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Socio-demographic and clinical characteristics of patients with diabetic ketoacidosis at King Salman bin Abdulaziz medical city in Al-Madinah, Saudi Arabia

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ABSTRACT

Background: Diabetic ketoacidosis (DKA) is defined by high blood glucose, metabolic acidosis and increased ketone concentration in the body. It is a serious and potentially fatal complication of diabetes mellitus (DM). The study aimed to determine the socio-demographic and clinical characteristics of patients with DKA. **Methods:** A retrospective cross-sectional study design was conducted in Madinah general hospital in Madinah, Saudi Arabia. Medical records were reviewed for all DKA patients admitted to the hospital from January 2019 to October 2022. Socio-demographic and clinical characteristics of diabetic ketoacidosis were retrieved for eligible patients. **Results:** Out of 260 files reviewed, only 258 were included. Participants' mean age was 35.6 ±19.4. Most participants had type 1 DM (62%). The main precipitating factors of DKA were infection (44.5%) and non-compliance (29.8%). Vomiting (71.3%) and abdominal pain (56.9%) were the most common clinical manifestations. **Conclusion:** The main leading precipitating factors of DKA were infection and non-compliance to treatments. The most frequent clinical manifestations in diabetic patients with ketoacidosis were vomiting and abdominal pain.

Keywords: Diabetic ketoacidosis (DKA), precipitating factors of DKA, type 1 and type 2 diabetes mellitus, DKA manifestation, Saudi Arabia.

1. INTRODUCTION

Diabetes mellitus is one of the most common chronic diseases which affects both children and adults in Saudi Arabia and nearly all countries worldwide (Zubair et al., 2018; Aldamigh ET AL., 2022). The International Diabetes Federation (IDF) reported that the Kingdom of Saudi Arabia is the seventh highest country in the world in the incidence of type 1 diabetes mellitus (IDF, 2009). Modernization, urbanization, socioeconomic development, higher obesity rate and lower physical activity rate are all contributing to an alarming rise in diabetes prevalence globally (Whiting et al., 2011). In Saudi Arabia, about seven million people are diabetic and approximately three million have pre-diabetes (Al-Dawish et al., 2016). Hyperglycemia is characterized by a lack of insulin production caused by pancreatic β -cell dysfunction or insulin resistance in the cells of the liver, adipose tissue and muscle. Diabetic ketoacidosis (DKA) is defined by a triad of hyperglycemia, acidemia and ketonemia. It is serious and could be a fatal complication of DM (Agarwal et al., 2016). The most frequent hyperglycemic presentation to emergency among diabetic patients is DKA which is highly occurred in patients with type 1 DM compared to patients with type 2 DM (Umpierrez and Kitabchi, 2003). Abdominal pain, nausea, vomiting and fruity-scented breath are common symptoms of DKA whereas some patients present with increased urination and thirst as the classic symptoms of DM (Seth et al., 2015). The most common precipitating factors of DKA are non-adherence to medications and infections (Alourfi et al., 2015; Misra and Oliver, 2015). Unfortunately, dehydration, hyperglycemia and electrolyte abnormalities in addition to precipitating factors among patients with DKA are inadequately managed (Singh et al., 1997; Solá et al., 2006). Up to our knowledge, no previous studies have been conducted in Al-Madinah region. Our study aimed to determine the socio-demographic and clinical characteristics of patients with DKA.

2. METHODOLOGY

A cross-sectional study design was conducted in Madinah general hospital which is the largest hospital in Madinah region. The target population was patients admitted with diabetic ketoacidosis at Madinah general hospital. The minimum required sample size was calculated to be 227 according to Open Epi web. A convenient non-probability sampling technique was used to recruit 258 patients. Medical records were reviewed for all patients who were admitted to the hospital in the period from 1 January 2019 to 31 October 2022. Patients were included if (a) were over 14 years old and (b) had a confirmed diagnosis of diabetic ketoacidosis according to the most recent guidelines (Wolfsdorf et al., 2018). Patients who have hyperosmolar states and hyperglycemia without ketoacidosis were excluded from the study. Socio-demographic data such as (age, gender, nationality and residence), clinical characteristics such as type of diabetes mellitus, treatment used before hospital admission, clinical presentations and the precipitating causes of DKA were retrieved from medical records.

Statistical analysis

Data were processed using Statistical Package for the Social Sciences, version 25 (IBM Corp, Armonk, NY, USA). Regarding quantitative variables mean and standard deviation were used and for qualitative variables frequencies and proportions were used.

3. RESULTS

Out of 260 files reviewed, 258 were included and two were excluded due to incomplete data. The participants' mean age was 35.6 \pm 19.4 and approximately two-thirds were younger than 40 years. Approximately, three-fourths of the study sample was Saudi (73.6%), living inside Al-Madinah (66.3%). Most of the participants had type 1 DM (160, 62%), known cases of DM (225, 87.2%) and were on insulin therapy (192, 74.4%) (Table 1).

Table 1 Socio-demographic and clinical characteristics of diabetic ketoacidosis patients (n=258)

| Characteristics | Number (%) |
|----------------------------|-----------------|
| Age (years), mean \pm SD | 35.6 \pm 19.4 |
| Age | |
| \leq 20 | 78 (30.2) |
| 21-40 | 91 (35.3) |
| 41-60 | 48 (18.6) |
| \geq 61 | 41 (15.9) |
| Gender | |
| Male | 129 (50.0) |

| | |
|-------------------------------------|-------------|
| Female | 129 (50.0) |
| Nationality | |
| Saudi | 190b (73.6) |
| Non-Saudi | 63 (24.4) |
| Unknown | 5 (1.9) |
| Residence area | |
| Living inside Al-Madinah | 171 (66.3) |
| Living outside Al-Madinah | 6 (2.3) |
| Unknown | 80 (31.0) |
| Type of DM | |
| Type1 | 160 (62.0) |
| Type2 | 84 (32.6) |
| Unknown | 14 (5.4) |
| DM status | |
| Current(known) DM | 225 (87.2) |
| Newly diagnosed DM at presentation | 22 (8.5) |
| Unknown | 11 (4.2) |
| DKA status | |
| First time DKA | 58 (22.4) |
| Previous(recurrent)DKA | 107 (41.5) |
| Unknown | 93 (36.0) |
| Treatment before hospital admission | |
| Insulin | 192 (74.4) |
| Oral hypoglycemic age | 37 (14.3) |
| None | 19 (7.4) |
| Unknown | 10 (3.9) |
| Family history of DM | |
| Yes | 56 (21.7) |
| No | 18 (6.9) |
| Unknown | 184 (71.3) |

SD: standard deviation, DM: diabetes mellitus, DKA: Diabetic ketoacidosis

Table 2 shows the laboratory results of the participants' blood tests (random blood sugar (RBS) at presentation, PH, HCO₃, anion gap, calcium, urea, creatinine, sodium and potassium).

Table 2 Laboratory results of diabetic ketoacidosis patients

| Laboratory Result | (Normal Values) | Mean ±SD |
|---------------------|---------------------|--------------|
| RBS at presentation | Less than 200 mg/dl | 420.2 ±138.1 |
| PH | 7.35–7.45 | 7.1 ±0.1 |
| HCO ₃ | 22–29 mmol/l | 11.4 ±4.8 |
| Anion gap | 12–20 mmol/l | 23.0 ±6.4 |
| Calcium | 2.12 -2.52 mmol/l | 1.8 ±0.5 |
| Urea | 2.5-8.07 mmol/l | 7.2 ±8.0 |
| Creatinine | 30-115 μmol/l | 95.7 ±132.2 |
| Sodium | 136-145 mmol/l | 133.5 ±6.5 |
| Potassium | 3.40-5.1 mmol/l | 6.5 ±0.8 |

RBS: Random blood sugar

In Table 3, the main precipitating factors of DKA were infection (115, 44.5%), non-compliance (77, 29.8%) and insulin omission (40, 15.5%), whereas the least common precipitating factors were urinary tract infection (7, 2.7%), acute pancreatitis (3, 1.1%) and stroke (3, 1.1%) (Figure 1).

Table 3 Precipitating factors among patients with diabetic ketoacidosis

| Precipitating factors | Number (%) |
|-------------------------|------------|
| Infection | 115 (44.5) |
| Urinary tract infection | 7 (2.7) |
| Pneumonia | 27 (10.4) |
| Non-compliance | 77 (29.8) |
| Insulin omission | 40 (15.5) |
| Acute pancreatitis | 3 (1.1) |
| Stroke | 3 (1.1) |
| Unknown | 35 (13.5) |
| Other | 24 (9.3) |

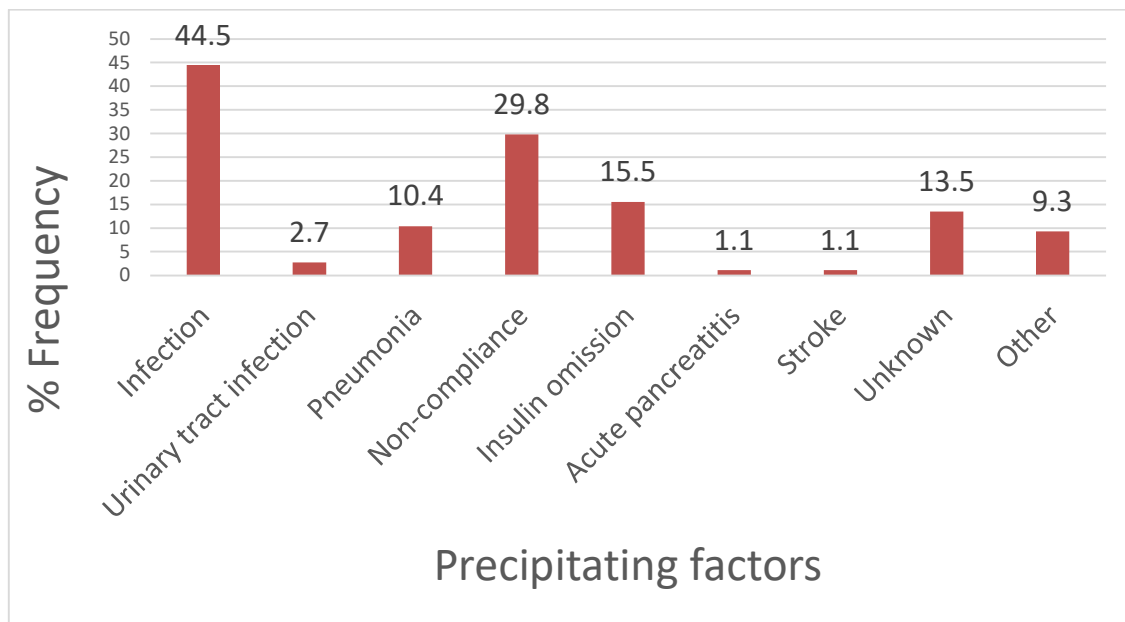


Figure 1 Precipitating factors

Table 4 shows the clinical manifestation of DKA; the top-rated manifestations among participants were vomiting (184, 71.3%), abdominal pain (147, 56.9%) and nausea (126, 48.8%), whereas the least-rated manifestations were polydipsia (13, 5.0%), coma (6, 2.3%) and blurred vision (2, 0.7%).

Table 4 Clinical manifestation among patients with diabetic ketoacidosis

| Clinical manifestation | Number (%) |
|---------------------------------|------------|
| Nausea | 126 (48.8) |
| Vomiting | 184 (71.3) |
| Polyurea | 21 (8.1) |
| Polydipsia | 13 (5.0) |
| Fever | 51 (19.7) |
| Abdominal pain | 147 (56.9) |
| Shortness of breath | 50 (19.3) |
| Blurred vision | 2 (0.7) |
| Impaired level of consciousness | 16 (6.2) |

| | |
|-------|-----------|
| Coma | 6 (2.3) |
| Other | 55 (21.3) |

4. DISCUSSION

In this study, we found the majority of study participants were younger than 40 years, participants' mean age was 35.6 and half of the patients were males which is nearly similar to other studies (Agarwal et al., 2016; Alotaibi et al., 2022). Most of the patients in our study were type 1 DM in line with previous studies (Agarwal et al., 2016; Alotaibi et al., 2022; Ndebele and Naidoo, 2018), contrary to other studies (Seth et al., 2015; Shahid et al., 2020) could be attributed to socioeconomic differences. Regarding the laboratory results of diabetic ketoacidosis patients in our study, we found that the mean concentration of glucose was 420.2 ± 138.1 mg/dl, pH 7.1 ± 0.1 , sodium 133.5 ± 6.5 mmol/l and anion gap 23.0 ± 6.4 mmol/l were quite similar to a previous study (Pinto et al., 2008).

Our study found that 8.5% of newly diagnosed patients with DM for the first time among patients admitted to the hospital with DKA which was lower than 16%-20% in previous studies (Almalki et al., 2016; Alotaibi et al., 2022; Iddi et al., 2017). Infection and non-compliance to treatments were the most precipitating factors among patients with diabetic ketoacidosis similar to reported studies (Ahuja et al., 2019; Alourfi et al., 2015; Mahesh et al., 2017; Rahim et al., 2018; Shahid et al., 2020; Tan et al., 2012). In our study, vomiting and abdominal pain were the most common clinical manifestations of diabetic ketoacidosis which is consistent with reported studies (Ahuja et al., 2019; Almalki et al., 2016; Shaltout et al., 2016) in contrary to a previous study which found that the majority of patients admitted to the hospital presented with polyuria and polydipsia (Iddi et al., 2017).

The limitations cannot be ruled out of the study. First, regarding the setting of the study, which was conducted in one hospital so the external validity was affected and could not be generalized to all populations in the Kingdom of Saudi Arabia. Second, as long as the results of the study are extracted from the patient's records so some of the information could be inaccurate or missed which may affect the internal validity.

5. CONCLUSION

Infection and non-compliance to treatments were the main leading precipitating factors of DKA. The most common clinical manifestations of diabetic ketoacidosis patients were vomiting and abdominal pain. The study recommends community awareness and family education programs regarding the precipitating factors and manifestations of DKA.

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Authors' contributions

Ahmed F Al-Ahmadi, Abdulhalim M Almurashi, Basem M Al-Johani, Turkey I Alrajabi, Abdulmajeed Al-Harbi, Ibrahim S Alhajjam and Sami Al-Dubai contributed to the writing of the manuscript and analyzed the data. Ghazi T Almohmmadi, Abdullah F Alhejaili, Ehdaa K Boudal, Hussam A Atallah, Ethar A Boudal, Yaser J Alrashidi, Mohammad J Bamagos have conceptualized the study, agreed with manuscript findings and collected the data, all authors critically reviewed the study and agreed to the final draft.

Ethical approval

The study was approved by Medical Ethics Committee of King Salman bin Abdulaziz medical city institutional review board (IRB log No: 22-073). Informed consent was not applicable in this study.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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