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Original Research Article

A Study of Clinicobiochemical Profile and Outcome of Patients with Diabetic Ketoacidosis Admitted to a Tertiary Care Centre

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Abstract:

Background: Diabetic ketoacidosis (DKA) is a serious acute complication of diabetes mellitus (DM) associated with significant morbidity and mortality. The current research aims at evaluating the clinical profile, precipitating factors and outcomes of DKA patients who are admitted to a tertiary care center.

Methods: A prospective observational study was conducted on 33 DKA patients. Data on demographic characteristics, clinical features, precipitating factors, biochemical parameters, and outcomes were collected and analyzed.

Results: The average age of the patients was 44.7±14.3 years, with a male predominance (57.6%). Type 2 diabetes (T2DM) was more common (75.8%) than type 1 diabetes (T1DM)(24.2%). The symptoms that presented most frequently were nausea/vomiting (66.7%), abdominal pain (45.5%), along with weakness (36.4%). Infections (57.6%) and noncompliance to treatment (45.5%) were the most common precipitating factors. The average blood glucose at admission was significantly greater in patients with T1DM than in T2DM (512.4±98.6mg/dl VS. 442.8±112.3mg/dl, p=0.041). The in-hospital mortality rate was 6.1%.

Conclusion: DKA is a dangerous complication of diabetes with a varied clinical presentation. Infections and non-compliance to treatment are the most common precipitating factors. To lower the morbidity and death rates linked to DKA, early diagnosis, prompt treatment, and patient education are essential.

Keywords: Diabetic Ketoacidosis, Clinical Profile, Precipitating Factors, Outcomes, Tertiary Care Center.

Introduction

DKA is a severe acute metabolic emergency of DM that is associated with elevated ketone bodies, metabolic acidosis, and hyperglycemia [1]. It is caused by a rise in catecholamines, growth hormone, cortisol, and other counter-regulatory hormones; additionally, there may be a relative or total lack of insulin [2]. Although type 1 diabetes (T1DM) patients are frequently affected by DKA, it can occur in type 2 diabetes patients (T2DM) in the background of a precipitating factor [3].

The occurrence of DKA varies worldwide, with estimates between 4.6 and 8 episodes for every 1,000 patient-years in Europe and North America [4]. In emerging economies, the frequency is also increasing, with reported rates of up to 25.9 episodes for every 1,000 patient-years [5]. Mortality rates associated with DKA have declined significantly in advanced countries, from 7.96% to 0.67% over the past two decades [6]. However, in developing countries, mortality rates remain high, ranging from 2.5% to 13.4% [7]. Several factors can precipitate DKA, including infections, not being compliant with insulin therapy, newly diagnosed diabetes, comorbidities like cardiovascular diseases, renal disorders, and stressors like cerebrovascular accidents, myocardial infarction, and post-operative stress [8]. Infections, particularly pneumonia and urinary tract infections, account for about 30-50% of DKA cases [9]. Non-adherence to insulin therapy, either due to socioeconomic factors or psychological reasons, is another significant precipitating factor [10].

A complicated relationship of hormonal & metabolic disturbances is part of the pathophysiology of the condition. Excessive glycogenolysis, gluconeogenesis, and insufficient glucose consumption by peripheral tissues are the results of insulin deficiency [11]. Simultaneously, the rise in counter-regulatory hormones further exacerbates hyperglycemia and promotes lipolysis and ketogenesis [12]. The resulting hyperglycemia and ketoacidosis cause dehydration, osmotic diuresis, as well as electrolyte imbalances [13]. Clinical presentation of DKA includes polyuria,

nausea, polydipsia, abdominal pain, vomiting, and altered sensorium [14]. A physical examination may identify Kussmaul's breathing, tachycardia, hypotension, and signs of dehydration [15]. The existence of hyperglycemia ("blood glucose >250mg/dL), acidosis (pH<7.3 or a serum bicarbonate level <18mEq/L), and ketosis (ketonemia or ketonuria") is used to diagnose DKA. [16].

Prompt correction of electrolyte imbalances, and hyperglycemia, alongside dehydration, is necessary for the management of DKA. Additionally, the precipitating factors must be identified and treated. [17]. Intravenous fluid resuscitation is the cornerstone for managing DKA, with the restoration of intravascular volume & improving tissue perfusion as its primary objective [18]. Insulin therapy is initiated to suppress ketogenesis and promote glucose utilization [19]. Electrolyte imbalances, particularly hypokalemia and hypophosphatemia, are common in DKA and require close monitoring and correction [20].

DKA continues to be a major cause of morbidity and death despite advancements in knowledge and treatment, especially in developing nations [21]. Factors causing poor outcomes in DKA are- older age, severity of acidosis, comorbidities, and delayed diagnosis and treatment [22]. In order to improve patient outcomes, early identification and timely commencement of suitable treatment are essential [23].

Aims and Objectives

The research aims to assess the clinical profile, estimate the parameters related to biochemistry, and analyze DKA patients' treatment results. The specific objectives are:

1. To evaluate the clinical profile of DKA patients
2. To estimate the biochemical parameters in DKA patients.
3. To assess the treatment outcome in DKA patients.

Materials and Methods

Study Design and Setting: From June 2023 to December 2023, an observational prospective study was conducted at Victoria Hospital, Bangalore Medical College and Research Institute (BMCRI), Bangalore, India. The Department of Internal Medicine conducted the study.

Sample Size: The nMaster software, version 2.0, was used to estimate the sample size. Using the formula for the sample size for a single proportion, the estimated sample size was determined to be 33 subjects with an alpha of 0.05 (2-sided), an accuracy level of 15%, and an expected proportion of 0.7333.

Inclusion and Exclusion Criteria: The study involved individuals over the age of 18 who satisfied the diagnostic requirements for DKA (ketoneuria or ketonemia, "blood glucose > 250 mg/dl, arterial pH <7.3, serum bicarbonate < 18 mEq/l) and" had been instructed to give informed written consent. Patients below 18 years of age, those unwilling to provide informed written consent, and those with hyperglycemia without acidosis were excluded from the study.

Data Collection and Methodology: Patients meeting the inclusion criteria were invited to take part in the research after receiving informed consent and approval from the institutional ethics committee. Investigations were performed, and data were collected as per the study proforma. The etiology, clinical features, biochemical parameters, along outcomes of DKA patients were studied in detail. ABG and routine investigations were performed with standard aseptic precautions, and their role in determining etiology, clinico-biochemical features, and outcomes was studied.

Outcome Measures: In-hospital mortality served as the main outcome measure. Recovery was defined in terms of resolution of acidosis: bicarbonate >18mEq/L, pH >7.30,normalization of anion gap (8-12mEq/L), and blood glucose less than 200mg/dl.

Statistical Analysis: Microsoft Excel was used for data collection, and SPSS (Statistical Package for Social Sciences) version 29.0 has been employed for analysis. While the standard deviation and mean were utilized for continuous variables, statistical methods like frequency analysis or percentage analysis were used for categorical variables. The chi-square test or Fisher's exact test had been employed to determine the association of significance in categorical data. A probability value of 0.05 was considered as the significance level. Data were presented in the form of tables, figures, and graphs wherever necessary. Based on the distribution of the data, any additional required tests that were deemed appropriate were addressed at the point of analysis.

Results

33 patients with DKA had been involved in the study. Table 1 displays the patients' demographic information. The patients' average age was 44.7±14.3 years, and the majority (33.3%) belonged to the 31–45 age group. It showed a slight male predominance with 19 (57.6%) male patients compared to 14 (42.4%) female patients. Among the patients, 8 (24.2%) had type 1 diabetes, while 25 (75.8%) had type 2 diabetes. The clinical profile of DKA patients is summarized in Table 2 and Table 3. The most frequently presenting symptoms had been nausea/vomiting (66.7%), fever(63.63%), abdominal pain (45.5%), easy fatiguability

(36.4%), altered sensorium(30.30%) and polyuria (27.3%).Among symptoms related to precipitating events, cough was most common(30.30%) followed by burning micturition(18.18%),loose stools(9.09%), diabetic foot(6.06%).On physical examination, tachycardia was seen in 25(84.8%), tachypnea in 25(75.75%) , Kussmaul type of breathing in 7(21.2%) and hypotension in 8(24.2%).24(72.7%) patients were dehydrated. Table 4 presents the precipitating factors of DKA in the study population. Infections were the most common precipitating factor, found in 28(84.84%) patients. The infections precipitating DKA are shown in Table 5.Pneumonia was the most typical infection in 10(33.33%) patients followed by urinary tract infection (pyelonephritis) in 5(16.67%) patients and acute gastroenteritis in 3(10%). 2(6.67%) patients had Diabetic foot. 2(6.67%) patients had Pulmonary tuberculosis. Mixed infections (pneumonia and pyelonephritis) were seen in 2(6.67%) patients. Noncompliance to treatment was the second most common factor, observed in 15 (45.5%) patients. Stressful conditions were noted in 5(16.67%) patients. Among them, 2 (6.67%) had a myocardial infarction, 2 had a stroke (6.67%), and 1(3.33%) patient had undergone surgery (cholecystectomy). 4 (12.12%) patients had DKA as their initial presentation. It is noteworthy that certain patients experienced more than one precipitating factor.

The biochemical parameters are demonstrated in Table 6. The mean blood glucose at admission was 512.4±98.6mg/dl in patients with T1DM and 442.8±112.3mg/dl in patients with T2DM. The mean serum potassium level was 4.7±0.8mEq/l, while the average arterial pH and bicarbonate levels were 7.12±0.11 and 8.4±3.2mEq/l, accordingly. The treatment characteristics and patients' outcomes are presented in Table 7. The average fluid requirement on Day 1 of therapy was 4.2±1.1L. The in-hospital mortality rate was 6.1%, with 2 patients succumbing to the complications of DKA.

Statistical analysis revealed that the difference in mean blood glucose at admission between T1DM and T2DM patients was statistically important (p=0.041). But, the connection between age and in-hospital mortality was not statistically significant (p=0.627).

Table 1: Demographic characteristics of DKA patients (n=33)

Characteristic	Number (%)
Age (years)	
18-30	6 (18.2%)
31-45	11 (33.3%)
46-60	10 (30.3%)
>60	6 (18.2%)
Mean age ± SD	44.7±14.3
Gender	
M	19 (57.6%)
F	14 (42.4%)
Type of diabetes	
T1DM	8 (24.2%)
T2DM	25 (75.8%)

Table 2: Symptom profile of DKA patients (n=33)

Clinical feature	Number (%)
Presenting symptoms	
Nausea/vomiting	22 (66.7)
Abdominal pain	15 (45.5)
Easy fatiguability	12 (36.4)
Polyuria/polydipsia	9 (27.3)
Fever	21(63.63)
Cough	10(30.30)
Burning micturition	6(18.18)
Loose stools	3(9.09)
Diabetic foot	2(6.06)
Altered sensorium	10(30.30)

Table 3: Physical examination in DKA patients (n=33)

Physical Examination	Number (%)
Tachycardia	28(84.84%)
Tachypnoea	25(75.75%)

Hypotension	8(24.2%)
Dehydration	24(72.7%)
Kussmaul breathing	7 (21.2%)

Table 4: Precipitating factors of DKA (n=33)

Precipitating factor	Number (%)
Infections	28(81.84)
Non-compliance to treatment	15 (45.5)
Stress	5(16.67)
The first presentation of diabetes	4 (12.12)

*Note: Some patients showed more than 1 precipitating factor.

Table 5: Infections in patients with DKA (n=33)

Infection	Numbers of Patients	Percentage (%)
Pneumonia	10	33.33
Pulmonary Tuberculosis	2	6.67
Urinary Tract Infection	5	16.67
Acute Gastroenteritis	3	10
Diabetic Foot	2	6.67
Mixed	2	6.67

Table 6: Biochemical parameters in patients with diabetic ketoacidosis (n=33)

Parameter	Mean ± SD
Blood glucose at admission (mg/dl)	
T1DM	512.4±98.6
T2DM	442.8±112.3
Serum potassium (mEq/l)	4.7±0.8
Arterial pH	7.12±0.11
Bicarbonate level (mEq/l)	8.4±3.2

Table 7: Treatment characteristics and outcomes (n=33)

Characteristic	Value
Fluid needs on day one of therapy (L)	4.2 ± 1.1
Hospital mortality, n (%)	2(6.06%)

Discussion

The current study sets at evaluating the clinical features, triggering variables, along with the prognosis of DKA patients who had been admitted to a tertiary care facility. 33 patients were included in the study. They had an average age 44.7±14.3 years & a male predominance (57.6%). T2DM affected 75.8% of the patients, which is in line with recent research findings [24, 25]. Barski et al. reported that out of 201 DKA patients, 64.7% had T2D [24]. Similarly, Newton and Raskin found that 21.7% of DKA admissions were due to type 2 diabetes [25].

The symptoms that present most frequently in our study were Nausea/vomiting (66.7%), abdominal pain (45.5%), and easy fatiguability (36.4%). These findings are in line with previous studies [26,27]. Munro et al. discovered that nausea and vomiting were experienced by 86% of patients with DKA [27], whereas according to Umpierrez et al., 46% of DKA patients had abdominal pain [26]. DKA was most often caused by infections in our study (81.81%), followed by noncompliance to treatment (45.5%). This is in line with what earlier research has shown. [28,29]. Umpierrez et al. reported that infections were responsible for 30-50% of DKA cases [28], while Randall et al. found that not following insulin instructions was a major cause of DKA in minority patients in urban areas ($p<0.001$) [29].

The average blood glucose at admission was greater in patients with T1DM (512.4±98.6mg/dl) than in T2DM (442.8±112.3mg/dl), & this difference was considered statistically important ($p=0.041$). This discovery is constant with the findings of a research by Barski et al., that reported a mean blood glucose of 531±149mg/dl in T1D patients and 442±142mg/dl in T2D patients ($p<0.001$) [24].

The in-hospital mortality rate in our investigation was 6.1%, which is comparable to the mortality rates reported in recent studies [30,31]. Venkatesh et al. found an in-hospital mortality rate of 6.7% in patients with DKA [30], while Azevedo et al.

reported a mortality rate of 8.6% [31]. Our investigation, however, did not discover a statistically significant correlation between age and in-hospital mortality (p=0.627), which contrasts with the findings of Azevedo et al., who reported that age >60 years was an independent predictor of mortality (OR 4.97, 95% CI 1.35-18.36, p=0.016) [31]. This finding showcases the significance of early detection & treatment of infections in patients with DKA to improve outcomes. Gosmanov et al. also emphasized the importance of treating underlying infections in patients with DKA to reduce morbidity and mortality [32].

In a tertiary care setting, our study offers significant knowledge regarding the clinical profile, precipitating variables, as well as the outcomes of DKA patients. The findings underscore the importance of early diagnosis and management of DKA, as well as the need for patient education to prevent non-compliance to treatment and reduce the incidence of DKA.

Conclusion

In this prospective study, we evaluated the clinical profile, precipitating factors, and outcomes 33 DKA patients admitted to a tertiary care center. The majority of patients had T2DM (75.8%), and the most common presenting symptoms were nausea/vomiting (66.7%), abdominal pain (45.5%), and easy fatiguability (36.4%). The most frequent causes of DKA were infections (81.81%) and treatment noncompliance (45.5%).

The average blood glucose at admission was significantly greater in patients with T1DM than T2DM (p=0.041). 6.1% was the in-hospital death rate, which is similar to the rates found in other recent studies.

Our findings highlight the importance of early diagnosis and management of DKA, along with the need for patient education to prevent non-compliance to treatment and reduce the incidence of DKA. Healthcare providers should be vigilant in identifying and treating underlying infections in patients with DKA to improve outcomes. More research into the variables linked to morbidity and death in DKA patients will require multicenter studies with more participants in the future.

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