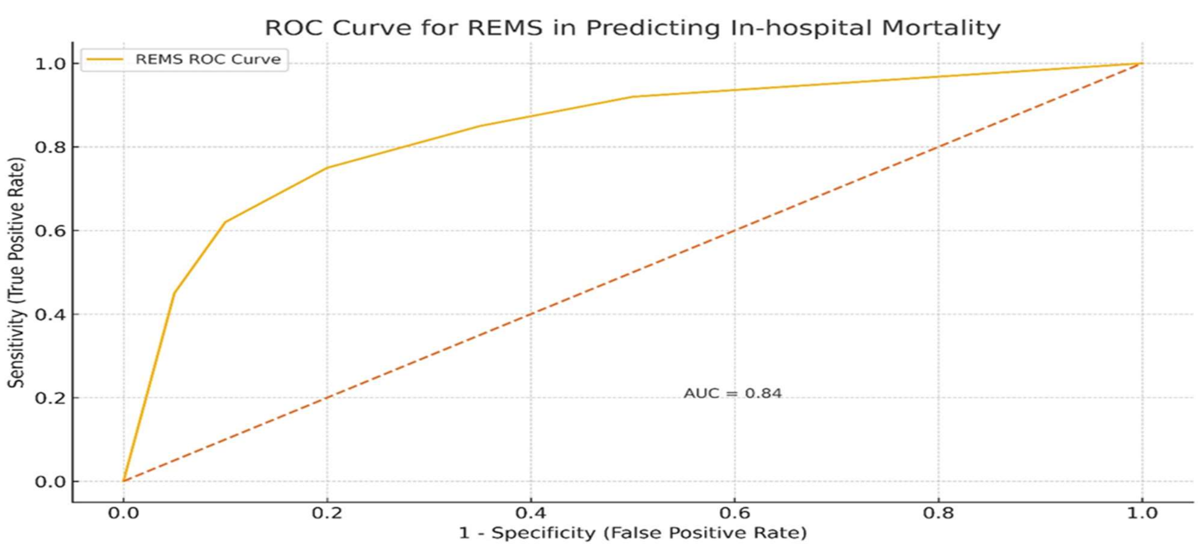

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Figure 1. Diagnostic performance of REMS for prediction of in-hospital mortality using ROC curve analysis.

Discussion

In this prospective observational study of 166 patients with sepsis presenting to a tertiary-care emergency department, we found that the Rapid Emergency Medicine Score (REMS) was a strong predictor of in-hospital mortality, with an overall mortality of 34.9%. This mortality rate is comparable to previously reported Bhudhrani et al., Cao et al., and Rudd et al., where sepsis mortality has ranged from 28% to 60%, depending on severity and resource availability [11,12,13]. The moderate-to-high mortality in our cohort reflects the real-world burden of late presentations and high disease severity commonly seen in public sector tertiary hospitals across India [14].

Non-survivors in our study were significantly older than survivors (63.8 ± 12.9 vs 52.3 ± 14.2 years, $p < 0.001$), which is consistent with the well-established observation that increasing age is associated with immunosenescence, reduced physiological reserve, and higher vulnerability to multiorgan dysfunction in sepsis [15,16]. Several large sepsis registries by Todi et al., and Edathadathil et al., have similarly reported age as an independent mortality predictor [17,18].

With regard to comorbidities, chronic kidney disease and hypertension were significantly more common among non-survivors. CKD is known to worsen sepsis outcomes due to chronic inflammation, impaired clearance of inflammatory mediators, and altered drug pharmacokinetics [5,19]. The significantly lower proportion of patients without comorbidities in the non-survivor group further emphasizes the role of baseline health status in determining sepsis prognosis [5].

In our cohort, respiratory infections were the most common source of sepsis (41%) and were significantly more frequent among non-survivors. This aligns with previous studies by Virk et al., Madkour et al., and Darkwah et al., showing that pneumonia-related sepsis carries higher mortality compared to urinary or soft tissue sources due to early hypoxia and systemic inflammatory burden [14,20,21]. CNS infections were also proportionately higher among non-survivors, possibly reflecting delayed presentation and rapid neurological deterioration [14].

Severe physiological derangements at presentation strongly correlated with mortality. Non-survivors had significantly higher heart rate and respiratory rate, lower mean arterial pressure, lower oxygen saturation, higher lactate levels and greater incidence of septic shock. Elevated lactate reflects impaired tissue perfusion and mitochondrial dysfunction and has consistently been validated as a strong prognostic marker in sepsis [22,23]. Our findings reinforce the concept that early hemodynamic instability and hypoxia are central contributors to poor sepsis outcomes [22].

The mean REMS score was significantly higher in non-survivors compared to survivors (11.1 ± 3.1 vs 6.4 ± 2.3, $p < 0.001$), and mortality rose sharply with increasing REMS category. Patients with REMS ≥10 had a mortality of over 62%, whereas those with REMS ≤5 had mortality below 5%, demonstrating excellent risk stratification ability. REMS showed strong predictive ability with an AUC of 0.84, indicating good discrimination. This is consistent with findings from van Dam et al., [24], who originally validated REMS and reported AUC values of 0.79–0.85 in emergency populations. Similar AUC values have been reported in studies by Reddy et al., and Badrinath et al., assessing REMS [25,26].

Compared to qSOFA, which often has lower sensitivity in emergency settings, REMS incorporates age, GCS and oxygen saturation, making it more comprehensive for early triage

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[27,28]. In high-volume, resource-limited emergency departments like ours, REMS provides a rapid and feasible bedside scoring system without waiting for laboratory parameters [28].

Multivariate logistic regression showed that REMS remained an independent predictor of mortality, with every one-point increase increasing the odds of death by 39% (AOR: 1.39, $p < 0.001$), even after adjusting for age, comorbidities, serum lactate and septic shock. This highlights that REMS integrates multiple high-risk physiological parameters into a single composite variable, strengthening its prognostic value [29,30]. Septic shock at presentation increased mortality risk by more than threefold, which mirrors global sepsis data where shock remains one of the strongest predictors of death [29,30]. Age and lactate also retained independent predictive significance, supporting their inclusion in comprehensive risk stratification models [30].

Clinical implications

The findings of our study suggest that REMS can be effectively used as a rapid triage and prognostication tool in Indian emergency departments, where ICU beds, monitors, and laboratory turnaround time may be limited. Early identification of high-risk patients using REMS could help guide aggressive resuscitation, early ICU referral, and better allocation of scarce critical care resources.

Limitations

This study has certain limitations that should be acknowledged. Being a single-center study, the findings may not be fully generalizable to other settings with different patient populations or healthcare infrastructures. REMS was calculated only at the time of emergency department presentation, and dynamic changes in REMS during the hospital course were not assessed, which might have provided additional prognostic information. As an observational study, causal relationships cannot be established, and unmeasured confounders may have influenced the outcomes. Factors such as timing and appropriateness of antibiotic therapy, microbiological profile, and variations in treatment protocols were not included in the analysis and could have affected mortality outcomes. Additionally, although the sample size was adequate for primary analysis, it may have limited the ability to perform detailed subgroup analyses based on infection source or comorbidity pattern.

Conclusion

In this prospective study involving 166 patients with sepsis, the Rapid Emergency Medicine Score (REMS) demonstrated good predictive accuracy for in-hospital mortality, with an AUC of 0.84 and an overall diagnostic accuracy of 79.5%. Higher REMS scores were strongly associated with increased mortality, and REMS remained an independent predictor of death even after adjusting for age, comorbidities, serum lactate levels, and the presence of septic shock. The score also showed excellent ability to stratify patients into low-, moderate-, and high-risk mortality categories at the time of emergency department presentation. Given its simplicity, reliance only on bedside clinical parameters, and absence of laboratory requirements, REMS can be effectively used as a rapid triage and prognostic tool in resource-limited emergency settings, particularly in developing countries like India. Early application of REMS may aid clinicians in making timely decisions regarding intensive monitoring, ICU admission, and aggressive resuscitation, thereby potentially improving outcomes in septic patients. Further multi-center studies with larger sample sizes are recommended to validate these findings and explore the integration of REMS into standard sepsis management protocols in emergency care.

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