

# Clinical and Biochemical Characteristics of Diabetic Ketoacidosis with its Outcome in a Tertiary Care Center

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## Abstract

**Introduction:** Diabetic ketoacidosis (DKA) is a common and important acute metabolic complication of diabetes mellitus with heterogeneous clinical presentation. It is a biochemical triad of hyperglycemia, ketonemia (ketonuria), and acidosis.

**Aim:** This study aims to study the clinical features and biochemical profile in DKA patients.

**Materials and Methods:** Patients with a diagnosis of DKA, who have hyperglycemia with RBS more than 250 mg/dl, positive ketone bodies, and metabolic acidosis were included in the study. Relevant clinical parameters were assessed: Physical examination, complete hemogram, renal function tests, serum electrolytes, liver function tests, urine ketone bodies, arterial blood gas (ABG) analysis, chest X-ray, urine culture and sensitivity, ultrasonogram abdomen, etc. Patients were categorized into three groups depending on the level of ABG bicarbonate at the time of admission and outcome compared between these three groups.

**Results:** Patients with severe bicarbonate deficiency at the time of admission have a high mortality rate, require more insulin and time to clear urine ketone bodies, and their hospital stay is more than mild and moderate bicarbonate deficiency. All these patients were clinically more sick than the other two groups. All patients who expired in this study were from the severe bicarbonate deficiency group. The majority of the patients were type 2 diabetes mellitus and most of the patients recovered with treatment.

**Conclusion:** The degree of bicarbonate deficiency at the time of admission in DKA patients is an important predictor of patient outcome. Patients with severe bicarbonate deficiency at the time of admission have a higher mortality rate and require more time in case of recovery.

**Key words:** Diabetes mellitus, Hyperglycemia, Urine ketone body, Diabetic ketoacidosis, Bicarbonate deficiency, Metabolic acidosis

## INTRODUCTION

Diabetic ketoacidosis (DKA) is an acute hyperglycemic emergency that is potentially fatal if left untreated. It is diagnosed by triad hyperglycemia with plasma sugar of more than 250 mg/dl, ketosis, and metabolic acidosis. Its annual incidence is varying from one geographic area to another area.<sup>[1]</sup>

The pathophysiology behind DKA revolves around two main factors: Relatively absent insulin level and increased influence of counter-regulatory hormones. Once the body does not utilize sugar, free fatty acids will be utilized for energy with the resultant formation of ketone bodies in the blood. There are many electrolyte disturbances observed in DKA, especially hypokalemia and hyponatremia.<sup>[2]</sup>

DKA may be the initial presentation of diabetes mellitus, or it may be precipitated by various underlying factors, most commonly infection and inadequate/irregular insulin or oral anti hypoglycemic agents (OHA) use with poor control of hyperglycemia. Other precipitating factors include acute myocardial infarction, cerebrovascular diseases, and post-operative stress. For the effective

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Month of Submission : 04-2021  
Month of Peer Review : 04-2021  
Month of Acceptance : 05-2021  
Month of Publishing : 06-2021

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treatment of DKA, the identification of precipitating factors is important.<sup>[3]</sup>

It is very important to treat all the patients with DKA aggressively as time goes on, the patient will deteriorate due to multiple metabolic disturbances in the body. DKAs mainstay is dehydration, insulin replacement, electrolyte correction, and treatment for precipitating factors. The aim is to correct the fluid deficit in the first 24 h.<sup>[4]</sup>

The outcome of DKA improved in recent years due to a better understanding of the disease, early diagnosis, better investigations facilities for the identification of precipitating factors, an improved facility for treatment and monitoring of the patient, more potent antibiotics, etc.<sup>[4]</sup>

### Aim

This study aims to study the clinical features and biochemical profile in DKA patients.

## MATERIALS AND METHODS

The study was a prospective observational study conducted on 75 inpatients diagnosed with DKA at the Department of General medicine, Kanyakumari Government Medical College, from March 2019 to August 2019. Inclusion criteria: Age >13 years, patients who were known people with diabetes either admitted in general medicine department with DKA, patients with accidental detection of DKA but they are primarily admitted to the general medicine department for other diseases. Exclusion criteria: Patient's refusal to participate in the study, CKD Stage IV and V.

The subjects were enrolled in the study after obtaining informed written consent from them. In addition, ethical committee approval was obtained for the study.

Relevant clinical parameters were assessed: Physical examination, complete hemogram, renal function tests, serum electrolytes, liver function tests, urine ketone bodies, arterial blood gas (ABG) analysis, chest X-ray, urine culture and sensitivity, ultrasonogram abdomen, etc. In addition, patients were categorized into three groups depending on the level of ABG bicarbonate at the time of admission and outcome compared between these three groups.

## RESULTS

In this study, out of 75 DKA cases, 67 were from type 2 diabetes mellitus (89.3%) and 8 were from type 1 diabetes mellitus (10.7%). Out of 75 patients, 48 patients are male (64%) and 27 patients are female (36%). The maximum

number of cases were observed in the age group of 41–50 years. The minimum duration of diabetes in DKA patients was 6 months and the maximum duration is 21 years. Twenty-nine patients (38.6) were diabetic for 2–5 years and 13 patients were diabetic for <1 year duration. It is observed that the maximum number of patients was on OHAs alone, which comprised 32 patients (42.6%) [Table 1]. Most of the patients had a precipitating factor, either an infection or inadequate treatment. Twenty-one patients (28%) gave a history of inadequate treatment. The most common infections which precipitated DKA were urinary tract infections (20%) and pneumonia (18.66%) [Table 2]. The most common symptoms observed in DKA patients in this study were abdominal pain and vomiting [Table 3]. The maximum number of patients were drowsy at the time of admission [Table 4]. The maximum number of patients in this study had a random blood sugar value at admission between 351 and 400.

Here, we divided the patients into three groups depending on the level of bicarbonate deficiency. The maximum number of patients included under mild bicarbonate deficiency constitutes 40% of total patients. On the other hand, 23% of patients had severe bicarbonate deficiency and 37% had moderate bicarbonate deficiency [Table 5].

When comparing the doses of insulin required to clear ketone bodies from urine, it is shown that more amount of insulin is needed in a group of patients with severe bicarbonate deficiency ( $P < 0.0001$ ).

The maximum number of patients took 49–72 h of insulin infusion to clear urine ketone bodies. It is 24 patients out of 70 patients (34.3%) who recovered from DKA. The least number of patients, 5 patients (7.1%), took <12 h to clear DKA.

This study observed that the maximum number of patients staying in the hospital for complete treatment is 6–9 days. This group involves 30 patients (42.9% of recovered).

On analyzing, all patients who needed more than 150 units of insulin to clear UKB were from severe bicarbonate deficiency group ( $P < 0.0001$ ).

It is observed that the total duration of insulin infusion has a significant relationship with the severity of bicarbonate deficiency. For example, nine out of 12 patients with severe bicarbonate deficiency took more than 72 h of an insulin infusion for UKB clearance, which constitutes 75% of severe bicarbonate deficiency patients and 100% of patients who needed more than 72 h insulin infusion. ( $P < 0.0001$ )

It is observed that the total duration of hospital stay has a significant relationship with the severity of bicarbonate

deficiency. It is clear from the study that patients admitted for a total mean duration of 8.77, 11.04, and 14.92 days in the mild, moderate, and severe bicarbonate deficiency group ( $P < 0.0001$ ) [Table 6].

Most of the patients in this study survived DKA. Out of 75 patients, 70 patients (93.3) recovered, and 5 patients (6.7%) expired in this study group [Table 7].

**Table 1: Patient characteristics**

Patient characteristics	Frequency	Percentage
DM		
T1DM	8	10.7
T2DM	67	89.3
Gender		
M	48	64.0
F	27	36.0
Age group		
<30	6	8.0
31–40	13	17.3
41–50	24	32.0
51–60	21	28.0
>61	11	14.7
Duration of diabetes		
<1	13	17.3
2–5	29	38.7
6–10	19	25.3
>11	14	18.7
Treatment		
OHA	32	42.7
I	22	29.3
I+OHA	15	20.0
NIL	6	8.0

**Table 2: Precipitating factors**

Precipitating factor	Frequency	Percentage
Age	1	1.3
Pancreatitis	2	2.7
CNS infection	3	4.0
CVA	8	10.7
Diabetic foot	4	5.3
Gluteal abscess	1	1.3
Inadequate Rx	21	28.0
Lung abscess	1	1.3
New DM	3	4.0
Perianal abscess	2	2.7
Pneumonia	14	18.7
UTI	15	20.0

UTI: Urinary tract infection, CVA: Cerebrovascular accident, CNS: Central nervous system

**Table 3: Clinical features**

Clinical features	Frequency	Percentage
Fever	34	45.3
Abdominal pain	47	62.7
Polyuria	35	46.7
Vomiting	49	65.3
Lethargy	42	56.0
Breathlessness	38	50.7

In this study, the patients who expired were from the severe bicarbonate deficiency group. When we go through the different features of these patients, at the time of admission of patients who survived and died, it is shown that “p value” of bicarbonate deficiency and high PCO<sub>2</sub> is statistically significant ( $P < 0.0001$ ).

## DISCUSSION

DKA is one of the important complications of diabetes mellitus. Because of modern lifestyle and eating habits, diabetes mellitus prevalence increased rapidly in recent years and hence cases of DKA are also increasing. Timely diagnosis and adequate treatment with special emphasis on precipitating factors are the mainstays in the management of DKA. Failure of adequate early treatment may cause the death of the patient. Better understandings of disease pathophysiology and good health-care system including facility for insulin infusion, sensitive antibiotics, and availability of investigations including ABG improved the patient's outcome.<sup>[4]</sup>

Faich *et al.* and Kreisberg *et al.* studies reported that the mean age of patients admitted for DKA was between 40 and 50 years.<sup>[5,6]</sup> Beigelman *et al.* study reported 47 years as the mean age of presentation for DKA.<sup>[7]</sup>

In this study, vomiting and abdominal pain were the most common and polyuria was the least common presentation

**Table 4: Mental status**

Mental status	Frequency	Percentage
Conscious	26	34.7
Drowsy	39	52.0
Stupor	10	13.3

**Table 5: HCO<sub>3</sub> deficiency**

HCO <sub>3</sub> deficiency	Frequency	Percentage
Mild	30	40.0
Moderate	28	37.3
Severe	17	22.7

**Table 6: Duration of hospital stay**

Duration of hospital stay	Frequency	Percentage
6–9 days	30	42.9
10–12 days	28	40.0
More than 13 days	12	17.1

**Table 7: Outcome of patients**

Outcome	Frequency	Percent
Expired	5	6.7
Survived	70	93.3

at admission. Most of the patients were drowsy at the time of admission.

With regard to presenting complaints, one study found that most patients had a history of vomiting for at least 1 day (74%), and 69% of the patients had abdominal pain.<sup>[8]</sup> Another study found vomiting to be a complaint in 64.7% of admissions.<sup>[9]</sup> These findings are in agreement with our results. Gastrointestinal manifestations, including abdominal pain, are common in patients with DKA.<sup>[10]</sup>

In our study, many patients had more than 1 precipitating factor, like patients who were non-compliant to treatment also had an infection and associated stressful situations such as acute myocardial infarction, cerebrovascular accident, and post-operative stress. Thus, non-compliance to treatment is an important precipitating factor that indicates that the prevalence of DKA can be reduced by proper education of patients about their illness and harm of non-compliance. Welch *et al.* did a case study on patients with type 2 diabetes presenting with DKA and found that some precipitating factor is required in type 2 diabetic patient to land up in DKA as similar to our study.<sup>[11]</sup>

The overall mortality in our study was 6.7% which is quite similar to other studies. Westphal found a mortality rate of 5.1%<sup>[12]</sup>, while Beigelman and Faich *et al.* found a mortality rate of 9%.<sup>[5,7]</sup> Adhikari *et al.* found mortality of 16.3% and Matoo *et al.* study showed mortality of 23.7%.<sup>[12,13]</sup> Estimated mortality rate for DKA is between 4 and 10% which showed by Chaisson *et al.*<sup>[14]</sup>

## CONCLUSION

From this, it is concluded that the degree of bicarbonate deficiency at the time of admission in DKA patients is an important predictor of patient outcome. Patients with severe bicarbonate deficiency at the time of admission have

a higher mortality rate. Patients with severe bicarbonate deficiency (<10 meq/L) at the time of admission required a higher dose and duration of insulin infusion. They stayed in the hospital longer duration than patients with mild and moderate bicarbonate deficiency in case of recovery. Clinical features and biochemical parameters also were more severe in those patients with severe bicarbonate deficiency. The incidence of DKA is increasing in type 2 diabetes mellitus. The majority of the patients responded well to the standard treatment of DKA.

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**How to cite this article:** Sankar S, Madhavan S, Sadik A. Clinical and Biochemical Characteristics of Diabetic Ketoacidosis with its Outcome in a Tertiary Care Center. *Int J Sci Stud* 2021;9(3):61-64.

**Source of Support:** Nil, **Conflicts of Interest:** None declared.