e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com doi: 10.25258/ijpqa.16.6.46

International Journal of Pharmaceutical Quality Assurance 2025; 16(6); 263-268

Original Research Article

Assessment of Biochemical Alterations in Type 2 Diabetes Mellitus Patients Presenting with Diabetic Ketoacidosis in a Tertiary Care Institute

Amit Kumar Singh[1], Jyoti Prakash[2], Rituraj Lahkar[3]

[1]Senior Resident, Department of General Medicine, AIIMS, Patna, Bihar, India
[2]Professor and HOD, Department of General Medicine, AIIMS, Patna, Bihar, India
[3]Senior Resident, Department of General Medicine, AIIMS, Patna, Bihar, India

Received: 11-04-2025 / Revised: 15-05-2025 / Accepted: 25-06-2025
Corresponding Author: Dr. Rituraj Lahkar
Conflict of interest: Nil

Abstract:

Background: Diabetic ketoacidosis (DKA) is a potentially life-threatening complication more commonly associated with type 1 diabetes but increasingly reported in type 2 diabetes mellitus (T2DM) as well. Understanding the biochemical derangements in T2DM patients with DKA is essential for timely diagnosis, appropriate management, and improved outcomes.

Aim: To evaluate the biochemical profile of patients with type 2 diabetes mellitus presenting with diabetic ketoacidosis in a tertiary care Institute.

Materials and Methods: A retrospective study included 100 adult patients diagnosed with T2DM and DKA at the Department of General Medicine, AIIMS, Patna. Demographic data and biochemical parameters including blood glucose, serum ketones, arterial blood gas (ABG) analysis, serum electrolytes, renal function, and lipid profile were collected and analyzed.

Results: The mean age of patients was 54.3 ± 11.7 years, with a slight male predominance. The most common precipitating factors were infection (48%) and poor medication compliance (32%). Mean blood glucose was 436.5 ± 96.2 mg/dL, serum bicarbonate was 11.8 ± 3.9 mmol/L, and arterial pH was 7.18 ± 0.07. Moderate to severe hypokalemia was observed in 38% of cases, while elevated serum creatinine was seen in 29% of patients.

Conclusion: DKA in T2DM patients presents with characteristic biochemical disturbances, predominantly marked hyperglycemia, metabolic acidosis, and variable electrolyte imbalances. Early recognition of these biochemical markers is essential for effective clinical management and reduction of morbidity and mortality.

Introduction

Diabetic ketoacidosis (DKA) is a serious and acute metabolic complication of diabetes mellitus, primarily associated with absolute or relative insulin deficiency and increased levels of counter-regulatory hormones [1]. While traditionally considered a hallmark of type 1 diabetes mellitus (T1DM), recent years have witnessed a growing incidence of DKA in patients with type 2 diabetes mellitus (T2DM), particularly in the Indian subcontinent and other low- to middle-income countries where delayed diagnosis and irregular glycemic control are common [2].

DKA is characterized biochemically by the triad of hyperglycemia, ketonemia (or ketonuria), and high anion gap metabolic acidosis. These derangements occur due to enhanced lipolysis and hepatic ketogenesis triggered by insulin deficiency and elevated levels of glucagon, catecholamines, cortisol, and growth hormone [3]. The resulting accumulation of ketone bodies primarily acetoacetate and β-hydroxybutyrate leads to a progressive drop in blood pH and bicarbonate levels. In parallel, hyperglycemia induces osmotic diuresis, causing fluid and electrolyte losses, including potassium, sodium, and chloride, further complicating the clinical picture [4].

Although the diagnostic and management criteria for DKA are well-established, there exists a paucity of data specifically focusing on the biochemical profiles of DKA in patients with T2DM. The pathophysiology, clinical presentation, and response to treatment in T2DM-associated DKA can differ significantly from that observed in T1DM patients, particularly in terms of age at presentation, precipitating factors, renal function status, and insulin requirements [5]. Identifying and profiling these biochemical parameters is essential to tailor management strategies, reduce hospital stay, and prevent complications such as cerebral edema, acute kidney injury, or even death [6].

Various precipitating factors have been implicated in DKA among T2DM patients, including infections (urinary tract infections, pneumonia), missed insulin

doses, newly diagnosed diabetes, myocardial infarction, stroke, pancreatitis, and the use of medications such as corticosteroids or SGLT2 inhibitors. The presence of these stressors, coupled with poor awareness and inadequate healthcare access, contributes to the rising burden of DKA in this patient group [7].

In the Indian context, the burden of diabetes mellitus is increasing rapidly due to urbanization, sedentary lifestyle, and dietary changes. However, health-seeking behavior and regular follow-up among diabetic patients, especially in rural and peri-urban areas, remain suboptimal. Thus, an observational evaluation of the biochemical parameters in patients presenting with DKA and known or newly diagnosed T2DM may provide valuable insight into patterns of metabolic derangements, help predict disease severity, and contribute to early and effective intervention.

This study is therefore aimed at assessing the biochemical profile of T2DM patients presenting with DKA, analyzing patterns of electrolyte and acid-base disturbances, and identifying correlations with clinical severity. It is hoped that the findings from this research will strengthen the evidence base for effective emergency management of diabetic emergencies in resource-limited settings.

Aim and Objectives

Aim: To evaluate the biochemical profile and associated metabolic abnormalities in patients with type 2 diabetes mellitus presenting with diabetic ketoacidosis.

Objectives:

1. To analyze the levels of blood glucose, serum ketones, and acid-base parameters (pH, bicarbonate) in T2DM patients with DKA.
2. To evaluate electrolyte disturbances, particularly sodium, potassium, and chloride levels, during DKA episodes.
3. To assess renal function parameters including blood urea nitrogen and serum creatinine in DKA patients.
4. To identify the common precipitating factors for DKA in T2DM patients.
5. To correlate the severity of biochemical abnormalities with clinical presentation and need for intensive care.
6. To contribute data to inform management strategies for T2DM patients with DKA in tertiary care settings.

Materials and Methods

Study Design: A retrospective study conducted at the Department of General Medicine, AIIMS, Patna, Bihar, India.

Study Duration: The study was conducted over a period of 12 months, from January 2024 to December 2024.

Study Population and Sample Size: The study included 100 adult patients diagnosed with type 2 diabetes mellitus who presented with diabetic ketoacidosis. The sample size was selected based on patient admissions during the study period, maintaining feasibility and statistical adequacy for meaningful interpretation.

Inclusion Criteria:

- Patients aged 30 years and above.
- Known or newly diagnosed cases of type 2 diabetes mellitus.
- Clinical and biochemical diagnosis of DKA (blood glucose >250 mg/dL, arterial pH <7.3, serum bicarbonate <18 mmol/L, and presence of ketonemia or ketonuria).

Exclusion Criteria:

- Patients with type 1 diabetes mellitus.
- Pregnant women.
- Patients with known chronic kidney disease stage 4 or 5.
- Patients with incomplete laboratory records.

Study Setting: All eligible patients were recruited from the inpatient wards and emergency unit of the Department of General Medicine at AIIMS, Patna. Ethical clearance was obtained from the institutional ethics committee prior to commencement.

Data Collection: Demographic data, clinical history, precipitating factors, and duration of diabetes were recorded. Blood samples were collected for the following investigations:

- Blood glucose (random and fasting)
- Serum ketones (semi-quantitative estimation)
- Arterial blood gas (ABG) analysis
- Serum electrolytes (Na^+, K^+, Cl^-)
- Blood urea nitrogen (BUN) and serum creatinine
- Serum bicarbonate (HCO_3^-)
- Lipid profile (optional depending on physician request)

Statistical Analysis: All data were entered into Microsoft Excel and analyzed using SPSS software version 25. Descriptive statistics such as mean, standard deviation, frequency, and percentages were used. Categorical variables were analyzed using Chi-square test, and continuous variables were compared using independent t-tests or Mann–Whitney U test as appropriate. A p-value <0.05 was considered statistically significant.

Results

This observational study was conducted on 100 adult patients with type 2 diabetes mellitus (T2DM)

who presented with diabetic ketoacidosis (DKA) to the Department of General Medicine at AIIMS, Patna. The study aimed to analyze the biochemical profile and identify common patterns of metabolic abnormalities in this population. The majority of patients presented with classical DKA symptoms such as polyuria, polydipsia, abdominal pain, vomiting, and altered sensorium. Relevant laboratory parameters including blood glucose, serum ketones, arterial blood pH, serum bicarbonate, electrolytes, and renal function markers were evaluated at the time of admission. Patients were managed as per standard institutional DKA treatment protocol. The results demonstrated significant derangements in glucose metabolism, acid-base status, and electrolyte balance. The most common precipitating factors identified were infection and poor medication adherence. The findings are presented in the following tables.

Table 1: Distribution of Patients by Age Group

Age Group (years)	Number of Patients (n=100)	Percentage (%)
30–40	12	12%
41–50	26	26%
51–60	38	38%
61–70	18	18%
>70	6	6%

Table 2: Gender Distribution of Study Participants

Gender	Number of Patients	Percentage (%)
Male	58	58%
Female	42	42%

Table 3: Duration of Diabetes in Enrolled Patients

Duration of Diabetes	Number of Patients	Percentage (%)
<1 year	30	30%
1–5 years	28	28%
6–10 years	22	22%
>10 years	20	20%

Table 4: Common Precipitating Factors Identified

Precipitating Factor	Number of Patients	Percentage (%)
Infection	48	48%
Missed medication	32	32%
Newly diagnosed T2DM	10	10%
Other (MI, Stroke)	10	10%

Table 5: Mean Blood Glucose and Serum Ketones at Admission

Parameter	Mean ± SD
Blood Glucose (mg/dL)	436.5 ± 96.2
Serum Ketones (mmol/L)	4.7 ± 1.3

Table 6: Arterial Blood Gas (ABG) Findings

Parameter	Mean ± SD
Arterial pH	7.18 ± 0.07
Serum Bicarbonate (mmol/L)	11.8 ± 3.9

Table 7: Serum Potassium Levels

Potassium Level (mmol/L)	Number of Patients	Percentage (%)
<3.5 (Hypokalemia)	38	38%
3.5–5.0 (Normal)	52	52%
>5.0 (Hyperkalemia)	10	10%

Table 8: Serum Sodium and Chloride Values

Parameter	Mean ± SD
Sodium (mmol/L)	134.2 ± 5.8
Chloride (mmol/L)	98.1 ± 7.4

Table 9: Renal Function at Admission

Parameter	Mean ± SD
Serum Urea (mg/dL)	54.6 ± 18.2
Serum Creatinine (mg/dL)	1.56 ± 0.5

Table 10: Requirement of ICU Admission

ICU Admission Required	Number of Patients	Percentage (%)
Yes	18	18%
No	82	82%

Table 1 shows that the highest number of DKA cases occurred in the 51–60 year age group. Table 2 indicates a slight male predominance in the study. Table 3 reveals that 30% of patients were newly diagnosed at the time of DKA presentation, emphasizing delayed recognition. Table 4 identifies infection (48%) and missed medication (32%) as the most common precipitating factors. Table 5 presents a significantly elevated mean blood glucose of 436.5 mg/dL and high serum ketones. Table 6 highlights severe metabolic acidosis with low pH and bicarbonate levels. Table 7 shows that 38% of patients had hypokalemia at admission, necessitating careful monitoring. Table 8 reflects mild hyponatremia and slightly low chloride levels, consistent with osmotic diuresis. Table 9 indicates mild renal impairment in several patients, with elevated urea and creatinine. Lastly, Table 10 demonstrates that 18% of patients required ICU admission, reflecting the severity of metabolic disturbances in this cohort.

Discussion

Diabetic ketoacidosis (DKA) remains one of the most serious acute complications of diabetes mellitus and is increasingly recognized not only in type 1 diabetes but also among patients with type 2 diabetes mellitus (T2DM), particularly in South Asia. This study provides a comprehensive overview of the biochemical profile observed in T2DM patients presenting with DKA in a tertiary care setting. The results offer valuable insights into the demographic, metabolic, and clinical characteristics of this patient population [8].

The demographic profile in this study demonstrated that middle-aged individuals were most commonly affected by DKA, with a slightly higher incidence among male patients. This pattern is consistent with national and international literature, suggesting that metabolic decompensation in T2DM often occurs later in life when insulin resistance and pancreatic beta-cell dysfunction are both significantly progressed. The gender difference, though subtle, may reflect healthcare-seeking patterns or underlying hormonal and behavioral factors [9].

A noteworthy observation in this study was the high proportion of newly diagnosed diabetics who presented with DKA. This underscores the silent progression of T2DM and the critical gaps in screening, diagnosis, and community awareness. Many patients remain undiagnosed until they present with an acute crisis, which poses a challenge for public health systems in low- and middle-income countries. It also highlights the need for opportunistic screening and regular check-ups, particularly in individuals with risk factors such as obesity, sedentary lifestyle, and family history of diabetes [10].

Infection emerged as the most common precipitating factor for DKA, followed by poor adherence to antidiabetic medications. This observation supports the known pathophysiological mechanisms in which infections trigger stress responses that exacerbate insulin resistance and promote ketogenesis. The immunocompromised state in diabetics, coupled with poor glycemic control, creates a fertile ground for infections to flourish. On the other hand, medication non-compliance reflects issues of accessibility, affordability, patient education, and psychological barriers to long-term disease management. Addressing these modifiable factors through patient counseling and structured follow-up could help prevent recurrence [11].

The biochemical derangements observed in this study were consistent with classical DKA patterns. Marked hyperglycemia was universally present, along with ketonemia, acidosis, and varying degrees of electrolyte imbalance. The severity of metabolic acidosis, as evidenced by low arterial pH and bicarbonate values, reinforces the need for early detection and prompt correction of acid-base status. Electrolyte abnormalities, especially hypokalemia and hyponatremia, were frequent. These disturbances, if not monitored and corrected diligently, can lead to life-threatening complications such as cardiac arrhythmias or cerebral edema [12].

Renal function impairment was noted in a significant number of cases, likely attributable to dehydration and hypovolemia from osmotic diuresis. While these changes were mostly reversible with fluid resuscitation, they serve as a reminder of the systemic effects of DKA beyond glucose metabolism. Additionally, a considerable proportion of patients required ICU-level care, indicating the potential severity of DKA presentations even in type 2 diabetes [13].

The findings of this study align with existing literature but also emphasize the growing burden of DKA in T2DM patients. As India faces a rising prevalence of type 2 diabetes, tertiary centers must be prepared to manage acute metabolic emergencies efficiently.

Preventive strategies should focus on early diagnosis, infection control, structured diabetes education, and adherence reinforcement. Clinicians must maintain a high index of suspicion for DKA in T2DM patients presenting with nonspecific symptoms such as fatigue, nausea, or altered mental status [14].

This study reaffirms that DKA in type 2 diabetes is a serious clinical entity with significant biochemical alterations. Timely recognition and evidence-based management are essential to reduce morbidity and mortality associated with this preventable complication.

Conclusion

This observational study highlights the significant biochemical disturbances that characterize diabetic ketoacidosis in patients with type 2 diabetes mellitus. The findings underscore that DKA is no longer confined to type 1 diabetes and increasingly affects individuals with T2DM, particularly in middle age. Severe hyperglycemia, metabolic acidosis, and electrolyte imbalances such as hypokalemia and hyponatremia were commonly observed, requiring meticulous correction and monitoring. The majority of cases were precipitated by infections and poor medication adherence, reflecting gaps in disease management and patient education. A substantial proportion of patients required intensive care, indicating the potentially life-threatening nature of DKA even in type 2 diabetes. Early diagnosis, effective triage, and protocol-driven treatment are essential to improving outcomes. Preventive strategies including patient counseling, routine follow-up, and infection control can significantly reduce the incidence and recurrence of DKA. Additionally, timely recognition of renal impairment and acid-base derangements is vital in preventing complications. Overall, this study emphasizes the need for an integrated approach combining clinical vigilance, biochemical monitoring, and patient-centered care to manage and prevent diabetic ketoacidosis in T2DM patients effectively.

References

1. Ooi E, Nash K, Rengarajan L, Melson E, Thomas L, Johnson A, Zhou D, Wallett L, Ghosh S, Narendran P, Kempegowda P. Clinical and biochemical profile of 786 sequential episodes of diabetic ketoacidosis in adults with type 1 and type 2 diabetes mellitus. BMJ Open Diabetes Res Care. 2021 Dec;9(2):e002451. doi: 10.1136/bmjdrc-2021-002451. PMID: 34879999; PMCID: PMC8655523.
2. Pal R, Banerjee M, Yadav U, Bhattacharjee S. Clinical profile and outcomes in COVID-19 patients with diabetic ketoacidosis: A systematic review of literature. Diabetes Metab Syndr. 2020 Nov-Dec;14(6):1563-1569. doi: 10.1016/j.dsx.2020.08.015. Epub 2020 Aug 18. PMID: 32853901; PMCID: PMC7434433.
3. Xu Y, Bai J, Wang G, Zhong S, Su X, Huang Z, Chen G, Zhang J, Hou X, Yu X, Lu B, Wang Y, Li X, Hu H, Zhang C, Liang Y, Shaw J, Wu X. Clinical profile of diabetic ketoacidosis in tertiary hospitals in China: a multicentre, clinic-based study. Diabet Med. 2016 Feb;33(2):261-8. doi: 10.1111/dme.12820. Epub 2015 Jul 2. PMID: 26032429.
4. Ndebele NFM, Naidoo M. The management of diabetic ketoacidosis at a rural regional hospital in KwaZulu-Natal. Afr J Prim Health Care Fam Med. 2018 Mar 22;10(1):e1-e6. doi: 10.4102/phcfm.v10i1.1612. PMID: 29781681; PMCID: PMC5913763.
5. Prajapati BK . Clinical Profile of Diabetic Ketoacidosis in Adults in Dhulikhel Hospital. Kathmandu Univ Med J (KUMJ). 2017 Jan.-Mar.;15(57):25-28. PMID: 29446358.
6. Rashid MO, Sheikh A, Salam A, Farooq S, Kiran Z, Islam N. Diabetic ketoacidosis characteristics and differences In type 1 versus type 2 diabetes patients. J Ayub Med Coll Abbottabad. 2017 Jul-Sep;29(3):398-402. PMID: 29076669.
7. Mohan V, Uma Sankari G, Amutha A, Anjana RM, Jeba Rani S, Unnikrishnan R, Venkatesan U, Shanthi Rani CS. Clinical and biochemical profile of childhood-adolescent-onset type 1 diabetes and adult-onset type 1 diabetes among Asian Indians. Acta Diabetol. 2023 Apr;60(4):579-586. doi: 10.1007/s00592-023-02034-x. Epub 2023 Jan 26. PMID: 36700996.
8. Nabi T, Rafiq N, Rahman MHU, Rasool S, Wani NUD. Comparative study of emphysematous pyelonephritis and pyelonephritis in type 2 diabetes: a single-centre experience. J Diabetes Metab Disord. 2020 Sep 28;19(2):1273-1282. doi: 10.1007/s40200-020-00640-y. PMID: 33553028; PMCID: PMC7843907.
9. Newton CA, Raskin P. Diabetic ketoacidosis in type 1 and type 2 diabetes mellitus: clinical and biochemical differences. Arch Intern Med. 2004 Sep 27;164(17):1925-31. doi: 10.1001/archinte.164.17.1925. PMID: 15451769.
10. Krentz AJ, Bailey CJ. Oral antidiabetic agents: current role in type 2 diabetes mellitus. Drugs. 2005;65(3):385-411. doi: 10.2165/00003495-200565030-00005. PMID: 15669880.
11. Tan H, Zhou Y, Yu Y. Characteristics of diabetic ketoacidosis in Chinese adults and adolescents -- a teaching hospital-based analysis. Diabetes Res Clin Pract. 2012 Aug;97(2):306-12. doi: 10.1016/j.diabres.2012.05.004. Epub 2012 Jun 15. PMID: 22704172.
12. Amutha A, Ranjit U, Anjana RM, Shanthi R CS, Rajalakshmi R, Venkatesan U, Muthukumar S, Philips R, Kayalvizhi S, Gupta PK, Sastry NG, Mohan V. Clinical profile and incidence of microvascular complications of child-

hood and adolescent onset type 1 and type 2 diabetes seen at a tertiary diabetes center in India. Pediatr Diabetes. 2021 Feb;22(1):67-74. doi: 10.1111/pedi.13033. Epub 2020 May 29. PMID: 32333449.

13. Dicks HN, Naidoo K. COVID-19 and diabetic ketoacidosis: A case series at an urban district hospital in South Africa. S Afr Fam Pract (2004). 2022 Sep 22;64(1):e1-e5. doi: 10.4102/safp.v64i1.5590. PMID: 36226949; PMCID: PMC9557943.
14. De Sanctis V, Soliman A, Alyafei F, Alaaraj N, Ahmed S, Elawwa A, Hamed N. Clinical and metabolic characteristics of children with hybrid diabetes mellitus (HD) compared to children with type 2 diabetes mellitus (T2DM): A preliminary comparative study. Acta Biomed. 2021 Nov 3;92(5):e2021511. doi: 10.23750/abm.v92i5.11598. PMID: 34738571; PMCID: PMC8689319.