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Commentary

Diabetic Ketoacidosis in the Modern Era: Advances in Diagnosis, Management and Prevention

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Abstract

Diabetic ketoacidosis (DKA) remains one of the most important acute metabolic emergencies encountered in patients with diabetes mellitus. Despite remarkable advances in insulin therapy, diabetes technology, and standardized treatment protocols, DKA continues to contribute significantly to hospital admissions, healthcare expenditure, and diabetes-related mortality worldwide. Recent years have witnessed major developments in the understanding and management of DKA, including recognition of sodium-glucose cotransporter-2 (SGLT2) inhibitor-associated euglycemic DKA, updated international diagnostic criteria, increasing reliance on blood β-hydroxybutyrate measurement, and the emerging role of continuous glucose monitoring (CGM) during hospitalization. Contemporary management has evolved beyond correction of hyperglycemia to emphasize rapid ketone clearance, individualized fluid resuscitation, meticulous electrolyte replacement, identification of precipitating factors, and prevention of recurrence. This commentary reviews recent advances in the epidemiology, pathophysiology, diagnosis, management, and prevention of DKA while highlighting practical implications of the 2024 International Consensus Report and the American Diabetes Association (ADA) Standards of Care 2026. It also discusses the emerging role of diabetes technology and emphasizes the importance of individualized risk stratification and structured patient education in reducing the burden of DKA.

Keywords: Diabetic ketoacidosis, Hyperglycemic crisis, Euglycemic diabetic ketoacidosis, Continuous glucose monitoring; SGLT2 inhibitors, β-hydroxybutyrate

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Introduction

Diabetic ketoacidosis (DKA) is a life-threatening endocrine emergency characterized by hyperglycemia, ketosis, and metabolic acidosis resulting from absolute or relative insulin deficiency **[1, 2].** Although traditionally regarded as a complication of type 1 diabetes mellitus, DKA is now increasingly recognized among patients with type 2 diabetes, ketosis-prone diabetes, latent autoimmune diabetes in adults (LADA), pancreatic diabetes, and individuals treated with sodium-glucose cotransporter-2 (SGLT2) inhibitors **[1, 3].**

Globally, diabetes continues to increase in prevalence, and the burden of hyperglycemic emergencies has risen accordingly. DKA remains one of the leading causes of emergency hospitalization among people with diabetes and continues to impose significant healthcare costs despite improvements in diabetes care **[1, 3].** Mortality has declined substantially in developed healthcare systems owing to earlier recognition, standardized treatment protocols, and improved critical care. Nevertheless, DKA continues to cause considerable morbidity, particularly among patients with recurrent episodes, delayed presentation, limited healthcare access, or significant comorbid illnesses **[1].**

The publication of the 2024 International Consensus Report on Hyperglycaemic Crises in Adults with Diabetes represents the most important update in DKA management in over 15 years **[1]**. Developed jointly by the American Diabetes Association (ADA), European Association for the Study of Diabetes (EASD), Joint British Diabetes Societies (JBDS), American Association of Clinical Endocrinology (AACE), and Diabetes Technology Society (DTS), the report introduces updated recommendations regarding diagnosis, biochemical monitoring, fluid therapy, insulin administration, electrolyte replacement, and prevention. Importantly, these recommendations shift the focus from correction of hyperglycemia alone toward biochemical resolution of ketosis and individualized patient management.

Simultaneously, advances in diabetes technology have transformed clinical practice. Continuous glucose monitoring (CGM), insulin pumps, and hybrid closed-loop systems have substantially improved outpatient diabetes management and are increasingly being evaluated for inpatient use. Although point-of-care capillary glucose testing remains the standard during active DKA, CGM has emerged as a promising adjunct for monitoring glucose trends and facilitating transition from intravenous to subcutaneous insulin therapy **[3].**

This commentary summarizes current evidence regarding the epidemiology, pathophysiology, diagnosis, management, prevention, and future directions of DKA. Particular emphasis is placed on evolving diagnostic strategies, modern treatment approaches, emerging diabetes technologies, and practical preventive strategies including individualized risk assessment and structured patient education.

Changing epidemiology

The epidemiology of DKA has changed considerably over recent decades. Although historically considered almost exclusively a complication of type 1 diabetes, DKA is increasingly encountered across the entire spectrum of diabetes. Adults with type 2 diabetes now account for a growing proportion of DKA admissions, particularly among individuals with ketosis-prone diabetes, severe insulin deficiency, or major physiological stress **[1, 4].**

Hospital admissions for DKA have increased steadily over the past decade despite major advances in diabetes care **[1, 3]**. Multiple factors contribute to this trend, including increasing diabetes prevalence, greater awareness of atypical presentations, wider use of diabetes technologies, and improved survival of patients with chronic diabetes. Recurrent DKA remains a major clinical challenge and is commonly associated with insulin omission, inadequate diabetes education, psychosocial illness, socioeconomic deprivation, and limited access to insulin rather than failure of acute medical management alone **[3].**

One of the most important developments in recent years has been the recognition of euglycemic diabetic ketoacidosis (euDKA). This condition is characterized by severe ketosis and metabolic acidosis despite relatively normal blood glucose concentrations and occurs most commonly in patients treated with SGLT2 inhibitors **[1, 5].** By increasing urinary glucose excretion, these agents reduce plasma glucose while allowing continued ketone production during periods of relative insulin deficiency. Consequently, clinicians must maintain a high index of suspicion for DKA in patients presenting with unexplained metabolic acidosis even when blood glucose is not markedly elevated.

Other recognized risk factors for euDKA include pregnancy, prolonged fasting, ketogenic diets, major surgery, acute illness, excessive alcohol intake, and persistent vomiting **[1, 5].** These observations have fundamentally changed modern diagnostic strategies and reinforce the importance of measuring ketones in all patients with suspected DKA irrespective of blood glucose concentration.

The COVID-19 pandemic also highlighted the complex relationship between severe systemic illness and DKA. Although COVID-19 is no longer a dominant precipitating factor, the pandemic reinforced the importance of early diagnosis, standardized treatment pathways, multidisciplinary care, and aggressive management of underlying precipitating illnesses in patients presenting with hyperglycemic emergencies **[1, 12].**

Pathophysiology

Diabetic ketoacidosis (DKA) results from absolute or relative insulin deficiency combined with increased secretion of counter-regulatory hormones, including glucagon, catecholamines, cortisol, and growth hormone **[2, 6].** This hormonal imbalance promotes hepatic gluconeogenesis, glycogenolysis, lipolysis, and ketogenesis while simultaneously impairing peripheral glucose utilization. The resulting metabolic disturbances produce the characteristic triad of hyperglycemia, ketosis, and high anion-gap metabolic acidosis **[1, 2].**

In the absence of adequate insulin, adipose tissue lipolysis releases large quantities of free fatty acids, which undergo hepatic β-oxidation to generate the ketone bodies β-hydroxybutyrate and acetoacetate. Accumulation of these organic acids leads to progressive metabolic acidosis and the clinical manifestations of DKA, including nausea, vomiting, abdominal pain, Kussmaul respiration, and altered mental status **[1, 2, 5].**

Hyperglycemia induces osmotic diuresis, resulting in substantial losses of water and electrolytes. Most patients present with a fluid deficit of approximately 5-8 L together with significant depletion of sodium, potassium, phosphate, and magnesium **[2].** Although serum potassium concentrations are frequently normal or elevated at presentation because of insulin deficiency and extracellular potassium shifts, total body potassium depletion is often severe. Consequently, potassium replacement remains one of the most critical aspects of DKA management.

Modern understanding also recognizes β-hydroxybutyrate as the predominant circulating ketone during acute DKA. This observation explains why direct measurement of blood β-hydroxybutyrate has become the preferred diagnostic method, replacing urine ketone testing in many institutions **[1].**

Advances in diagnosis

The diagnosis of DKA has evolved considerably over the past decade. Traditionally, diagnosis relied on the presence of hyperglycemia, ketonuria, and metabolic acidosis. However, the 2024 International Consensus Report recommends a more physiology-based approach that emphasizes ketosis and metabolic acidosis rather than glucose concentration alone **[1].**

Current recommendations identify three essential components for diagnosis:

- Hyperglycemia (glucose value of ≥ 11.1 mmol/l (200 mg/dl)or known diabetes.
- Elevated ketone concentrations, preferably blood β-hydroxybutyrate.
- Metabolic acidosis demonstrated by reduced serum bicarbonate and/or decreased venous pH **[1].**

One of the most important advances has been widespread adoption of blood β-hydroxybutyrate measurement. Compared with urine ketones, blood ketone testing provides earlier diagnosis, correlates more closely with disease severity, and better reflects treatment response because β-hydroxybutyrate is the predominant ketone body during acute DKA **[1, 5]**. Urine ketones may remain positive after ketoacidosis has resolved, potentially delaying transition from intravenous insulin therapy **[1, 5].**

Another important development is increased use of venous blood gas analysis instead of arterial sampling. Venous pH and bicarbonate closely correlate with arterial values in most patients, reducing patient discomfort without compromising diagnostic accuracy **[1].**

Recognition of euglycemic DKA represents another major advance. Patients receiving SGLT2 inhibitors, pregnant women, or those with prolonged fasting or reduced carbohydrate intake may develop severe ketoacidosis despite blood glucose concentrations below traditional diagnostic thresholds **[1, 4].** Consequently, clinicians should consider DKA whenever unexplained high anion-gap metabolic acidosis is accompanied by elevated ketones, regardless of glucose concentration.

Finally, recent recommendations emphasize that resolution of DKA should be determined by correction of ketosis and metabolic acidosis rather than glucose normalization alone. Blood β-hydroxybutyrate, serum bicarbonate, venous pH, closure of the anion gap, and overall clinical recovery provide more reliable indicators of metabolic resolution than plasma glucose concentration **[1].**

Contemporary management

Management of DKA **[Table 1]** has become increasingly standardized through evidence-based treatment protocols. The principal therapeutic objectives include restoration of intravascular volume, suppression of ketogenesis, correction of electrolyte abnormalities, identification of precipitating factors, and safe transition to long-term diabetes therapy **[1, 2].**

Fluid therapy

Intravenous fluid replacement remains the cornerstone of DKA management. Early administration of isotonic crystalloids restores circulating volume, improves renal perfusion, enhances urinary glucose clearance, and reduces circulating counter-regulatory hormones **[1, 2, 7].**

Although 0.9% normal saline has traditionally been recommended as the initial resuscitation fluid, recent randomized trials have suggested that balanced crystalloids, including Plasma-Lyte and Ringer's lactate, may reduce hyperchloremic metabolic acidosis and shorten time to DKA resolution **[8, 9].** Current international guidelines consider both appropriate, with fluid selection individualized according to patient characteristics and institutional practice **[1].**

Particular attention should be given to patients with heart failure, chronic kidney disease, pregnancy, or advanced age, where excessive fluid administration may increase the risk of complications.

Insulin therapy

Continuous intravenous infusion of regular insulin remains the preferred treatment for moderate and severe DKA. Insulin suppresses ketone production, decreases hepatic glucose output, and restores peripheral glucose utilization **[2].**

Current consensus recommendations support a fixed-rate intravenous insulin infusion of approximately 0.1 units/kg/hour, with subsequent adjustments guided by metabolic response rather than glucose concentration alone **[1].** As plasma glucose falls to approximately 11-14 mmol/L (200-250 mg/dL), dextrose-containing intravenous fluids should be initiated while continuing insulin infusion to ensure ongoing suppression of ketogenesis until DKA has resolved **[1].** If blood glucose continues to decline despite ongoing insulin requirements, higher-concentration dextrose solutions (e.g., 5 or 10% dextrose) may be required to maintain euglycemia while allowing uninterrupted insulin administration, rather than reducing or discontinuing insulin prematurely. The choice and concentration of dextrose should be individualized according to the patient's glucose levels, fluid status, and electrolyte requirements **[1].**

Selected patients with mild DKA may be treated safely using subcutaneous rapid-acting insulin analogues in experienced centers with appropriate monitoring, potentially reducing intensive care utilization and healthcare costs **[1].**

Electrolyte replacement

Potassium replacement remains one of the most critical aspects of DKA management. Because total body potassium depletion is substantial despite frequently normal serum concentrations, insulin therapy should not begin in patients with severe hypokalemia (<3.3 mmol/L) until potassium replacement has been initiated **[2].**

Routine phosphate replacement is generally unnecessary except in patients with severe hypophosphatemia, respiratory muscle weakness, cardiac dysfunction, or significant anemia. Magnesium replacement should be individualized according to biochemical measurements and clinical status **[1, 2].**

Bicarbonate therapy

Routine bicarbonate administration is not recommended because available evidence demonstrates limited clinical benefit and potential adverse effects including hypokalemia, paradoxical intracellular acidosis, and delayed ketone clearance **[1, 2].** Current international recommendations reserve bicarbonate therapy for patients with severe acidemia (pH <6.9) **[1-3].**

Transition to subcutaneous insulin

Following biochemical resolution of DKA and restoration of oral intake, patients should be transitioned to an individualized subcutaneous insulin regimen. Patients already receiving basal insulin should continue basal insulin during intravenous insulin infusion whenever possible to maintain background insulin coverage and reduce the risk of rebound hyperglycemia and recurrent ketosis **[1]**. For new patients, basal insulin should be initiated and administered at least 2 hours before discontinuing intravenous insulin to prevent rebound hyperglycemia and recurrent ketosis **[1].**

Before discharge, precipitating factors should be identified and addressed, and patients should receive structured diabetes education and appropriate follow-up to reduce the risk of recurrent DKA **[1, 3].**

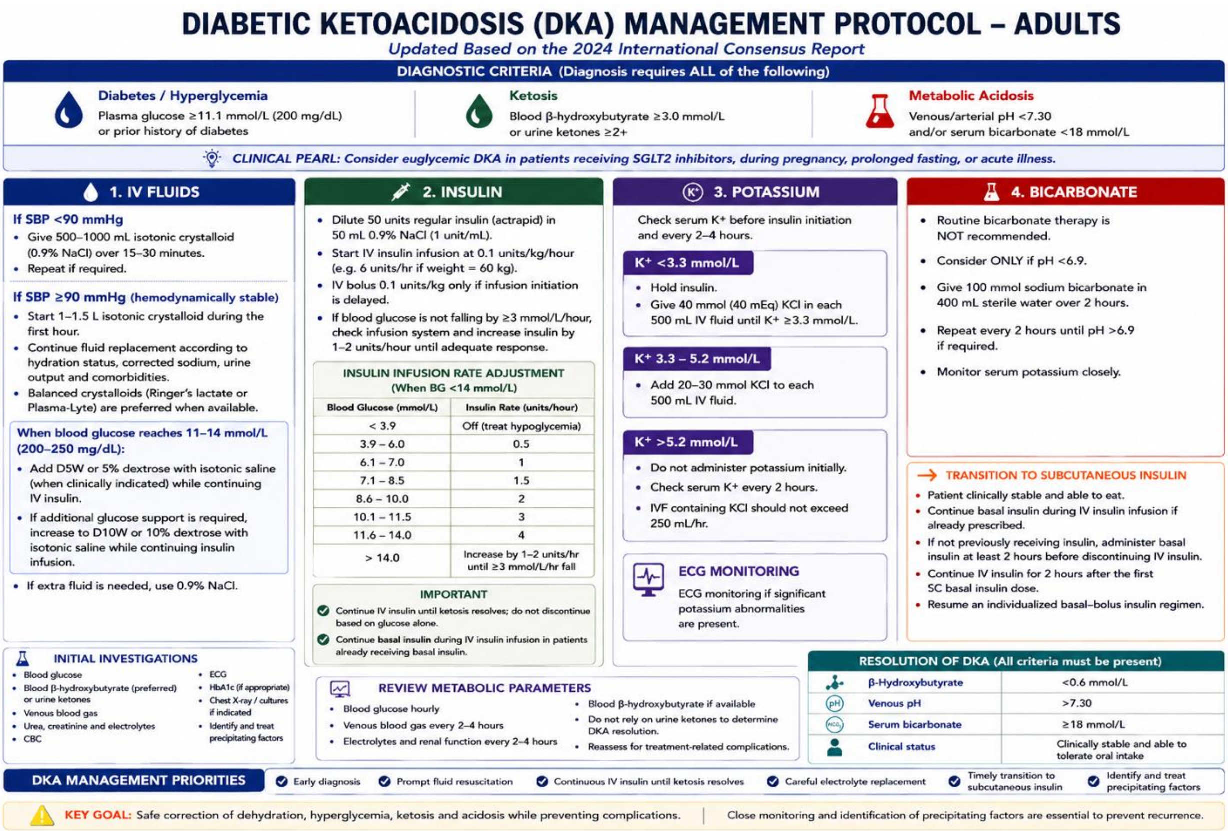

Table 1: Management of diabetic ketoacidosis in adult [1].

Continuous glucose monitoring during diabetic ketoacidosis

Continuous glucose monitoring (CGM) has transformed outpatient diabetes management and is increasingly being evaluated for inpatient care, including the management of diabetic ketoacidosis (DKA). Although current international guidelines continue to recommend point-of-care capillary or laboratory glucose measurements as the standard of care during active DKA, CGM has emerged as a valuable adjunct for monitoring glucose trends and facilitating clinical decision-making **[1, 3].**

The principal advantage of CGM is its ability to provide near real-time glucose measurements and trend analysis, enabling clinicians to identify rapid glucose fluctuations, anticipate the need for dextrose supplementation during intravenous insulin therapy, and facilitate the transition from intravenous to subcutaneous insulin. CGM may also reduce the frequency of finger-stick testing, improve patient comfort, and decrease nursing workload. However, during active DKA, severe dehydration, impaired peripheral perfusion, and rapidly changing glucose concentrations may reduce sensor accuracy. Therefore, insulin infusion should continue to be guided by point-of-care or laboratory glucose measurements, with CGM serving as an adjunct rather than a replacement until metabolic stability is achieved **[1, 3, 10, 11, 12].**

Future improvements in sensor accuracy, continuous ketone monitoring, remote inpatient surveillance, and artificial intelligence-assisted insulin titration may further expand the role of diabetes technology in the management of hyperglycemic emergencies.

Prevention

Although advances in acute management have improved outcomes, prevention remains the most effective strategy for reducing DKA. Structured diabetes education, individualized sick-day management, uninterrupted access to insulin, regular specialist follow-up, and early identification of high-risk patients are essential to prevent recurrent DKA **[1, 3].**

Patients should receive education on insulin adjustment during illness, maintaining adequate hydration, ketone monitoring when appropriate, and recognizing when to seek urgent medical attention. Individuals receiving SGLT2 inhibitors should be advised to temporarily withhold therapy during acute illness, prolonged fasting, dehydration, or before major surgery to reduce the risk of euglycemic DKA **[1, 4].**

Pre-Ramadan assessment using the IDF-DAR risk stratification tool, together with structured diabetes education and individualized treatment adjustments, has been shown to improve fasting safety and reduce the risk of acute metabolic complications, including DKA, during Ramadan **[13].**

Diabetes technology also plays an increasingly important role in DKA prevention. Continuous glucose monitoring (CGM), insulin pump therapy, and hybrid closed-loop systems improve glycemic control, facilitate early recognition of insulin deficiency or insulin delivery failure, and reduce the risk of DKA, particularly in people with type 1 diabetes. Wider implementation of these technologies, together with structured patient education, has the potential to further reduce DKA-related hospitalizations and improve long-term outcomes **[13].**

The ADA Standards of Care also recommend reviewing previous episodes of DKA, addressing psychosocial and socioeconomic barriers, and ensuring timely follow-up and equitable access to diabetes technologies and medications as essential components of long-term DKA prevention **[3].**

Future perspectives

The management of DKA continues to evolve with advances in diabetes technology and precision medicine. Continuous glucose monitoring, hybrid closed-loop insulin delivery systems, remote glucose surveillance, and emerging continuous ketone monitoring technologies have the potential to improve early recognition of metabolic deterioration and reduce hospital admissions.

Future research should focus on individualized fluid therapy, optimization of insulin protocols, integration of artificial intelligence into clinical decision support, and development of predictive models to identify patients at highest risk of recurrent DKA. Equally important is expanding structured diabetes education and equitable access to insulin and diabetes technologies, particularly in resource-limited settings.

Conclusion

Diabetic ketoacidosis remains a preventable yet potentially life-threatening endocrine emergency. Contemporary management has evolved beyond correction of hyperglycemia to emphasize rapid ketone clearance, individualized fluid resuscitation, meticulous electrolyte replacement, and identification of precipitating factors. Recognition of euglycemic DKA together with implementation of the 2024 International Consensus Report has refined diagnostic and therapeutic strategies. Emerging technologies, including continuous glucose monitoring, offer promising opportunities to enhance inpatient diabetes care, while individualized risk stratification and structured patient education remain fundamental to preventing recurrent DKA. Future DKA care should move beyond acute treatment toward proactive prevention through standardized evidence-based protocols, diabetes technology, and personalized patient-centered care.

References

1) Umpierrez GE, Davis GM, ElSayed NA, Fadini GP, Galindo RJ, et al. Hyperglycaemic crises in adults with diabetes: a consensus report. Diabetologia. 2024, 67:1455-1479.
2) Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic crises in adult patients with diabetes. N Engl J Med. 2009, 360:1606-1617.
3) American Diabetes Association Professional Practice Committee. Diabetes care in the hospital: standards of care in diabetes-2026. Diabetes Care. 2026, 49 (Suppl 1):S339-355.
4) Peters AL, Buschur EO, Buse JB, Cohan P, Diner JC, et al. Euglycemic diabetic ketoacidosis: A potential complication of treatment with sodium-glucose cotransporter 2 inhibitors. Diabetes Care. 2015, 38:1687-1693.
5) Dhatariya KK, Glaser NS, Codner E, Umpierrez GE. Diabetic ketoacidosis. Nat Rev Dis Primers. 2020, 6:40.
6) Umpierrez GE, Korytkowski M. Diabetic emergencies-ketoacidosis, hyperglycaemic hyperosmolar state and hypoglycaemia. Nat Rev Endocrinol. 2016, 12:222-232.
7) Glaser N, Fritsch M, Priyambada L, Rewers A, Cherubini V, et al. ISPAD Clinical Practice Consensus Guidelines 2022: Diabetic ketoacidosis and hyperglycemic hyperosmolar state. Pediatr Diabetes. 2022, 23:835-856.
8) Self WH, Evans CS, Jenkins CA, Wanderer JP, Ehrenfeld J, et al. Balanced crystalloids versus saline in critically ill adults. N Engl J Med. 2018, 378:829-839.
9) Semler MW, Self WH, Wanderer JP, Wang L, Byrne DW, et al. Balanced crystalloids versus saline in noncritically ill adults. N Engl J Med. 2018, 378:819-828.
10) American Diabetes Association Professional Practice Committee. Glycemic goals, hypoglycemia, and hyperglycemic crises: standards of care in diabetes-2026. Diabetes Care. 2026, 49(Suppl 1):S132-149.
11) Rodriguez Alvarez P, San Martin VT, Morey-Vargas O. Hyperglycemic crises in adults: A look at the 2024 consensus report. Cleve Clin J Med. 2025, 92:152-158.
12) Al-Reesi A, Al-Reesi H. Diabetic ketoacidosis among COVID-19 patients admitted to Sohar Hospital, Oman: Clinical characteristics and outcomes. J Diabetes Metab. 2021, 12:866.
13) Al-Reesi AKS, Hamed Al Reesi, Salem Al Ghaithi, Ibrahim Al Ali, Salwa Al Balushi, et al. Impact of the IDF-DAR risk stratification and pre-ramadan education on diabetes-related complications. J Diabetes Endocr Pract. 2025, 8:179-185.