



Original Article

Electrolyte Abnormalities in Diabetic Ketoacidosis and Their Clinical Implications: A Prospective Observational Study

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ABSTRACT

Background: Diabetic ketoacidosis (DKA) is a life-threatening metabolic emergency characterized by hyperglycemia, metabolic acidosis, and profound electrolyte disturbances. While potassium abnormalities are widely recognized, other electrolyte derangements such as sodium, magnesium, and calcium imbalances are often underappreciated despite their potential clinical significance.

Objective: To evaluate the pattern of electrolyte abnormalities in patients with DKA and determine their association with clinical outcomes.

Materials and Methods: This prospective observational study included 80 adult patients diagnosed with DKA. Baseline serum electrolyte parameters including sodium, potassium, chloride, calcium, and magnesium were assessed at admission. Corrected sodium was calculated to account for hyperglycemia. Patients were followed for clinical outcomes including recovery, ICU requirement, and mortality. Statistical analysis was performed using chi-square test.

Results: Hyponatremia was observed in 42.5% of patients based on measured sodium levels, which reduced to 15.0% after correction. Hyperkalemia was present in 22.5% of patients, while hypokalemia was noted in 11.2%. Hypomagnesemia and hypocalcemia were observed in 15.7% and 12.9% of patients, respectively. Hyperkalemia ($p = 0.041$) and hypomagnesemia ($p = 0.047$) were significantly associated with poor clinical outcomes, whereas hyponatremia and hypocalcemia were not.

Conclusion: Electrolyte abnormalities are highly prevalent in DKA. Corrected sodium must be used for accurate assessment. Hyperkalemia and hypomagnesemia are significant predictors of adverse outcomes. Early identification and targeted correction of electrolyte disturbances are crucial in improving prognosis.

Keywords: Diabetic ketoacidosis, Electrolyte imbalance, Hyperkalemia, Hyponatremia, Hypomagnesemia.

INTRODUCTION

Diabetic ketoacidosis (DKA) is a serious acute complication of diabetes mellitus characterized by hyperglycemia, ketosis, and metabolic acidosis. Despite advances in management, it continues to contribute significantly to morbidity and mortality worldwide.^{1,2}

Electrolyte disturbances in DKA arise due to a complex interplay of insulin deficiency, osmotic diuresis, metabolic acidosis, and transcellular shifts.³ Among these, potassium imbalance has been extensively studied due to its direct impact on cardiac conduction and neuromuscular function.⁴ However, abnormalities in sodium, magnesium, and calcium are equally important but often under-recognized.²³ Hyponatremia in DKA is frequently dilutional, resulting from osmotic movement of water from intracellular to extracellular compartments due to hyperglycemia.^{5,8} This necessitates the use of corrected sodium levels for accurate interpretation.⁹ Magnesium depletion, often due to renal losses, can exacerbate hypokalemia and predispose to cardiac arrhythmias.^{6,12} Similarly, hypocalcemia, though less frequently highlighted, may contribute to neuromuscular instability and cardiovascular dysfunction.¹⁴

Previous studies have primarily focused on individual electrolyte disturbances, particularly potassium. However, comprehensive evaluation of electrolyte abnormalities and their combined impact on clinical outcomes remains limited, especially in prospective settings.^{7,17} Understanding the pattern and prognostic significance of electrolyte imbalances is crucial for optimizing management strategies in DKA. Early recognition and appropriate correction may help reduce complications, ICU stay, and mortality.^{18,19}

AIM AND OBJECTIVE

This study aims to systematically evaluate electrolyte abnormalities and their association with clinical outcomes. Objective of this study was to assess electrolyte abnormalities in DKA and their association with clinical outcomes.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective observational study conducted in the Department of General Medicine at a tertiary care hospital over a period of 18 months.

Study Population: A total of 80 adult patients (>18 years) diagnosed with diabetic ketoacidosis based on standard biochemical criteria (hyperglycemia, metabolic acidosis, and ketonuria) were included.

Inclusion Criteria: Patients aged >18 years; diagnosed with DKA.

Exclusion Criteria: Chronic kidney disease; Known parathyroid disorders; Patients on diuretics or electrolyte-altering drugs; Malabsorption syndromes

Data Collection: At admission, detailed clinical and biochemical evaluation was performed, including Serum sodium, potassium, chloride; Serum calcium and magnesium; Blood glucose levels; Arterial blood gas analysis. Corrected serum sodium was calculated using standard correction formulas for hyperglycemia.

Outcome Measures: Clinical outcomes were categorized as Recovery; Requirement of ICU care; and Death.

RESULTS

Data were analyzed using SPSS software. Continuous variables were expressed as mean \pm SD and categorical variables as percentages. Associations between electrolyte abnormalities and outcomes were assessed using Chi-square test. A p-value <0.05 was considered statistically significant.

Table 1: Serum Electrolyte Profile at Admission

Parameter	Total (N=80)	Male (n=50)	Female (n=30)	p-value
Serum Sodium (mEq/L)	134.8 \pm 6.1	134.2 \pm 6.4	135.7 \pm 5.6	0.286
Serum Potassium (mEq/L)	4.62 \pm 0.71	4.68 \pm 0.74	4.52 \pm 0.66	0.319
Serum Chloride (mEq/L)	101.2 \pm 5.4	100.8 \pm 5.6	101.9 \pm 5.1	0.374
Serum Calcium (mg/dL)	8.92 \pm 0.63	8.88 \pm 0.66	8.98 \pm 0.59	0.487
Serum Magnesium (mg/dL)	2.01 \pm 0.31	2.03 \pm 0.32	1.98 \pm 0.29	0.428

Table 2: Electrolyte Status Distribution

Parameter	Category	Frequency (%)
Sodium	Hyponatremia	42.5%
	Normal	53.8%
Potassium	Hypernatremia	3.7%
	Hypokalemia	11.2%
	Normal	66.3%
	Hyperkalemia	22.5%

Table 3: Measured vs Corrected Sodium

Parameter	Value	
Measured Sodium	134.8 \pm 6.1	
Corrected Sodium	139.6 \pm 6.4	
Sodium Status	Measured (%)	Corrected (%)
Hyponatremia	42.5	15.0
Normal	53.8	76.3
Hypernatremia	3.7	8.7

p-value = 0.012 (significant)

Table 4: Electrolyte Abnormalities and Clinical Outcome

Electrolyte Abnormality	Poor Outcome (%)	Good Outcome (%)	p-value
Hyponatremia	60.0	40.0	0.214
Hyperkalemia	50.0	18.6	0.041*
Hypocalcemia	30.0	12.9	0.168
Hypomagnesemia	40.0	15.7	0.047*

DISCUSSION

Electrolyte disturbances are a hallmark of diabetic ketoacidosis and arise from complex physiological mechanisms including osmotic diuresis, insulin deficiency, and acid-base imbalance.^{3,15} In the present study, a high prevalence of electrolyte abnormalities was observed, reinforcing their clinical importance.

Sodium Abnormalities

Hyponatremia was observed in 42.5% of patients at presentation. However, after correcting for hyperglycemia, the prevalence decreased to 15.0%. This highlights the classical concept of translocational (dilutional) hyponatremia, where elevated glucose levels draw water into the extracellular space, reducing measured sodium concentration.^{5,8} This finding is consistent with studies by Hillier et al. and Adrogue et al., which emphasize the importance of corrected sodium in hyperglycemic states.^{5,9} Failure to correct sodium may lead to misdiagnosis and inappropriate fluid therapy.¹⁶

Importantly, findings from the study by Tamma VK et al.²⁰ further reinforce the clinical relevance of hyponatremia in critically ill patients. Their study conducted in a MICU setting demonstrated that hyponatremia is the most common electrolyte abnormality, often associated with neurological manifestations such as confusion and seizures, particularly in severe cases. They also reported that euvolemic hyponatremia was the predominant type (50%), with SIADH being the leading etiology (46%), frequently linked to infections such as tuberculosis. This highlights the broader systemic context in which sodium disturbances occur, particularly in critically ill populations. Although hyponatremia in the present study did not show a statistically significant association with outcomes, its high prevalence and known neurological implications underscore the importance of careful evaluation and correction.

Potassium Abnormalities

Hyperkalemia was observed in a significant proportion of patients and showed a statistically significant association with poor outcomes. Despite elevated serum potassium levels, total body potassium stores are typically depleted in DKA due to osmotic diuresis and renal losses.^{4,21} Acidosis and insulin deficiency promote extracellular potassium shift, leading to falsely elevated serum potassium levels.^{10,22} Similar observations have been reported in previous studies evaluating electrolyte imbalance in hyperglycemic emergencies.^{11,23} The association between hyperkalemia and poor outcomes in this study likely reflects more severe metabolic derangement and greater insulin deficiency.

Magnesium Abnormalities

Hypomagnesemia was another important abnormality observed in this study and demonstrated a statistically significant association with adverse outcomes. Magnesium plays a critical role in myocardial stability, neuromuscular conduction, and maintenance of intracellular potassium levels.^{6,12} Magnesium deficiency may worsen potassium imbalance, predispose to arrhythmias, and contribute to refractory hypokalemia.¹³ Previous critical care studies have demonstrated increased mortality among critically ill patients with hypomagnesemia.^{13,24}

Calcium Abnormalities

Hypocalcemia was identified in a subset of patients but did not demonstrate a statistically significant association with clinical outcomes. Calcium abnormalities in DKA are often influenced by serum albumin concentration and changes in blood pH.¹⁴ Although less commonly emphasized, calcium disturbances may contribute to neuromuscular symptoms and cardiac instability in severe DKA.

Integrated Electrolyte Perspective

Electrolyte abnormalities in DKA rarely occur in isolation and instead represent interconnected metabolic disturbances driven by dehydration, acidosis, insulin deficiency, and renal dysfunction.^{15,23} The significant association of hyperkalemia and hypomagnesemia with poor outcomes suggests that these abnormalities may serve as markers of disease severity and systemic physiological stress rather than isolated biochemical findings.¹⁶

Clinical Implications

The findings of the present study have several important clinical implications:

- Corrected sodium should be routinely calculated in DKA
- Early identification of hyperkalemia is essential to prevent arrhythmias
- Magnesium monitoring should be incorporated into DKA management protocols
- Electrolyte abnormalities may aid in risk stratification and prognostication in DKA patients^{18,19}

CONCLUSION

Electrolyte abnormalities are common in DKA and have significant clinical implications. Hyperkalemia and hypomagnesemia are important predictors of adverse outcomes. Routine monitoring and targeted correction of electrolyte disturbances are essential for improving patient prognosis.

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