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MORTALITY PREDICTORS AND PROGNOSTICATION MODELS IN DIABETIC KETOACIDOSIS: A PROSPECTIVE COHORT STUDY

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Abstract

Background: Diabetic ketoacidosis (DKA) remains a significant cause of morbidity and mortality worldwide, especially in developing countries. Understanding predictors of mortality and applying reliable prognostication models is essential for improving patient outcomes.

Objectives: To evaluate and compare the efficacy of the DKA Mortality Prediction Model (DKA-MPM) and APACHE II scoring systems in predicting mortality among DKA patients, and identify clinical and laboratory parameters significantly associated with mortality.

Methods: A prospective cohort study involving 100 DKA patients admitted from the Medical Triage Ward to the ICU. Parameters including age, sex, serum glucose, acid-base balance, mental status, fever, and insulin requirements were recorded. Mortality predictors were statistically analyzed using chi-square and Student T-tests.

Results: Mortality was 34%. Significant factors associated with mortality included advanced age, male sex, fever, depressed mental status, serum glucose >300 mg/dL, heart rate, respiratory rate, serum creatinine, pH, and GCS score (all $p < 0.05$). The APACHE II and DKA-MPM scores also significantly predicted mortality ($p < 0.05$). Comorbidities were not significantly correlated with mortality ($p = 0.377$).

Conclusion: Clinical parameters along with scoring systems like APACHE II and DKA-MPM can effectively predict DKA mortality. Early identification of high-risk patients may improve management strategies and outcomes

Keywords: Diabetic ketoacidosis, Mortality prediction, APACHE II, DKA-MPM, Prognostic models, Diabetes mellitus

INTRODUCTION

Diabetes mellitus (DM) is a complex disorder characterized by hyperglycemia resulting from impaired insulin secretion, increased insulin resistance, or increased glucose production. The global prevalence of DM has increased dramatically—from 108 million individuals in 1980 to projected estimates of 642 million by 2040—impacting primarily low- and middle-income countries.

DKA is a life-threatening acute complication of DM, predominantly in Type 1 DM, characterized by hyperglycemia, ketosis, and acidosis. Precipitating factors include infections, non-compliance, myocardial infarction, stroke, stress, and trauma. Management focuses on correcting underlying causes, rehydration, and insulin therapy.

The study of prognostic indicators and the application of scoring tools such as APACHE II and DKA-MPM help in clinical decision-making and outcome improvement.

MATERIALS AND METHODS

Study Design and Setting

Prospective cohort study conducted at Govt K.A.P.V Medical College Hospital, Trichy.

Participants

100 patients with confirmed DKA admitted during the study period. Inclusion required clinical and laboratory diagnosis of DKA based on blood glucose and ketone levels.

Data Collection

Demographic data, clinical presentation, laboratory values (serum glucose, pH, creatinine), insulin usage, presence of fever, mental status, vital signs, and comorbidities were recorded. APACHE II and DKA-MPM scores were calculated.

Statistical Analysis

Chi-square and Student's T tests evaluated associations between clinical variables and mortality. $p < 0.05$ was considered statistically significant.

RESULTS

Demographics

- Mean age distribution showed increased mortality in older age groups (41-50 and 71-80 years showed 55% and 56% mortality respectively, $p < 0.05$).
- Male patients had higher mortality (42%) compared to females (26%), $p < 0.05$.
- Type 2 DM patients constituted 86% of cases with higher mortality (38%) compared to Type 1 (7.1%).

Clinical Parameters and Mortality

- Fever presence was significantly associated with mortality (60% vs. 27%, $p < 0.05$).
- Depressed mental status was a profound predictor of mortality (94% vs. 5.8%, $p < 0.05$).
- Heart rate and respiratory rate were significantly higher in non-survivors ($p < 0.05$).
- Serum glucose >300 mg/dL at admission correlated with 45% mortality ($p < 0.05$).
- Serum creatinine and APACHE II and DKA-MPM scores were higher in non-survivors ($p < 0.05$).

Insulin Units and Mortality

Most non-survivors required >50 units insulin in 12 hours, although the association was not statistically significant ($p=0.14$).

Blood Gas Analysis

pH values were lower in non-survivors, but difference was less significant on Student's T-test ($p \sim 0.47$).

DISCUSSION

Diabetic ketoacidosis (DKA) is a severe acute metabolic complication predominantly affecting patients with diabetes mellitus, especially those with Type 1 DM, although Type 2 DM patients are also increasingly affected. Despite advances in diagnostic techniques and therapeutic modalities, DKA continues to carry substantial morbidity and mortality, particularly in resource-limited settings. This prospective cohort study aimed to identify clinical and laboratory predictors of mortality among DKA patients admitted to Govt K.A.P.V Medical College Hospital, Trichy, and evaluate the utility of prognostication scoring systems DKA-MPM and APACHE II in predicting mortality risk.

Demographic and Clinical Predictors of Mortality

Our study reported an overall mortality rate of 34%, which aligns with mortality rates reported in other developing countries, reflecting the continuing challenge of managing severe DKA cases in such contexts. Advanced age emerged as a significant predictor of mortality, with patients aged above 40 years, particularly those in the 41-50 and 71-80 age groups, exhibiting mortality rates as high as 55% and 56%, respectively ($p < 0.05$). This association may be attributable to several factors, including the presence of comorbid illnesses, decreased physiological reserves, and possibly delayed presentation. These findings corroborate with previous studies wherein older age was consistently linked with adverse outcomes in DKA patients.

Male patients exhibited a significantly higher mortality (42%) compared to females (26%) ($p < 0.05$). The gender disparity in mortality could be rooted in differences in health-seeking behavior, severity at presentation, or underlying cardiovascular risk profiles, which have been observed in other epidemiological studies as well.

Interestingly, while DKA traditionally affects type 1 diabetes patients more frequently, in our cohort, type 2 DM patients accounted for 86% of cases and had a notably higher mortality rate (38%) compared to type 1 DM patients (7.1%) ($p < 0.05$). This higher mortality among type 2 DM patients likely reflects the influence of additional comorbidities, delayed recognition due to partial insulin secretion, and perhaps more severe precipitating factors such as infections or cardiovascular events. This observation is consistent with emerging evidence suggesting that DKA is becoming increasingly prevalent and severe in type 2 diabetes populations, emphasizing the need to adapt clinical vigilance accordingly.

Impact of Clinical Signs and Laboratory Parameters

Fever, as a clinical marker suggestive of infection or systemic inflammatory response, was significantly associated with mortality (60% in febrile versus 27% in afebrile patients, $p < 0.05$). This stresses the importance of early identification and treatment of infectious triggers during DKA management, as infections are known to augment the metabolic derangements and systemic toxicity.

Depressed mental status, measured by Glasgow Coma Scale (GCS), was one of the strongest mortality predictors, with mortality rates reaching 94% among patients with altered sensorium ($p < 0.05$). This finding is in agreement with

global literature where impaired consciousness reflects severe acidosis, cerebral edema, or advanced systemic complications, all of which portend a poor prognosis.

Vital sign abnormalities were found significant in mortality prediction. Elevated heart rate (mean 118.2 bpm in non-survivors vs 111.06 bpm in survivors, $p < 0.05$) and increased respiratory rate (29.7/min vs 25.8/min, $p < 0.05$) likely indicate the body's compensatory response to severe metabolic acidosis and dehydration, and may also reflect early signs of sepsis or cardiovascular strain.

Serum glucose levels greater than 300 mg/dL at admission were notably associated with increased mortality (45%, $p < 0.05$). Hyperglycemia severity at presentation indicates a prolonged or more intense metabolic insult. This underscores the value of immediate glycemic control in DKA management protocols.

Serum creatinine levels in non-survivors were significantly higher compared to survivors ($p < 0.05$), suggesting that acute kidney injury or pre-existing renal impairment contributes markedly to mortality. This is consistent with the understanding that renal dysfunction in DKA patients worsens electrolyte and acid-base imbalances and reduces the clearance of toxic metabolites.

Contrary to some studies, we did not find significant associations between comorbidities and mortality ($p=0.377$). While this might be due to sample size limitations or uniform management practices, comorbidities are widely recognized as important risk factors in other DKA cohorts, indicating that larger multicentric studies are necessary for conclusive evidence.

Scoring Systems for Prognostication

Both APACHE II and the DKA Mortality Prediction Model (DKA-MPM) scores were significantly higher in non-survivors ($p < 0.05$), reinforcing their utility in risk stratification for DKA patients. APACHE II, a widely validated ICU scoring system that incorporates acute physiology and chronic health evaluation, provides valuable prognostic insight that supports clinical decision-making in critical care settings.

DKA-MPM, being more specific to diabetic ketoacidosis, offers tailored assessment based on diabetes-related parameters, potentially enhancing predictive accuracy for this population. The high significance of these models suggests that integrating such scoring tools into routine clinical assessment could improve triage, resource allocation, and potentially patient outcomes by identifying high-risk individuals early.

Insulin Therapy and Mortality

While patients requiring more than 50 units of insulin within the first 12 hours appeared to have higher mortality, this finding did not reach statistical significance ($p=0.14$). This could reflect that higher insulin demand may mirror severity of illness but may also be confounded by individual patient responsiveness and insulin resistance. As insulin dosing is typically adjusted dynamically, its utility as an isolated predictor is limited without considering the clinical context.

Blood Gas and Electrolyte Parameters

Blood pH values were lower among non-survivors, but the difference was not statistically significant in this study ($p \sim 0.47$). Similarly, parameters such as mean arterial pressure, partial pressure of oxygen (PaO_2), sodium, potassium, hematocrit, and total leukocyte counts were not significantly associated with mortality. These findings suggest that while acid-base and electrolyte status are critical for clinical management, their isolated values at admission may not be robust independent predictors of mortality compared to clinical and systemic parameters.

Clinical Implications

The results of this study emphasize that a multifactorial approach is needed for mortality risk assessment in DKA. Age, sex, clinical signs (fever, mental status), vital signs (heart rate, respiratory rate), serum glucose, serum creatinine, and validated scoring systems collectively provide valuable information for early identification of patients at risk for poor outcomes.

Early recognition of febrile states and depressed mental status should prompt aggressive intervention including infection control and supportive intensive care. The integration of scoring systems such as APACHE II and DKA-MPM into the clinical workflow can standardize and objectify prognosis, assisting in informed clinical decision-making and appropriate allocation of critical care resources.

LIMITATIONS OF OUR STUDY

This single-center prospective cohort study was limited by relatively small sample size and the inclusion of patients from a single hospital setting, which may restrict generalizability. The lack of significant association between comorbidities and mortality could be influenced by sample heterogeneity or incomplete capture of chronic illness severity. Additionally, long-term follow-up post-discharge was not conducted, which would have added data on delayed mortality and morbidity.

Future multicentric studies with larger sample sizes, inclusion of additional biomarkers (e.g., inflammatory cytokines, lactate), and evaluation of treatment interventions would enrich understanding of mortality predictors and improve

prognostication models. Inclusion of quality-of-life measures and cost-effectiveness analyses of prognostic scoring incorporation would also be valuable

CONCLUSION

DKA remains a critical emergency with significant mortality risk. Clinical signs such as fever, mental status, and serum glucose levels, combined with scoring systems like APACHE II and DKA-MPM, can effectively guide clinicians in prognostication and management decisions, potentially reducing mortality.

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