Section: General Medicine

Original Research Article

# CLINICAL PROFILE OF DIABETIC KETOACIDOSIS PATIENTS ATTENDING A TERTIARY CARE HOSPITAL IN UTTARAKHAND: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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*Received* : 11/09/2025
*Received in revised form* : 20/10/2025
*Accepted* : 07/11/2025

*Keywords:*
*Diabetic ketoacidosis; clinical profile; precipitating factors; type 2 diabetes; tertiary care; Uttarakhand.*

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DOI: 10.47009/jamp.2025.7.6.56

Source of Support: Nil,
Conflict of Interest: None declared

*Int J Acad Med Pharm*
2025; 7 (6); 283-287

## ABSTRACT

**Background:** Diabetic ketoacidosis (DKA) is a preventable hyperglycaemic emergency, increasingly reported among adults with type 2 diabetes in North India, but local data from Uttarakhand are limited. The aim is to evaluate the clinical profile and precipitating factors of DKA in hospitalized patients at a tertiary-care hospital in Uttarakhand. **Materials and Methods:** Hospital-based cross-sectional observational study including 84 consecutive patients (≥16 years) admitted with DKA (hyperglycaemia, ketonuria and metabolic acidosis). Sociodemographic, clinical, precipitating and biochemical parameters were recorded in a structured proforma and DKA was graded as per ADA criteria. Descriptive statistics and comparison across severity groups were done. **Result:** Most patients were 46–60 years and male; type 2 diabetes constituted the majority. Infection was the commonest precipitating factor, followed by insulin/drug omission. Moderate DKA was the most frequent category. Mean RBS was >400 mg/dL and HbA1c values indicated poor chronic glycaemic control. Most patients recovered with standard DKA management; mortality was low. **Conclusion:** DKA in this setting predominantly affected adults with poorly controlled type 2 diabetes and was mainly triggered by infection and treatment non-adherence, indicating scope for prevention through diabetes education and early infection control.

## INTRODUCTION

Diabetic ketoacidosis (DKA) is one of the most serious and life-threatening acute complications of diabetes mellitus. It is characterized by a triad of hyperglycemia, metabolic acidosis, and ketonemia, primarily resulting from an absolute or relative deficiency of insulin coupled with elevated levels of counter-regulatory hormones such as glucagon, catecholamines, cortisol, and growth hormone.[1] These metabolic abnormalities lead to increased hepatic glucose production, decreased peripheral glucose utilization, enhanced lipolysis, and subsequent ketogenesis — contributing to the hallmark biochemical disturbances observed in DKA.[2]

Globally, DKA continues to be a significant cause of diabetes-related hospitalizations and mortality, especially among individuals with type 1 diabetes mellitus. However, recent evidence also suggests an increasing incidence among patients with type 2 diabetes, particularly in populations exposed to socioeconomic stress, poor health literacy, and limited access to insulin therapy.[3] Clinically, patients with DKA often present with polyuria, polydipsia, dehydration, vomiting, abdominal pain, tachypnea, and in severe cases, altered mental status or coma. If not promptly recognized and treated, DKA can lead to serious complications such as cerebral edema, shock, and death.[4]

In the Indian context, the burden of DKA is amplified by systemic challenges including delayed diagnosis, irregular insulin administration, self-medication practices, and a lack of diabetes education, particularly in rural and semi-urban regions. Studies from different parts of India have consistently identified precipitating factors such as infection, insulin omission, and undiagnosed diabetes as leading contributors to DKA episodes.[5-7] Moreover, inappropriate management of hyperglycemia, either due to resource constraints or poor awareness, increases the likelihood of recurrent DKA and associated complications.[8]


ISSN (O): 2687-5365; ISSN (P): 2753-6556

The American Diabetes Association (ADA) and the International Society for Pediatric and Adolescent Diabetes (ISPAD) provide standard guidelines for the diagnosis and classification of DKA severity, based on parameters such as arterial pH, serum bicarbonate, and mental status.[9] However, while these criteria are widely accepted, regional variations in clinical presentation and outcomes are evident, especially in diverse populations like India's. The epidemiology and precipitating factors of DKA may vary significantly across geographical areas, healthcare access levels, and cultural practices.

The Kumaon region of Uttarakhand presents a unique demographic and healthcare landscape, encompassing hilly terrain, dispersed rural settlements, and limited tertiary care access. Despite a growing prevalence of diabetes in this region, there is a notable scarcity of published data evaluating the clinical features and outcomes of DKA in this population. Given the public health implications and preventability of DKA with timely intervention, it is critical to understand local patterns in its presentation, severity, and management outcomes.

Therefore, the present study was undertaken to evaluate the clinical and biochemical profile of patients presenting with DKA at a tertiary care center in the Kumaon region, with an emphasis on identifying common precipitating factors, grading disease severity, and understanding associated outcomes.

**Aim and Objectives**

**Aim:** To evaluate the clinical profile and precipitating factors of diabetic ketoacidosis in hospitalized patients.

**Objectives:**

- To assess the common clinical presentations and biochemical patterns in DKA.
- To identify frequent precipitating causes.

## MATERIALS AND METHODS

**Study design and setting:** A hospital-based, cross-sectional observational study was conducted in the Department of General Medicine at Dr. Sushila Tiwari Government Hospital, Haldwani, a tertiary care teaching institute in the Kumaon region of Uttarakhand.

**Ethical approval:** The study protocol was reviewed and approved by the Institutional Ethics Committee of Government Medical College, Haldwani. Written informed consent was obtained from all participants prior to enrollment.

**Study population and duration:** The study included 84 patients admitted with diabetic ketoacidosis (DKA) over a 18 months (July 2023-December 2024).

**Inclusion criteria**

Patients aged 16 years and above, diagnosed with diabetes mellitus and meeting the ADA 2009 criteria for DKA (blood glucose >250 mg/dL, arterial pH <7.3, serum bicarbonate <18 mmol/L, and positive serum or urine ketones) were included.

**Exclusion criteria**

Patients with hyperosmolar hyperglycemic state (HHS), mixed acid–base disorders, pregnant women, or those unwilling to provide consent were excluded.

**Data collection:** Patient information was collected using a structured proforma including demographic details, clinical features, precipitating factors, biochemical parameters (glucose, pH, bicarbonate, electrolytes, ketones, HbA1c), and outcome measures. The severity of DKA was graded as mild, moderate, or severe based on arterial pH and serum bicarbonate levels, according to ADA guidelines.

**Treatment and follow-up:** All patients were managed according to the institutional DKA protocol, involving fluid resuscitation, intravenous insulin, and correction of electrolyte imbalances. Patients were monitored during hospitalization for resolution of DKA and any complications.

**Statistical analysis:** Data were analyzed using SPSS version 25. Categorical variables were presented as percentages and frequencies; continuous variables were expressed as mean ± standard deviation (SD). Association between variables was assessed using Chi-square and Student's t-test where applicable. A p-value <0.05 was considered statistically significant.

## RESULTS

The present study included a total of 84 patients diagnosed with diabetic ketoacidosis (DKA). The most affected age group was 46–60 years, accounting for 41.7% of participants, followed by 27.4% in the 31–45 years category. Only 16.7% were between 16–30 years and 14.3% were above 60 years. A majority of the patients were from urban areas (60.7%), while 39.3% were rural residents. Most participants belonged to the lower-middle (42.9%) and middle (29.8%) socio-economic classes as per the Modified BG Prasad classification. In terms of type of diabetes, 82.1% had type 2 diabetes mellitus and 17.9% had type 1 diabetes mellitus, indicating the predominance of DKA even in adult-onset diabetes in this cohort [Table 1].

Poor compliance with insulin or oral hypoglycemic agents emerged as the most common precipitating factor for DKA, found in 38.1% of cases. Infectious causes contributed significantly, with pneumonia and urinary tract infections each accounting for 11.9%, and pulmonary tuberculosis present in 10.7% of patients. Other infections made up 14.3% of cases. Non-infectious comorbidities such as coronary artery disease (7.1%) and cerebrovascular accidents (2.4%) were also noted. A small proportion of cases (3.6%) had other or unclear precipitating factors, indicating that preventable or manageable causes still play a dominant role in DKA episodes [Table 2].

Severity classification based on arterial pH revealed that 56.0% of the cases had moderate DKA, followed


ISSN (O): 2687-5365; ISSN (P): 2753-6556

by 22.6% with severe and 21.4% with mild DKA. When categorized by serum bicarbonate ($HCO_3^-$) levels, 41.7% were moderate, 39.3% severe, and 19.0% mild. The average random blood sugar was elevated at 387.88 ± 142.02 mg/dL, and the mean HbA1c was 10.4 ± 1.5%, reflecting consistently poor glycemic control in the study population. The average serum bicarbonate level was 12.4 ± 3.1 mmol/L, highlighting significant metabolic acidosis among these patients. These values correlate with clinical diagnosis and validate the use of both arterial pH and bicarbonate levels in classifying DKA severity [Table 3].

A statistically significant association was observed between DKA severity and HbA1c levels (p = 0.031). Among patients with mild DKA, 63.3% had HbA1c between 9–11.9%, while a smaller proportion had levels above 12%. In moderate cases, the distribution was broader, with 24.4% having HbA1c <9% and 24.4% ≥12%. Severe DKA was predominantly seen in those with HbA1c >9%, emphasizing that poor long-term glycaemic control is directly correlated with increasing severity of DKA. This reinforces the utility of HbA1c as both a diagnostic and prognostic marker in diabetic emergencies [Table 4].

**Table 1: Sociodemographic Profile of Study Participants (n = 84)**

| Variable | Category | n | % |
|---|---|---|---|
| Age Group (years) | 16 – 30 | 14 | 16.7 |
| | 31 – 45 | 23 | 27.4 |
| | 46 – 60 | 35 | 41.7 |
| | > 60 | 12 | 14.3 |
| Residence | Urban | 51 | 60.7 |
| | Rural | 33 | 39.3 |
| Socio-economic class | Lower | 12 | 14.3 |
| | Lower middle | 36 | 42.9 |
| | Middle | 25 | 29.8 |
| | Upper middle | 11 | 13.1 |
| Type of diabetes | Type 1 DM | 15 | 17.9 |
| | Type 2 DM | 69 | 82.1 |

**Table 2: Precipitating Factors Among DKA Patients (n = 84)**

| Precipitating Factor | n | % |
|---|---|---|
| Poor compliance | 32 | 38.1% |
| Pneumonia | 10 | 11.9% |
| Urinary tract infection (UTI) | 10 | 11.9% |
| Pulmonary tuberculosis (PTB) | 9 | 10.7% |
| Other infections | 12 | 14.3% |
| Coronary artery disease (CAD) | 6 | 7.1% |
| Cerebrovascular accident (CVA) | 2 | 2.4% |
| Others | 3 | 3.6% |

**Table 3: Clinical Severity and Biochemical Profile of DKA Patients (n = 84)**

| Parameter | Category / Mean ± SD | n (%) |
|---|---|---|
| DKA Severity (Arterial pH) | | |
| • Mild | pH 7.25 – 7.30 | 18 (21.4%) |
| • Moderate | pH 7.00 – 7.24 | 47 (56.0%) |
| • Severe | pH < 7.00 | 19 (22.6%) |
| DKA Severity ($HCO_3^-$) | | |
| • Mild | 15 – 18 mmol/L | 16 (19.0%) |
| • Moderate | 10 – <15 mmol/L | 35 (41.7%) |
| • Severe | <10 mmol/L | 33 (39.3%) |
| Random Blood Sugar (mg/dL) | 387.88 ± 142.02 | — |
| HbA1c (%) | 10.4 ± 1.5 | — |
| Serum Bicarbonate (mmol/L) | 12.4 ± 3.1 | — |

**Table 4: Correlation of DKA Severity with HbA1c Levels (n = 84)**

| DKA Severity | HbA1c < 7 | HbA1c 7–8.9 | HbA1c 9–11.9 | HbA1c ≥ 12 | Total (n) | Total (%) | p value |
|---|---|---|---|---|---|---|---|
| Mild | 0 | 5 | 19 | 6 | 30 | 35.7 % | |
| Moderate | 4 | 8 | 19 | 10 | 41 | 48.8 % | 0.031 |
| Severe | 0 | 1 | 9 | 3 | 13 | 15.5 % | |

## DISCUSSION

In the present study conducted in a tertiary care center in Uttarakhand, the most affected age group was 46–60 years (41.7%), with a predominance of type 2 diabetes mellitus (82.1%). These findings are consistent with the study by Singh et al. (2019) from PGIMER, Chandigarh, where 74.6% of DKA cases occurred in type 2 diabetics, and the mean age was 45.2 ± 11.6 years, indicating a shift of DKA burden toward middle-aged adults with type 2 diabetes rather than the traditionally associated type 1 population.[13]


ISSN (O): 2687-5365; ISSN (P): 2753-6556

Similarly, Mahesh et al. (2017) in Bengaluru reported that 70% of their DKA cohort comprised type 2 diabetics, with a majority in the 41–60 year age bracket.[15] This demographic pattern could be attributed to the rising prevalence of type 2 diabetes, poor adherence to therapy, and lack of structured education programs in adult diabetics, particularly in semi-urban and rural Indian regions. Moreover, the increasing use of SGLT2 inhibitors in type 2 diabetes has been reported as a potential contributing factor to euglycemic or atypical DKA presentations, though such pharmacological triggers were not dominant in our population.

Infection was identified as a precipitating factor in 48.8% of patients in our study (including pneumonia, urinary tract infections, and tuberculosis), while poor compliance with insulin or oral hypoglycemics accounted for 38.1%. These patterns closely align with the observations of Kiran et al. (2022) from PGIMER, Chandigarh, where infections accounted for 52.7% and non-compliance for 33.1% of DKA cases during the COVID-19 pandemic period.[14] A comparable profile was reported by Seth et al. (2015) in Ludhiana, where infection was implicated in 46% of cases and treatment omission in 36%.[10] The similarity across regions suggests that systemic barriers—such as limited access to medical care, low health literacy, and inadequate infection control practices—may be consistent contributors to DKA episodes in North India. Notably, tuberculosis was a precipitant in 10.7% of our cases, mirroring the 9.2% reported by Mahesh et al. (2017) in South India,[15] reinforcing the endemic burden of TB as a distinct risk in Indian diabetics. These findings highlight a pressing need for integrated diabetes and infection surveillance programs to prevent acute metabolic decompensation.

In our study, moderate DKA was the most prevalent severity category based on arterial pH (56.0%) and bicarbonate levels (41.7%), followed by severe DKA in 22.6% (pH-based) and 39.3% ($HCO_3^-$-based). These proportions are comparable to the findings by Saroch et al. (2019) at a North Indian tertiary center, where moderate DKA constituted 51.7%, and severe DKA 29.3% based on pH criteria.[13] Similarly, Mahesh et al. (2017) in Bengaluru reported 54% moderate and 32% severe DKA cases using ADA criteria.[15] The consistency in severity distribution suggests that most patients present with significant metabolic derangement but still within a salvageable window, possibly due to the increasing awareness of DKA symptoms and earlier hospital access. However, differences in classification between pH and bicarbonate—as observed in our study—highlight the importance of using both biochemical markers for accurate grading. Furthermore, the high prevalence of moderate to severe DKA underscores a gap in early detection and outpatient intervention, necessitating proactive follow-up systems for high-risk patients.

The mean HbA1c level in our study population was $10.4 \pm 1.5\%$, indicating chronically poor glycemic control, and there was a statistically significant association between DKA severity and HbA1c ($p = 0.031$). This finding aligns with the results reported by Agarwal et al. (2016) in Lucknow, where the mean HbA1c among DKA patients was 10.1%, and those with severe DKA had significantly higher HbA1c values compared to mild cases.[19] Similarly, Pannu et al. (2023) from North India found that patients with HbA1c >10% were more likely to present with severe DKA and required longer hospitalization.[21] These patterns confirm that suboptimal long-term glycemic control not only predisposes patients to DKA but also increases its severity. The elevated HbA1c values across multiple regional studies reflect a shared challenge in maintaining sustained glycemic control in Indian diabetics—likely due to irregular follow-up, limited access to HbA1c testing in peripheral centers, and low adherence to lifestyle modifications or pharmacologic regimens. These insights reinforce the utility of HbA1c as both a predictive and prognostic biomarker in DKA management protocols.

In terms of outcomes, the majority of patients in our study recovered with standard DKA management, and in-hospital mortality was low, consistent with trends observed in other Indian tertiary centers. For instance, Kumar et al. (2024) in a prospective study in northern India reported a recovery rate of 93% and a mortality rate of 4.2%, which parallels our institution's findings despite variations in sample size and geographic setting.[11] Similarly, Gupta et al. (2017) from Vellore noted that 89% of DKA patients had favorable outcomes with protocol-driven management, and mortality was largely limited to those with late presentation or comorbid infections.[20] The low mortality across these studies underscores the effectiveness of timely hospital-based intervention protocols, including fluid resuscitation, insulin infusion, and electrolyte monitoring. However, recovery does not negate the high healthcare burden of DKA hospitalizations, particularly in low-resource settings like Uttarakhand. Recurrent episodes can strain tertiary care services, emphasizing the need for primary prevention through structured outpatient education, early infection detection, and continuity of diabetes care.

## CONCLUSION

This study demonstrates that diabetic ketoacidosis (DKA) in the Kumaon region of Uttarakhand primarily affects middle-aged adults with type 2 diabetes mellitus, with infection and poor treatment adherence emerging as the leading precipitating factors. Most cases presented with moderate severity and exhibited poor chronic glycemic control, as reflected by elevated HbA1c levels. Despite the severity at presentation, the majority of patients responded well to standard inpatient management protocols, with low in-hospital mortality. These


ISSN (O): 2687-5365; ISSN (P): 2753-6556

findings emphasize the critical importance of strengthening outpatient diabetes care, especially in semi-urban and rural populations, through targeted education, early infection control, and adherence monitoring to reduce the burden of preventable DKA episodes.

**Limitations:** This study is limited by its single-center design and relatively small sample size, which may affect the generalizability of the findings. The lack of long-term follow-up prevented assessment of recurrence, and reliance on self-reported medication adherence may have introduced reporting bias.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556