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Systematic Review

Early potassium assessment and replacement during emergency department treatment of diabetic ketoacidosis: a systematic review

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Abstract

Background: Diabetic ketoacidosis (DKA) causes metabolic and electrolyte disturbances. Although total-body potassium is depleted, serum potassium at presentation appears normal or even elevated because of transcellular shifts, which create a risk of underestimating impending hypokalemia during treatment. **Objective**: we aimed to synthesize the available studies on early potassium assessment and replacement during ED and ICU management of DKA. Methods: A systematic review was conducted according to PRISMA 2020. We searched PubMed, Embase, Scopus, Web of Science, and CENTRAL from inception to 2026. Eligible studies included patients with DKA receiving early potassium assessment and replacement during ED or ICU management. Randomized, prospective, and retrospective original studies were included. Qualitative synthesis was performed. **Results**: Eleven studies published between 1972 and 2025 were included. Hypokalemia at presentation was uncommon, with reported prevalence of 1.3% to 5.6% in adult cohorts. Potassium measurement methods impact clinical interpretation, and pH-adjusted potassium reflects physiological risk rather than unadjusted values. Early protocolized supplementation was associated with more stable potassium levels and better clinical outcomes. **Conclusions**: In DKA, the principal potassium-related danger is hypokalemia developing after treatment begins. Early assessment, frequent monitoring, and quick replacement are essential, and stronger comparative studies are needed to define replacement strategies.

Keywords: diabetic ketoacidosis; potassium; hypokalemia; emergency department; electrolyte replacement

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Introduction

Diabetic ketoacidosis (DKA) is acute metabolic emergency in diabetes and result in morbidity, mortality, and healthcare burden in spite of advances in diagnosis and treatment [1–3]. DKA is associated with type 1 diabetes, but increasingly recognized in a wider range of patients, including adults with type 2 diabetes, and precipitated by infection, insulin omission, acute medical stress, and, in selected cases, sodium-glucose cotransporter-2 inhibitor use [1–3]. The metabolic derangements of DKA arise from insulin deficiency with excess counter-regulatory hormones, which result in hyperglycemia, ketosis, metabolic acidosis, osmotic diuresis, dehydration, and marked electrolyte losses [1,3,4].

Potassium disturbance is important because serum potassium at presentation is misleading. Despite total-body potassium depletion, patients present with normal or elevated serum potassium concentrations because insulin deficiency, and acidosis shift potassium from the intracellular to the extracellular [1,3,4]. This apparent biochemical reassurance is deceptive, because insulin administration, correction of acidosis, volume expansion, and urinary losses rapidly unmask clinically significant hypokalemia during treatment [1–3]. Hypokalemia contributes to arrhythmias, muscle weakness, prolonged hospitalization, and adverse outcomes, so early assessment and replacement are central to safe DKA management [1,5,6].

Studies show potassium monitoring and replacement, but there is a knowledge gap regarding the optimal method of assessment, the most appropriate threshold for replacement, and the ideal formulation and rate of potassium administration [4,7,8]. Major guidelines recommend delaying insulin when potassium is very low and initiating potassium supplementation once serum levels fall below the upper-normal range [1,7,8]. Literature has suggested that acidosis-adjusted potassium better reflect true physiological risk than unadjusted serum values, which indicate a gap between pathophysiology and routine bedside practice [6]. In this study we aim to synthesize the studies on early potassium assessment and replacement during ED management of DKA to clarify current knowledge, and priorities for safer care.

Methods

This systematic review was conducted according to the PRISMA 2020 statement. The study protocol was developed a priori to define the search strategy, inclusion criteria, and data synthesis methods.

We include studies conducted in adult or pediatric patients diagnosed with DKA in ED or ICU. Initial assessment of potassium levels and early potassium replacement strategies. Standard care, different potassium salt forms, or timing of replacement. Prevalence of treatment-induced hypokalemia, time to DKA resolution, incidence of arrhythmias, or mortality. Randomized controlled trials, prospective observational studies, and retrospective cohort analyses or chart reviews. Case reports and review articles were excluded.

A literature search was performed in five electronic databases from their inception to March 2026: PubMed, Embase, Scopus, Web of Science, and the Cochrane Central Register of Controlled Trials (CENTRAL). The search strategy used a combination of MeSH and free-text keywords related to "Diabetic Ketoacidosis," "Potassium," "Hypokalemia," and "Emergency Management." The reference lists of all eligible studies were manually screened to identify additional records. No language restrictions were applied.

Records identified through the search were exported to Mendeley software for deduplication. Two reviewers screened titles and abstracts for the eligibility criteria. The full texts of relevant articles were retrieved and assessed for final inclusion.

A standardized data extraction form was used to collect the following information from each included study: Lead author, year of publication, country, and study design. Sample size and age group. Assessment methods, potassium replacement protocols, and primary findings related to electrolyte disturbances or clinical outcomes. A narrative synthesis was performed to summarize the findings across the included studies, focusing on the prevalence of hypokalemia and the efficacy of various replacement strategies.

The methodological quality of the included studies was assessed using appropriate tools based on study design. Assessment focused on selection bias, comparability of cohorts, and the adequacy of outcome reporting.

Results

We include 11 studies in this systematic review, comprising prospective cross-sectional studies, retrospective cohort analyses, and clinical balance studies. A literature was conducted to collect studies published from 1972 to 2025. The included studies were conducted in the United States, Canada, Brazil, Australia, Japan, Malaysia, China, and the United Kingdom. Five studies focused on adult populations, four on pediatric cohorts, and two included mixed or unspecified age ranges within emergency and critical care settings.

Studies of potassium status upon arrival in the ED indicate that actual hypokalemia is uncommon at presentation. Arora et al. reported a prevalence of 5.6% in an urban adult population, while Jang et al. found a lower incidence of 1.3% in a large multicenter cohort. This data shows that while total body potassium is depleted in DKA, extracellular shifts secondary to acidosis maintain serum levels within or above the normal range during the initial assessment phase.

The method of potassium assessment influences clinical decision-making in the ED. Fu et al. [9] found that potassium concentrations measured via blood gas analysis (BGA) were lower than those measured in serum chemistry. This difference is important because it leads to the premature initiation of potassium replacement if BGA results are used in isolation. Usman et al. noted the utility of pH-adjusted potassium as a superior predictor of clinical outcomes, noting that lower adjusted values were associated with prolonged hospitalization.

The development of hypokalemia during treatment is frequent and often severe. Carlotti et al. [10] observed that 81% of pediatric patients developed hypokalemia within 24 hours of starting therapy, driven by high fractional excretion of potassium and

insulin-mediated intracellular shifts. Wong et al. found a 38% prevalence of treatment-induced hypokalemia, identifying that 50% of these cases were associated with management errors, for example inadequate replacement or infrequent monitoring.

Okada et al. [11] used a database of 14,216 patients to show that initial fluid therapy containing potassium concentrations was associated with lower in-hospital mortality compared to lower concentrations. Basnet et al. found that a standardized infusion maintained stable serum levels while Jucha and Hummel found no significant difference in the time to DKA resolution between potassium acetate and potassium chloride.

The impact of potassium management is apparent in several studies. Inadequate replacement linked to increased mortality [11] and longer hospital stays [12]. Soler et al. found that sodium bicarbonate use increases potassium requirements, necessitating closer monitoring. Zhang et al. noted that with modern protocols, 67.9% of patients experienced potassium disturbances during the acute phase.

Table 1: Characteristics of included studies

Citation	Country	Study design	Population	Objective
Arora et al. (2012) [13]	USA	Prospective cross-sectional	106 adult patients with DKA	Estimate the prevalence of hypokalemia before initiation of fluid resuscitation and insulin.
Basnet et al. (2020) [14]	USA	Retrospective study	92 pediatric cases in the PICU	Determine the effect of potassium infusions on serum levels during DKA treatment.
Carlotti et al. (2013) [10]	Canada	Prospective observational	31 pediatric patients	Investigate if hypokalemia in DKA is caused by increased urinary potassium excretion associated with insulin.
Fu et al. (2004) [9]	Australia	Retrospective agreement study	40 patients with DKA	Determine the agreement between potassium measured on blood gas analysis versus serum.
Jang et al. (2014) [15]	USA	Multicenter retrospective cross-sectional	Adult patients diagnosed with DKA in the ED	Assess the incidence of hypokalemia at presentation in the emergency department.
Jucha & Hummel (2021) [16]	USA	Retrospective cohort	124 pediatric cases	Compare time to resolution of ketoacidosis using potassium acetate versus potassium chloride.
Okada et al. (2021) [11]	Japan	Retrospective cohort	18,349 DKA patients	Evaluate the association between initial potassium infusion concentration and in-hospital mortality.
Soler et al. (1972) [17]	UK	Prospective study	25 patients in severe DKA	Study potassium balance and replacement requirements during the first 24 hours of treatment.
Usman et al. (2021) [12]	Malaysia	Retrospective paper	Adult DKA patients	Map the role of pH-adjusted potassium in predicting hypokalemia and patient outcomes.

Wong et al. (2016) [18]	Canada	Retrospective chart review	40 adult DKA cases	Assess hypokalemia prevalence and identify preventable management errors.
Zhang et al. (2025) [19]	China	Original research	Patients with DKA managed for potassium disorders	Provide knowledge into acute management of potassium disorders in DKA.

Table 2: assessment findings, replacement strategies, and clinical outcomes

Citation	Assessment and replacement strategy	key findings and clinical outcomes
Arora et al. (2012) [13]	Pre-treatment serum potassium measurement.	Only 5.6% of patients presented with hypokalemia (K < 3.5 mmol/L).
Basnet et al. (2020) [14]	40 mEq/L potassium infusion over a median of 13 hours.	82% of cases received standardized infusion; serum levels were monitored in the PICU.
Carlotti et al. (2013) [10]	Measurement of urine K-to-creatinine ratio and fractional excretion.	81% developed hypokalemia; those with hypokalemia had significantly higher urinary potassium loss linked to insulin dose.
Fu et al. (2004) [9]	Comparison of potassium values from blood gas vs. serum samples.	Evaluated the clinical acceptability of differences between sampling methods for rapid assessment.
Jang et al. (2014) [15]	Evaluation of initial potassium levels in the ED.	Hypokalemia at presentation was less common than the 4% previously reported.
Jucha & Hummel (2021) [16]	Comparison of K-acetate and K-chloride in a two-bag system.	Assessed time to DKA resolution and electrolyte variations based on the salt form used.
Okada et al. (2021) [11]	Analysis of initial potassium concentration in fluid therapy (range 0–40 mmol/L).	Lower initial potassium concentrations (median 13 mmol/L) were common compared to international guidelines.

Soler et al. (1972) [17]	Guided by continuous ECG and frequent serum determinations.	Saline groups required 30 mEq/L of K+; high bicarbonate groups required 40 mEq/L due to increased shift/loss.
Usman et al. (2021) [12]	Use of pH-adjusted potassium to assess real-time status.	Found that pH-adjusted potassium better reflects the risk of subsequent hypokalemia.
Wong et al. (2016) [18]	Audit of clinical practice guideline deviations during the first 48 hours.	38% prevalence of treatment-induced hypokalemia; errors included inadequate K+ replacement (50%) and infrequent monitoring (50%).
Zhang et al. (2025) [19]	Evaluation of potassium management protocols.	Identified significant internal environmental disruptions upon DKA presentation.

Discussion

In the present study we found that hypokalemia at presentation was uncommon, and treatment-emergent hypokalemia was clinically consequential. This pattern is plausible and is consistent among the wider DKA literature, which shows that total-body potassium depletion coexist with high initial serum potassium because acidosis, insulin deficiency, and hyperosmolality shift potassium into the extracellular compartment [1,3,4]. The low prevalence of hypokalemia on arrival in the included adult studies should not be interpreted as evidence of preserved potassium balance, but as a signal that serum potassium at presentation underestimate the severity of underlying potassium depletion [1,3,5].

We found that the method of potassium assessment impacts early clinical decision-making. The discrepancy between blood gas and serum potassium measurements reflect that dependence on a single analytical method affect the timing and aggressiveness of replacement. This is relevant in emergency settings, where fast blood gas testing is used to guide immediate care, but treatment decisions based on lower blood gas potassium values lead to excessive replacement in some patients. According to the findings related to pH-adjusted potassium support, unadjusted serum potassium does do not entirely capture physiological risk during severe acidosis. This observation is aligned with the literature and suggests that acidosis alters potassium distribution and conventional potassium interpretation oversimplify risk stratification in DKA [3,6].

The high frequency of hypokalemia developing after treatment initiation is a major finding of this review and is concordant with current pathophysiological understanding and consensus documents. Insulin administration, correction of acidemia, restoration of renal perfusion, and continued kaliuresis result in a rapid fall in serum potassium after treatment begins, and recent consensus guidance notes that potassium commonly declines during the first 24 to 48 hours of DKA management despite protocol-based replacement [1,8]. The findings from the included studies are important because they show that treatment-induced hypokalemia is exacerbated by delayed replacement, inadequate supplementation, and infrequent monitoring. Our observations are consistent with studies showing that potassium replacement is essential in DKA, yet high-quality trials comparing optimal replacement rates and formulations remain lacking [2,4,7].

Observational studies in the included studies indicate that appropriate early potassium supplementation is associated with better outcomes, including lower in-hospital mortality, while standardized infusion strategies are capable of maintaining more stable potassium levels in pediatric settings. The absence of a difference in time to DKA resolution between potassium acetate and potassium chloride indicate that adequacy and timing of replacement are more important than the salt form alone in many clinical contexts. recommendations vary between adding 20–30 mmol/L when potassium falls below 5.0–5.2 mmol/L and using 40 mmol/L when levels are below 5.5 mmol/L in patients who are passing urine, while recognizing that direct comparative studies is insufficient to favor one strategy over another [1,7,8]. This evidence indicate that early and protocolized replacement is necessary, but they indicate that current practices are guided more by expert consensus than by solid comparative trials [2,4].

The present review has several strengths, including its focus on a clinically important aspect of DKA care, inclusion of adult and pediatric evidence, and attention to assessment methods as well as replacement strategies. The interpretation of the findings should be tempered by limitations. Most included studies were observational and heterogeneous in design, setting, and outcome definitions. Sample sizes differ markedly, some studies were older and not fully mirror contemporary practice, and cardiovascular outcomes were reported. The literature indicates that the data for potassium management in DKA is weak, with few randomized comparisons and persistent reliance on driven protocols [2,4,6].

Conclusion

We found that the potassium-related threat in DKA is the rapid emergence of hypokalemia during treatment in the setting of pre-existing total-body depletion. Early assessment is important and quick replacement is more important. Methodological issues in potassium measurement and the value of acidosis-adjusted interpretation require more investigation. Future prospective studies should compare replacement thresholds, dosing regimens, monitoring frequency, and clinically meaningful outcomes.

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