International Journal of Research in Medical Sciences
Jansari TR et al. Int J Res Med Sci. 2023 Mar;11(3):900-904
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20230571

Original Research Article

Spectrum of clinical and biochemical profile and its importance in diabetic ketoacidosis: a tertiary care hospital experience in Gujarat

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Received: 10 February 2023
Revised: 19 February 2023
Accepted: 20 February 2023

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ABSTRACT

Background: Diabetes mellitus (DM) is a disorder of multiple etiologies, and diabetic ketoacidosis (DKA) is one of the life-threatening complications of DM. This study was aimed to study the clinical and biochemical profile of DKA patients.
Methods: We conducted this retrospective study at a tertiary care hospital in Gujarat. We included total 100 patients above the age of 18 years having DM, presented with DKA. A detailed history, clinical examination and biochemical tests were carried out: random blood sugar, urinalysis, arterial blood gas analysis, serum ketone, HbA1c, serum creatinine, serum electrolytes- potassium and sodium and serum osmolality. The results were analysed using Microsoft excel.
Results: Out of total 100 patients, 76 (76%) patients had type 1 DM and 24 (24%) had type 2 DM, 42 (42%) were in the age group of 18-30 years. The mean age was 39.75±12.14 years. There were 56 (56%) males and 44 (44%) females with male: female ratio of 1.3:1. Most common clinical features of DKA were nausea/vomiting (88%), breathlessness (43%) and fever (35%). The main biochemical parameters altered were blood sugar (>400 mg/dl in 41%) and serum ketones (≥5 in 84%) as well as majority of patients (64%) had their HbA1c level between 11-15% with the mean HbA1c value of 12.25±2.43%.
Conclusions: DKA is a frequently observed emergency with high mortality rate. Education regarding symptoms of ketoacidosis, not missing insulin doses especially during illness, strict adherence to treatment and lifestyle modifications can greatly reduce DKA occurrence.

Keywords: Diabetes mellitus, Diabetic ketoacidosis, Hyperglycemia, Lipolysis

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder of multiple etiologies, characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both. Diabetes is considered the fifth leading cause of death, and it is a leading cause of morbidity and mortality in the developed world, as well as in many developing countries. Diabetes prevalence (in adults) is reported to be 31% in India.[1]

Diabetic ketoacidosis (DKA) is one of the life-threatening acute complications of diabetes mellitus (DM) that mainly occurs in type 1 diabetes patients, as well as in some patients with type 2 diabetes. DKA is characterized by hyperglycemia, ketoacidosis, and ketonuria.[1-3] The true annual incidence rate for DKA is difficult to establish, but population-based studies have reported ranges from 4.6 to 8 cases per 1,000 patients with diabetes.[4,5] Most cases of DKA arise due to missed insulin doses, either as a result of negligence or poor socioeconomic status.[6] Other precipitators of DKA include infections, cerebrovascular accidents, alcohol/drug abuse, pancreatitis, myocardial

infarction, trauma and medicines that affect carbohydrate metabolism.[7] Mortality due to DKA is, 5% according to the American Diabetes Association (ADA).[8,9] It is important that patients with DKA are detected earlier and get medical help as soon as possible.[7]

This study was aimed to study the clinical and biochemical profile of DKA patients, and the information that collected, can be used for prevention, early recognition and better care of DKA in diabetic patients.

METHODS

Study type

This was a retrospective, cross-sectional and observational study.

Study place

The present study was conducted at a tertiary care hospital (SBKS MI&RC) in Gujarat.

Study period

Total 100 patients admitted with diabetic ketoacidosis from August 2021 to July 2022 were enrolled for the study.

Selection criteria

Total 100 patients above 18 years of age with type 1 and type 2 DM who presented with DKA were included in the study.

Study procedure

A detailed history, thorough clinical examination and following biochemical tests were carried out in all patients: random blood sugar (RBS), urinalysis, arterial blood gas (ABG) analysis, serum ketone, HbA1c, serum creatinine, serum electrolytes- potassium and sodium and serum osmolality.

Ethical approval

Ethical approval was taken from the Institutional Ethics Committee.

Statistical analysis

The results were plotted in tabulated and graphical format and the analysis was done using statistical package for the social sciences (SPSS) software and Microsoft excel.

RESULTS

Total 100 patients above the age of 18 years with type 1 and type 2 DM who presented with DKA were included in the present retrospective cross-sectional observational study. Out of total 100 patients, 76 (76%) patients had type 1 DM and 24 (24%) patients had type 2 DM (Figure 1).

The study showed highest numbers of patients 42 (42%) were in the age group of 18-30 years with the mean age of 39.75±12.14 years (Table 1).

Table 1: Age-wise distribution.

Age (years)	No. of patients (n=100) (%)
18-30	42 (42)
31-40	19 (19)
41-50	13 (13)
51-60	14 (14)
>60	12 (12)
Total	100 (100)

In the present study, 56 (56%) were males and 44 (44%) were females with male: female ratio of 1.3:1 (Table 2). In our study, the main clinical features of DKA were nausea/vomiting (88%), breathlessness (43%) and fever (35%) (Table 3).

Table 2: Gender distribution.

Gender	No. of patients (%)	Type 1 DM (%)	Type 2 DM (%)
Male	56 (56)	42 (75)	14 (25)
Female	44 (44)	34 (77)	10 (23)
Total	100	76	24

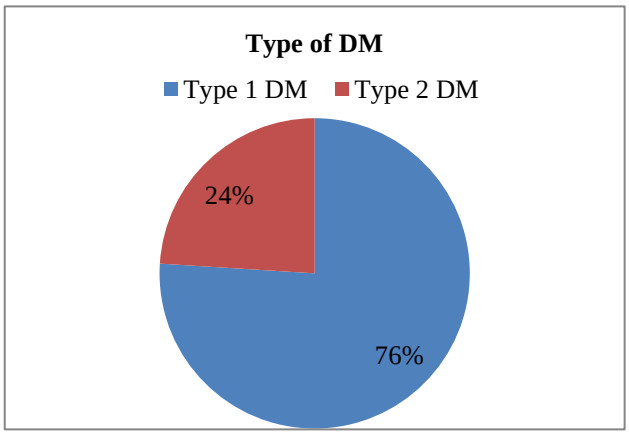

Figure 1: Type of diabetes mellitus.

Table 3: Clinical presentation.

Clinical presentation	No. of patients (n=100) (%)
Nausea/vomiting	88 (88)
Breathlessness	43 (43)
Fever	35 (35)
Abdominal pain	21 (21)
Altered sensorium	15 (15)
Hypotension	10 (10)
Weakness	8 (8)

The study showed that the majority of patients (64%) had their HbA1c level between 11-15% with the mean HbA1c value of 12.25±2.43% (Figure 2). All the biochemical parameters of our study are as shown in the Table 4.

Table 4: Biochemical parameters.

Parameter and value	No. of patients (n=100)	Percentage (%)
Blood sugar (mg/dl)		
<200	2	2
201-300	22	22
301-400	35	35
>400	41	41
Serum creatinine (mg/dl)		
≤1.2	46	46
>1.2	54	54
Arterial pH		
<7.0	18	18
7.00-7.24	63	63
7.25-7.30	19	19
Serum sodium (mEq/l)		
<120	3	3
121-135	67	67
136-145	28	28
>146	2	2
Serum potassium (mEq/l)		
<3.5	22	22
3.6-5.0	65	65
>5.0	13	13
Arterial bicarbonate (mEq/l)		
<10	34	34
11-15	22	22
>15	44	44
Serum osmolality (mOsm/kg)		
<320	76	76
≥320	24	24
Serum ketone (mEq/l)		
<5	16	16
≥5	84	84

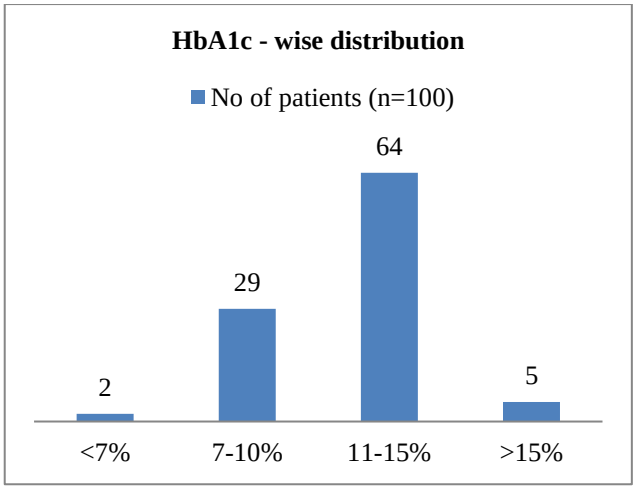

Figure 2: HbA1c wise distribution.

Table 5: Diagnostic criteria for diabetic ketoacidosis.

Parameters	DKA		
	Mild	**Mode-rate**	**Severe**
Plasma glucose (mg/dl)	>250	>250	>250
Arterial pH	7.25–7.30	7.00–7.24	<7.00
Serum bicarbonate (mEq/l)	15–18	10 to <15	<10
Urine ketones	Positive	Positi-ve	Positi-ve
Serum ketones	Positive	Positi-ve	Positi-ve
Effective serum osmolality (mOsm/kg)	Variable	Variab-le	Varia-ble
Anion gap	>10	>12	>12
Alteration in sensorium or mental obtundation	Alert	Alert/ drowsy	Alert/stupor/ coma

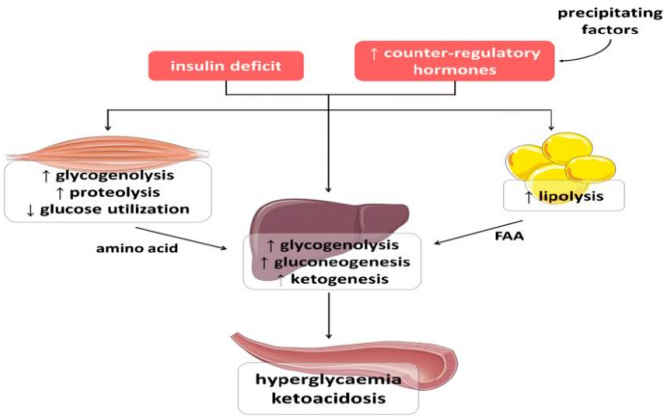

Figure 3: Pathophysiology of DKA.

Table 6: Biochemical parameter study comparison.

Biochemical parameters	Present study	Singh et al[22]
Blood sugar (mg/dl)	386.41±91.2	406.8±130.4
Serum creatinine (mg/dl)	1.39±0.54	1.35±1.18
Arterial pH	7.13±0.12	7.128±0.157
S. sodium (mEq/l)	132.5±6.63	137.0±6.4
S. potassium (mEq/l)	4.2±0.69	3.9±1.0
Arterial bicarbonate (mEq/l)	12.85±5.10	8.2±5.0
S. ketone (mEq/l)	5.48±0.63	5.38±1.56

DISCUSSION

The earliest documented description of diabetes was found in a 1552 BC Egyptian papyrus.[10] In 1886, Dreschfeld provided the first description of diabetic ketoacidosis in the modern medical literature.[11] In 1971, Roger Unger described DKA as a bihormonal disorder involving insulin deficiency and glucagon excess.[12] Before the discovery of insulin by Dr. Frederick Banting in 1921, the mortality of DKA was 100%.[13,14]

The most common precipitating factor in DKA is infection, with pneumonia and urinary tract infections.[15,16] Recent studies suggest that omission of insulin or under treatment with insulin may be the most important precipitating factors.[16-18]

DKA occurs as the result of a relative or absolute insulin deficiency and an excess of insulin counter-regulatory hormones (ICRH), e.g. glucagon, catecholamines, cortisol and growth hormone, leading to hyperglycemia, osmotic diuresis and production of keton bodies. This results in metabolic acidosis with increased anion gap (Figure 3).[19]

The hyperglycemia seen in DKA results from a combination of glucose under use and overproduction. In the absence of adequate insulin, the body is unable to use or store circulating glucose, and ICRH levels increase. The glucagon becomes the primary hormone driving carbohydrate metabolism, stimulating hepatic glycogenolysis (breakdown of glycogen to glucose) and gluconeogenesis (glucose production from noncarbohydrate precursors). Hyperglycemia leads to glycosuria, osmotic diuresis, and dehydration. As a result of the osmotic diuresis, large amounts of sodium, chloride, and potassium are lost in the urine, resulting in the dehydration and electrolyte abnormalities.[13]

The combined relative insulin deficiency and ICRH excess promote the breakdown of triglycerides and the release of free fatty acids into the blood. Insulin deficiency is primarily responsible for the mobilization of free fatty acids, while the presence of glucagon is primarily responsible for accelerated fatty acid oxidation. Glucagon exerts its effects by acting on the carnitine palmitoyl transferase system of enzymes responsible for the transport of fatty acids into the mitochondria and by inhibiting conversion of acetyl CoA to malonyl CoA by acetyl CoA carboxylase.[20] Because lipogenesis is blocked, fatty acids are unable to enter the citric acid cycle and instead enter the mitochondria, where they are oxidized further to ketone bodies.[16] The major ketone bodies are acetoacetate and b- hydroxybutyrate, with acetone contributing a minor component.[19]

The general appearance of patients with DKA is one of fatigue and dehydration. The patient may be tachypneic with Kussmaul respirations as a result of volume depletion, sepsis or both. Patients may be normothermic or hypothermic despite accompanying infection. Hypothermia is caused primarily by peripheral vasodilation. A fruity odor on the patient's breath because of the exhaled acetone. Patients may have a depressed sensorium, and, in severe cases, may present comatose. The skin should be examined thoroughly for infection such as abscess, cellulitis, or decubitus ulcers. A urinalysis needs to be performed on all patients to screen for urinary tract infection. The most common complications include hypoglycemia, hypokalemia, hyperglycemia, and hyperchloremia. Less common complications include cerebral edema, fluid overload, acute respiratory distress syndrome, thromboembolism, and acute gastric dilation.[15] The diagnostic criteria for the DKA have been depicted in Table 5.[16]

In our study, out of 100 patients 76 (76%) patients had type 1 diabetes mellitus and 24 (24%) had type 2 diabetes mellitus. The study by Sreekumar et al and Singh et al also showed predominance of type 1 DM as compared to type 2 DM who presented with DKA.[21,22]

The mean age in the present study was 39.75±12.14 years which is similar to the studies done by Nazneen et al and Sankar et al.[23,24]

In our study, the main clinical features of DKA were nausea/vomiting (88%), breathlessness (43%) and fever (35%), which was similar to the study done by Singh et al.[22]

The results of all biochemical parameters of our study matched with the study done by Singh et al (Table 6).[22]

In DKA, ketoacidemia represents the effects of insulin lack at multiple enzyme level leading to increased hepatic ketogenesis. This increased level of various ketoacids like β-hydroxybutyrate, acetone and acetoacetate lead to metabolic acidosis and decreased pH.[22]

Limitations of our study was that the patients presenting late after any complication were difficult to get investigated properly and consequences could not be prevented.

CONCLUSION

DKA is a frequently observed emergency with high mortality rate amongst diabetic patients. Our study concluded that the DKA is more in type 1 DM than type 2 DM. Infections, inadequate insulin are the main precipitating factors of DKA. The complications can be prevented with proper patient education and effective communication along with efficient management.

Education of diabetic patients regarding symptoms of ketoacidosis and strict adherence to treatment is necessary for prevention, early diagnosis and treatment of DKA as well as for prevention of complications. Simple lifestyle modifications, patient education regarding not missing insulin doses especially during illness and providing the patients with an adequate insulin regimen, can greatly reduce DKA occurrence.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Jansari TR, Chauhan AP, Patel JP, Jasani JH. Spectrum of clinical and biochemical profile and its importance in diabetic ketoacidosis: a tertiary care hospital experience in Gujarat. Int J Res Med Sci 2023;11:900-4.