Medical Science

Characteristics and outcome of severe diabetic ketoacidosis in East Jeddah Hospital, Saudi Arabia

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ABSTRACT

Introduction: Diabetic ketoacidosis (DKA) is a critical situation of diabetes that mostly happens in type 1 diabetes mellitus (T1DM) patients. *Objective*: This study aims to analyze the clinical, biochemical characteristics as well as outcome of admitted patients with severe DKA. *Methods*: this is a retrospective observational study carried out at secondary hospital at Jeddah, Saudi Arabia period between July 2018 and July 2019. We included both genders older than 14 years with confirmed diagnosis of DKA. *Results*: In the present study the majority of cases were female (71.4%). All the patient was diagnosed as TIDM and their mean duration of DM 10 ±8.032 years. Half of them admitted to ICU. The most common precipitating factors was missing insulin dose or non-compliance (78.6%) followed by infection (21.4%). All of who develop complications most documented complication finds to be retinopathy (40%), nephropathy (20%), and neuropathy (40%). The most initial clinical presentation was abdominal pain, vomiting, and nausea. *Conclusions:* The non-compliance for insulin dose was the most precipitating factor in DKA, an intensive efficient educational program for patient compliance should be applied. However, the outcome reflects good improvement as no reported expired cases and the mean duration for a hospital stay for DKA patients was three days that these results would seem to help the hospital in inpatient admission management.

Keywords: Diabetic ketoacidosis, Saudi Arabia, Biochemical tests, Patient's compliance, T1DM

1. INTRODUCTION

Diabetic ketoacidosis (DKA) is a critical and life-threatening situation of diabetes. It is identified by the triad of hyperglycemia, acidosis, and ketosis (Al-Bunyan et al. 2021). Definitive laboratory diagnosis of DKA are plasma glucose concentration >250 mg/dl (>13.8mmol/L), venous pH<7, Bicarbonate (HCO3) <18 mEq/L, and ketonemia and/or ketonuria (Kitabchi et al., 2009).

Globally, diabetes mellitus (DM) estimated that 426.3 million adults in 2019 have diabetes, it will increase by 38.8% by 2030 and 96.5% by 2045, the prevalence of type 1 diabetes mellitus (T1DM) in Saudi Arabia is one of the highest worldwide, with an estimated number of 27,800 cases of type 1 diabetes in 2019 (Federation, 2019). The high incidence rates of type 1 diabetes mellitus (TIDM) in children and adolescents of 31.4 per 100,000, makes Saudi Arabia the 5th country globally concerning the incidence rate (Al-Herbish et al., 2008; Cherian et al., 2010; Federation, 2019).

Diabetic ketoacidosis is classified as mild, moderate or severe, and the presence or absence of altered mental status is also linked to the episode's severity. Severe cases of DKA (pH ≤ 7.00, bicarbonate level ≤ 10.0, anion gap > 12, positive ketones, and altered mental status are commonly encountered in patients with type 1 diabetes and are thought to carry an ominous prognosis (Kitabchi et al., 2009). The reported annual incidence rate for DKA ranges from 4 to 9 cases per 1,000 patients with diabetes (FAICH et al., 1983). The classical clinical features of DKA include vomiting, abdominal pain, polyuria, polydipsia, Kussmaul's respiration, dehydration, and occasionally coma. The widespread precipitating factors in the development of DKA have missed insulin doses. Other factors include infections, mental health issues, stress, cerebrovascular accident, alcohol abuse, pancreatitis, myocardial infarction, and drugs such as corticosteroids, thiazides (Dunger et al., 2004; FAICH et al., 1983). Besides, DKA may be the first hospital admission for previously unknown diabetes.

The mortality rate in patients with DKA is reported to be less than 5%. The management of DKA has improved over the years, as evident by the decrease in the mortality rate (Efstathiou et al., 2002). Management of DKA requires intensive monitoring of patients, correction of hypovolemia, hyperglycemia, replacement of electrolyte loss, and careful search for the precipitating cause (Wallace & Matthews, 2004). Several studies have research for the characteristics of DKA patients as in the Emirate found the most risk factor was non-compliance to treatment 31.4%, followed by infections 22.7% and others (Abbas et al., 2019).

This study aims to evaluate the clinical, biochemical characteristics and clinical outcome of admitted patients with severe diabetic ketoacidosis in Jeddah, Saudi Arabia. Study the relationship between biochemical (glucose, anion gap, and serum bicarbonate) and clinical outcome parameters in patients with severe DKA.

2. METHODS

This is a retrospective observational study conducted at secondary hospital in Jeddah at East Jeddah Hospital in Saudi Arabia. East Jeddah Hospital is one of major hospitals and most advance health facilities located in western of Saudi Arabia in Jeddah city with a bed capacity 300 beds.

Saudi Arabia Ministry of Health (MOH) Institutional Review Board (IRB) approved for conducting the research with the given approval number [H-02-J-002]. A retrospective review study was done at East Jeddah Hospital in Saudi Arabia. Investigator reviewed the electronic medical files diagnosed with diabetic ketoacidosis (DKA) patient's code during the period July 2018 to July 2019. One thousand, five hundred eight outpatients who had diabetes mellitus and 67 admitted hospital patients identified by the electronic diagnostic code of DKA.

Sample size determined to be 67 by the electronic medical file department out of the 67-patient diagnosed as DKA we exclude mild to moderate DKA and studied only who fulfilled the criteria of severe DKA which yielded a total of 14 patients. Also, patients with DM who were younger than 14 years or on corticosteroids or pregnant women were excluded. The inclusion criteria include all cases confirmed diagnosis severe DKA of both genders above 14 years of age. The demographic data such as; age, gender, weight, the clinical profile including; date of DM diagnosis, their concurrent insulin regimen, presenting symptoms, precipitating factors, serum biochemical profile, the severity of DKA, duration of hospital admission, and clinical outcome has been reviewed. Also, study the relationship between biochemical as (glucose, anion gap, and serum bicarbonate) and clinical parameters in patients with severe DKA.

Data entry was performed using Microsoft Excel 2010, and statistical analysis was performed by a statistical package for the social sciences SPSS V21. Frequencies and percentages were done for categorical variables and measures of central tendency were calculated for the continuous variables.

3. RESULTS

Gender constitutes to be the most affected female (71.4%), while the male (28.6%). Saudi represents (92.9%) and the remaining (7.1%) were non-Saudi. Documented marital status to be (80%) unmarried and (20%) were married. All the patient samples were diagnosed as TIDM and their mean duration of DM 10 years (±8.032 St. Deviation). In the past year (54.5%) who had a history of previous DKA episode with a range (7-1) previous episodes and the mean of 3 episodes (±1.966 St. Deviation). The mean age was found to be 23 years (±12.580 St. Deviation). Half of them admitted to ICU and the other half in the medical ward. The most

common precipitating factors was missing insulin dose or non-compliance (78.6%) followed by infection (21.4%). All of who develop complications most documented complication finds to be retinopathy (40%), nephropathy (20%), and neuropathy (40%). The most initial clinical presentation was abdominal pain, vomiting, and nausea. Vitals signs were recorded as shows in (Table 1). Their presentations for the level of consciousness majority of them were alert shows in (Figure 1). Insulin types were used insulin Glargine, Aspart, and Glulisine shows mean doses in (Table 2).

Table 1 Vital Signs

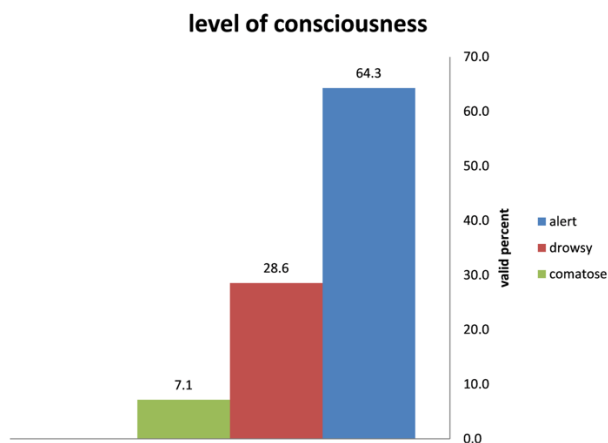| Variables	Range	Mean
PRª (beat/minute)	80 -152	118.07
SBPª (mmHg)	104 -142	119.84
DBPª (mmHg)	52 – 98	70.15
RRª (breaths/minute)	20.0 - 29.0	23.14
Temperature ª (°C)	36.0 - 37.0	36.85
BMIª (kg/m2)	13.50 - 33.00	23.18
GCSª	3 – 15	13.37
PR= pulse rate, SBP= systolic blood pressure, DBP= diastolic blood pressure, RR= respiratory rate, BMI= body mass index and GCS= Glasgow coma scale		

Figure 1 Level of consciousness

Table 2 Insulin types and Mean doses.

Basal insulin(s)			Rapid acting insulin(s)			
Glargine Percent %	Mean dose	SD	Aspart Percent %	Glulisine Percent %	Mean dose	SD
92.2	29	9.278	85.7	14.3	20	11.593
SD: St. Deviation						

The outcome was (92.9%) who improved and discharged while (7.1%) had comorbidity and no expired cases. Their mean duration for the total length of hospital stay was three days and it ranges from (7-1) days. Biochemical laboratory results are shown in (Table 3). The association biochemical parameters (glucose, anion gap, and serum bicarbonate) with clinical outcome were statically insignificant.

Table 3 Biochemical laboratory results

Variables	N=	Mean		Minimum Maximum
		Statistic	Std. Error	(Range)
WBC (103/uL)	14	17.60	1.90	6.80 – 32
HGB (gm/dl)	12	13.92	0.69	10.00 - 16.80

Platelet (103/uL)	12	399.58	47.47	234.0 – 770
RBG arterial (mg/dl)	14	523.52	53.45	295.00 – 980
PH venous	14	6.97	0.02	6.72 - 7.09
Bicarbonate (mEq/l)	14	7.15	.45	4.0 - 9.9
Urine ketone (mg/dl)	9	10.33	7.71	2.0 – 72
Potassium (mEq/l)	14	4.72	0.27	3.3 - 7.3
Chloride (mEq/l)	14	100.57	2.40	86.0 – 114
Sodium (mEq/l)	14	131.50	1.25	122.0 – 138
Urea (mg/dl)	12	14.91	2.62	7.0 – 37
Creatinine (mg/dl)	14	1.45	0.22	0.7 - 3.7
Calcium (mg/dl)	14	8.83	0.20	7.31 - 9.94
Phosphate (mg/dl)	6	26.03	21.62	1.5 – 134
Anion gap (mEq/l)	14	24.50	1.52	15.5 - 35
Plasma osmolality (mOsmol/kg)	14	300.07	6.75	275.3 – 380
AST (IU/L)	14	20.14	1.91	9.0 – 33
ALT (IU/L)	13	16.53	4.11	6.0 – 58
GGT (IU/L)	6	46.16	11.57	20.0 – 90
Alkaline phosphate (IU/L)	6	159.50	18.93	121.0 – 236
Amylase (IU/L)	7	75.14	39.45	9.0 – 309
Lipase (IU/L)	8	105.87	89.98	4.0 – 735
Albumin (g/dL)	10	4.03	0.16	3.2 - 4.7

4. DISCUSSION

Diabetic ketoacidosis (DKA) is a critical situation of diabetes that mostly happens in type 1 diabetes mellitus (T1DM) patients. The reported annual incidence rate for DKA ranges from 4 to 9 cases per 1,000 patients with diabetes (FAICH et al., 1983). Its required a good management included intensive monitoring of patients, correction of hypovolemia, hyperglycemia, replacement of electrolyte loss, and careful search for the precipitating cause (Wallace & Matthews, 2004). In the present study the aim of study to evaluate the clinical and biochemical characteristics of admitted severe DKA patients in East Jeddah Hospital. Study demographic data showed the most affected to be female rather than male similarly to data reported from previous studies was done in UAE and Ethiopia who also found the mean age to be 33 years as their result represent TIDM and T2DM, while in our research their mean age 23 years who found to be all TIDM known for younger age (Abbas et al., 2019; Alemnew & Abegaz, 2019).

Most of the recent similar previous studies in the Asian region found the most clinical presentation in DKA is to be a gastrointestinal symptom (Abbas et al., 2019; Ahuja et al., 2019; Harpreet Singh et al., 2019). Contrarily polyuria and polydipsia shown to be the most clinical presented in African country studies that may vary due to ethnicity and perhaps genetics relation (Alemnew & Abegaz, 2019; Edo, 2012). Precipitating factors found in our patients were missing insulin dose followed by infection to be the most factor as those similar studies (Abbas et al., 2019; Singh et al., 2019), non-compliance or missing insulin dose may due to quality of life affection from their multiple insulin injections type that required daily long-duration use in TIDM patients with their younger age behavior. As a consequence, complications as retinopathy were the most reported.

A study of DKA patients was found 24.6% of them admitted to the ICU and the mortality rate was 4.7% (Sagy et al., 2020). In comparison to the similar Indian study of biochemical laboratory profile parameters of glucose, pH, and bicarbonate our study sample showed to be lower in those parameters and higher in anion gap than their study due to only included severe DKA patient in this study. Also, urea has significant distinguishing differences in means, and our hematological parameters mean determine most likely not to be an HGB anemic cases (Singh et al., 2019).

The outcome of patients majority had improved and discharged while slightly of them had comorbidity diseases however no expired cases were found some study was found the majority of their case had been admitted to the ICU and few was expired that could be referred to the management protocol of different hospitals (Sagy et al., 2020).

5. CONCLUSION

The non-compliance with insulin dose was the most precipitating factor for the DKA in this study hence an intensive efficient educational program, and quality of life improvement for diabetic patients should be applied. Providing wide insulin injections options with less daily injections uses and understanding the behavior of non-compliance may favor the outcome of repeated DKA admission of young age patients. Gastrointestinal symptoms of abdominal pain to nausea and vomiting were the most initial presentation for Saudi T1DM in our severe DKA patients, an ethnicity research is also recommended for a better distinguishing of different ethnicities' initial clinical presentation to non-gastrointestinal symptoms as polyuria and polydipsia of DKA in TIDM patients. The outcome reflects good improvement as no reported expired cases. The mean duration for hospital stays admission for DKA patients is three days that these results would seem to help the hospital in management decisions.

Authors' contributions:
Nasser R Aljuhani: Primary author read and approved the final manuscript. Nada M Alamoudi, Nadreen B Majali, Rania M Algouzi, Fatima A Alzubaidi, Sally M Alnajri: This work carried out in collaboration among all authors. All authors read and approved the final manuscript.

Conflict of Interest
The author declares that there are no conflicts of interests.

Data and materials availability
All data associated with this study are present in the paper.

Ethical Approval and Patient consent
Ethical approval was taken by Saudi Arabia Ministry of Health (MOH) Institutional Review Board (IRB) issued approval H-02-J-002. Consent was obtained by all participants in this study.

Abbreviations
DKA: Diabetic ketoacidosis
T1DM: type 1 diabetes mellitus
DM: Diabetes mellitus
GDM: gestational diabetes
T2DM   type 2 diabetes mellitus

Data and materials availability
All data associated with this study are present in the paper.

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