









The Predictive Power of Rapid Acute Physiology Score and Rapid Emergency Medicine Score in Mortality Risk of Diabetic Ketoacidosis Patients

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ABSTRACT

Objective: This study aimed to evaluate the effectiveness of the Rapid Emergency Medicine Score (REMS) and the Rapid Acute Physiology Score (RAPS) in predicting mortality among patients with diabetic ketoacidosis (DKA) in the emergency department.

Methods: A retrospective cross-sectional study was conducted on 111 patients diagnosed with DKA who were admitted to the emergency department of a tertiary hospital between June 1, 2021, and June 1, 2022. Inclusion criteria were patients aged 18 years and older who met the diagnostic criteria for DKA as defined by the American Diabetes Association. Data on vital signs, laboratory results, and clinical outcomes were collected. The predictive power of the REMS and RAPS scores for mortality was assessed using Receiver Operating Characteristic (ROC) curve analysis to determine the area under the curve (AUC) for each score. Descriptive statistics and non-parametric tests were used to analyze the data.

Results: A total of 111 patients with DKA were included in this study. The cohort comprised 64 males (57.6%) and 47 females (42.3%), with a mean age of 51.86 ± 20.27 years. Among the patients, 7 (6.31%) were discharged, 56 (50.45%) were admitted to the general ward, 35 (31.53%) to the intensive care unit (ICU), and 13 (11.71%) patients died. The REMS score demonstrated a higher predictive power for mortality in DKA patients, with an AUC of 0.712, compared to an AUC of 0.60 for the RAPS score.

Conclusion: The REMS score proved to be a more effective tool than the RAPS score in predicting mortality among DKA patients. Given its higher accuracy and reliability, the REMS score could be valuable as an early warning system in the management of DKA in emergency settings. Routine use of REMS in similar critical conditions is recommended.

INTRODUCTION

Diabetic ketoacidosis (DKA) is a metabolic emergency frequently observed in patients with type 1 diabetes and is potentially life-threatening. DKA is characterized by hy-

perglycemia, ketonemia, and metabolic acidosis as a result of insulin deficiency and increased levels of counter-regulatory hormones. This condition can lead to severe dehydration, electrolyte imbalances, and acid-base disturbances. [1-5] The diagnosis and management of DKA in emergency

departments are of great importance because the mortality rate is significantly high if not treated promptly and appropriately. Rapid and accurate recognition and management of DKA increase patients' chances of survival and reduce complications.

In critical conditions such as DKA, the implementation of scoring systems is indispensable for guiding clinical decision-making and optimizing patient care. DKA, marked by severe metabolic disturbances, including hyperglycemia, ketonemia, and acidosis, poses a significant risk of morbidity and mortality if not promptly and effectively managed. Scoring systems provide a structured approach to evaluating the severity of a patient's condition by quantifying vital physiological parameters. These tools allow clinicians to prioritize interventions based on the patient's risk profile, ensuring that those with the highest need receive timely and appropriate treatment. By offering a standardized method to assess and monitor disease progression, scoring systems are critical in improving outcomes in patients with life-threatening conditions like DKA.

The Rapid Emergency Medicine Score (REMS) and the Rapid Acute Physiology Score (RAPS) are two important scoring systems used in emergency departments to quickly assess the overall condition of patients and estimate their mortality risk.^[6-8] In REMS, parameters such as age, mean arterial pressure, heart rate, respiratory rate, body temperature, and the Glasgow Coma Scale (GCS) are included. Each of these parameters is assessed with specific points, and the total score reflects the patient's overall condition and mortality risk.^[9,10] In RAPS, parameters such as mean arterial pressure, heart rate, respiratory rate, and GCS are included, and similarly, it is used to quickly assess the patient's physiological condition.^[11,12] These scores play a crucial role in clinical decision-making processes and can be applied quickly and effectively in emergency departments.

The aim of this study is to examine the predictive power of RAPS and REMS scores in estimating mortality in patients with DKA.

MATERIALS AND METHODS

This retrospective cross-sectional study includes patients diagnosed with DKA who presented to the emergency department of a tertiary hospital between June 1, 2021, and June 1, 2022. Ethics approval was obtained from Kartal Dr. Lütfi Kırdar City Hospital Ethics Committee with the decision dated 30.06.2022 and numbered 2022/514/228/3. The study included patients over the age of 18 who presented to the emergency department and met the diagnostic criteria for DKA. The diagnostic criteria for DKA include hyperglycemia, ketonemia or ketonuria, and metabolic acidosis, as defined by the American Diabetes Association (ADA).^[13] The data were obtained from the hospital's electronic patient record management system. Patients who did not meet the DKA diagnostic criteria, patients for whom REMS or RAPS scores could not be calculated, patients whose emergency department triage

data could not be accessed through the electronic patient record management system, and patients transferred from another hospital were excluded from the study.

For all patients included in the study, age, gender, vital signs (blood pressure, heart rate, respiratory rate, body temperature), laboratory parameters (blood glucose, serum electrolytes, blood gases), and medical history were recorded digitally. Vital signs and laboratory results were evaluated as the initial data obtained at the time of the emergency department visit.

The REMS includes parameters such as age, mean arterial pressure, heart rate, respiratory rate, body temperature, and GCS. The RAPS, on the other hand, includes parameters such as mean arterial pressure, heart rate, respiratory rate, and GCS. These scores are used to estimate the overall condition and mortality risk of patients. Higher REMS and RAPS indicate worse clinical outcomes and a higher risk of mortality.

The primary aim of the study is to evaluate the effectiveness of REMS and RAPS in predicting mortality in DKA patients presenting to the emergency department.

Statistical Analysis

Statistical analyses were performed using the SPSS version 25 statistical software package. Descriptive statistical methods (mean, frequency, percentage) were used to summarize the data during the evaluation of the study findings. The normality distribution of continuous variables was assessed using the Shapiro-Wilk test. Since the assumption of normal distribution was not met, the Mann-Whitney U test was applied to examine differences between the two groups. Relationships between two continuous variables were investigated using Spearman's rho correlation coefficients. To determine the predictive power of the scores used in identifying patient mortality, ROC analysis was performed. A p-value of <0.05 was considered statistically significant for all tests.

RESULTS

In this study, 111 patients diagnosed with DKA who met the inclusion criteria were included. Of these patients, 64 (57.6%) were male, and 47 (42.3%) were female, with a mean age of 51.86 ± 20.27 years (range 19-90 years). Seven patients (6.31%) were discharged, 56 (50.45%) were admitted to the ward, and 35 (31.53%) were admitted to the intensive care unit (ICU), with 13 (11.71%) patients who died. Patients admitted to the ward stayed an average of 5.81 ± 4.86 days (range 0-23), while those in the ICU stayed an average of 6.04 ± 3.69 days (range 1-18). The demographic information of the patients, along with their hospital admission, non-survivor, and discharge statuses, is presented in Table 1.

The statistical data for the criteria used in the REMS and RAPS, including age, mean arterial pressure, heart rate, respiratory rate, oxygen saturation, and GCS values, which were used to predict patient mortality, are summa-

Table 1. Basic statistics of categorical variables of patients

Variable	Frequency	Percentage
Sex		
Man	64	57.66
Woman	47	42.34
Outcome		
Outpatient	7	6.31
Inpatient Unit	56	50.45
Intensive Care Unit	35	31.53
Non-survivor	13	11.71

rized in Table 2.

A ROC analysis was performed to compare the power of the RAPS and REMS in predicting patient mortality. This analysis identified the appropriate positivity threshold, critical values, and the quality of mortality prediction for each score. According to the ROC analysis results presented in Table 3, the area under the curve (AUC) for the RAPS was 0.60 ($p>0.05$), which was not statistically significant. For the REMS, the AUC was 0.712 ($p<0.05$), which was statistically significant (Tables 3-4).

The sensitivity of correctly identifying non-survivor patients was higher for the REMS, while the specificity of correctly identifying non-survivor patients was higher for the RAPS. Based on the Youden J index, the discriminatory ability of the REMS in predicting mortality was higher than that of the RAPS. Additionally, when considering the non-survivor criteria, it was observed that a RAPS greater than 4 and a REMS greater than 5 were associated with a higher likelihood of non-survival (Tables 3-4).

DISCUSSION

The key findings of this study reveal that REMS and RAPS scores have different levels of effectiveness in predicting mortality in DKA patients. It was observed that the REMS score could be used with higher accuracy for mortality prediction. ROC analyses demonstrated that the REMS score has higher sensitivity and specificity rates, while the RAPS score did not exhibit sufficient performance in this regard. These findings suggest that the REMS score may be a more effective tool in the management of DKA patients in emergency departments.

Scoring systems in emergency departments play a crucial role in the rapid and accurate assessment of patients' clinical conditions. These tools provide healthcare profession-

Table 2. Basic statistics of vital values of patients

Variable	Mean	Standard Deviation	Minimum-Maximum
Age (years)	51.86	20.27	19-90
Mean arterial pressure (mmHg)	93.11	46.86	36.67-156.67
Pulse rate (/min)	99.40	19.48	64-160
Respiratory rate (/min)	20.95	7.76	12-40
Oxygen Saturation (%)	95.92	5.74	50-100

Table 3. Predictive performance of RAPS in terms of severity in diabetic ketoacidosis patients

AUROC (95% CI)	Youden J	Cut-off	Sensitivity (95% CI)	Specificity (95% CI)	p value
0.600 (0.503-0.692)	0.283	>4	46.2 (35.3-65.5)	89.8 (67.5-94.6)	0.3367

RAPS: Rapid Acute Physiology Score; AUROC: Area under the receiver operating characteristic; CI: Confidence interval.

Table 4. Predictive performance of REMS in terms of severity in diabetic ketoacidosis patients

AUROC (95% CI)	Youden J	Cut-off	Sensitivity (95% CI)	Specificity (95% CI)	p value
0.712 (0.619-0.794)	0.3760	>5	69.2 (45.7-77.5)	68.4 (49.2-84.3)	0.0134

REMS: Rapid Emergency Medicine Score; AUROC: Area under the receiver operating characteristic; CI: Confidence interval.

als with a standardized method to evaluate the severity of illness, prioritize treatment, and make informed decisions about patient management. By quantifying various physiological parameters, scoring systems such as the REMS allow for early identification of high-risk patients, ensuring timely intervention. The integration of these systems into routine practice not only enhances patient outcomes but also optimizes the allocation of limited resources in the fast-paced and high-stakes environment of emergency care.

In critical conditions such as DKA, the use of scoring systems is essential for assessing the severity of the patient's condition and guiding clinical management. DKA is a life-threatening metabolic emergency that requires prompt and precise treatment to prevent complications and reduce mortality. Scoring systems like REMS or the RAPS score enable clinicians to systematically evaluate the physiological derangements associated with DKA, such as electrolyte imbalances, acid-base disturbances, and organ dysfunction. By providing a quantifiable measure of illness severity, these tools help prioritize interventions and monitor the patient's response to treatment, ultimately improving the chances of survival in such critical scenarios.

DKA is a common and serious complication, particularly in type 1 diabetes. Diagnosing and managing DKA in emergency departments is critical to increasing patients' chances of survival. DKA is characterized by hyperglycemia, ketonemia, and metabolic acidosis due to insulin deficiency and elevated counter-regulatory hormone levels. Hyperglycemia leads to severe dehydration and electrolyte loss through osmotic diuresis. This condition, especially when combined with potassium imbalance and metabolic acidosis, increases the risk of cardiac and neurological complications. Ketonemia and ketonuria result from increased lipolysis and the production of ketone bodies, which are the primary causes of metabolic acidosis. The pathophysiology of DKA is a complex process requiring prompt and appropriate treatment, and managing this condition in emergency departments is crucial for reducing patient mortality and morbidity. Treatment generally focuses on insulin replacement, fluid therapy, and electrolyte balance. However, the rapid and accurate assessment of patients' clinical conditions enhances the effectiveness of the treatment process and helps prevent complications.^[14-16]

REMS and RAPS are important tools used in patient assessment and triage processes in emergency departments. REMS includes parameters such as age, mean arterial pressure, heart rate, respiratory rate, body temperature, and GCS. These parameters reflect the patient's overall physiological condition and are used to determine mortality risk. For example, the age factor indicates that older patients have a higher mortality risk compared to younger ones. Mean arterial pressure is an indicator of hemodynamic stability, with low pressures associated with a higher risk of mortality. Heart rate and respiratory rate assess the status of cardiac and respiratory functions. Body temperature can indicate the presence of infection or a systemic inflammatory response. GCS provides a rapid assessment of neurological status, with lower scores associated with

poor prognosis. The RAPS, on the other hand, includes mean arterial pressure, heart rate, respiratory rate, and GCS parameters and is similarly used for quickly assessing the patient's physiological condition. However, it has been observed that the REMS offers a more comprehensive evaluation and, therefore, may have broader applicability in emergency departments.^[17]

In the literature, there are various studies on the use and effectiveness of REMS and RAPS scores in different clinical scenarios. Many studies have demonstrated that the REMS is a reliable tool for predicting mortality in conditions such as sepsis, trauma, and other critical illnesses. For instance, a study conducted by Imhoff et al.^[18] reported that the REMS had high accuracy in predicting mortality among trauma patients. This study showed that the REMS was particularly effective in predicting mortality in trauma patients at the time of hospital admission.^[18] Similarly, in the study conducted by Ruangsomboon et al.,^[19] the use of the REMS in patients with suspected sepsis was examined, and it was shown to have higher accuracy in predicting mortality compared to other early warning systems. These studies support the broad applicability of the REMS in various critical situations. Additionally, studies on the use of the RAPS in emergency departments have shown that it can be a useful tool for quick assessment. However, it has been determined that the REMS offers higher accuracy and reliability.

This research faces certain limitations. Firstly, as it is a retrospective study, there is an inherent risk of inaccuracies in data collection and recording. Additionally, since the study was conducted at a single center, the results may not be widely applicable to other settings. Furthermore, the relatively small sample size could limit the strength of the conclusions, indicating that larger studies might yield more definitive results. To address these issues, future research should focus on prospective and multicenter studies to confirm and expand upon these findings.

Conclusion

This study evaluated the effectiveness of REMS and RAPS in predicting mortality in DKA patients. The findings indicate that the REMS is more effective in predicting mortality in DKA patients. The REMS can be used as a rapid and accurate assessment tool in emergency departments and may play a significant role in patient management. Therefore, it is recommended that the routine use of the REMS be considered in DKA and similar critical conditions.

Ethics Committee Approval

The study was approved by the Kartal Dr. Lutfi Kırdar City Hospital Ethics Committee (Date: 30.06.2022, Decision No: 2022/514/228/3).

Informed Consent

Retrospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept: A.U.S., R.A.; Design: A.U.S., R.A.; Supervision:

A.U.S.; Fundings: A.U.S. ;Materials: Y.A.K.D., Y.E.E., A.Ş., B.A., Ş.D., M.K.M.; Data: Y.A.K.D., Y.E.E., A.Ş., B.A., Ş.D., M.K.M.; Analysis: Y.E.E., Ş.D.; Literature search: M.K.M., Y.A.K.D., B.A.; Writing: A.U.S., R.A., Y.A.K.D., A.Ş., B.A.; Critical revision: A.U.S., R.A., Y.E.E., S.D., M.K.M.

Conflict of Interest

None declared.

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Diyabetik Ketoasidoz Hastalarında Mortalite Riskinin Belirlenmesinde Hızlı Akut Fizyoloji Skoru ve Hızlı Acil Tıp Skorunun Öngörü Gücü

Amaç: Bu çalışma, acil serviste diyabetik ketoasidoz (DKA) hastalarında mortalite tahmininde Rapid Emergency Medicine Score (REMS) ve Rapid Acute Physiology Score (RAPS) skorlarının etkinliğini değerlendirmeyi amaçladı.

Gereç ve Yöntem: Retrospektif kesitsel bir çalışma, 1 Haziran 2021 - 1 Haziran 2022 tarihleri arasında bir üçüncü basamak hastanenin acil servisine başvuran ve DKA tanısı alan 111 hasta üzerinde gerçekleştirildi. Dahil edilme kriterleri, Amerikan Diyabet Derneği tarafından tanımlanan DKA tanı kriterlerine sahip 18 yaş ve üzeri hastaları içeriyordu. Vital bulgular, laboratuvar sonuçları ve klinik sonuçlara ilişkin veriler toplandı. REMS ve RAPS skorlarının mortaliteyi tahmin etme gücü, her bir skor için eğri altındaki alanı (EAA) belirlemek amacıyla ROC (Receiver Operating Characteristic) eğrisi analizi kullanılarak değerlendirildi. Verilerin analizi için tanımlayıcı istatistikler ve parametrik olmayan testler kullanıldı.

Bulgular: Bu çalışmaya toplam 111 DKA hastası alındı. Kohort, 64 erkek (%57.6) ve 47 kadından (%42.3) oluşmakta olup, yaş ortalaması 51.86±20.27 yıldır. Hastalardan 7'si (%6.31) taburcu edilirken, 56'sı (%50.45) servise, 35'i (%31.53) yoğun bakım ünitesine (YBÜ) kabul edilmiş ve 13 hasta (%11.71) hayatını kaybetmiştir. REMS skoru, DKA hastalarında mortaliteyi öngörmede RAPS skoruna kıyasla daha yüksek bir prediktif güce sahip olup, EAA değeri 0.712 iken, RAPS skoru için bu değer 0,60 olarak bulunmuştur.

Sonuç: REMS skoru, DKA hastalarında mortaliteyi tahmin etmede RAPS skorundan daha etkili bir araç olarak öne çıktı. Yüksek doğruluğu ve güvenilirliği göz önüne alındığında, REMS skoru, acil servislerde DKA yönetiminde erken uyarı sistemi olarak değerli olabilir. REMS skorunun benzer kritik durumlarda rutin kullanımının değerlendirilmesi önerilmektedir.

Anahtar Sözcükler: Acil servis; diyabetik ketoasidoz; erken uyarı sistemleri.