



SAINT PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE
DEPARTMENT OF EMERGENCY AND CRITICAL CARE
MEDICINE

CLINICAL PATTERN, PRECIPITATING FACTORS AND
OUTCOME OF DIABETIC KETOACIDOSIS AMONG
PATIENTS VISITING ADULT EMERGENCY AT SAINT
PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE

INVESTIGATOR: TADESSE BELACHEW (MD, EMERGENCY AND
CRITICAL CARE MEDICINE RESIDENT)

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Addis Ababa, Ethiopia

St. Paul's Hospital Millennium Medical College
Department of Emergency and Critical Care Medicine

**Assessment of clinical Pattern, precipitating factors and outcome of
Diabetic Keto-acidosis among patients visiting Adult Emergency at
Saint Paul's Hospital Millennium Medical College**

Investigator: Tadesse Belachew (MD, ECCM Resident)

Advisors:

- 1. Tesfaye Getachew (Assistant Professor of ECCM, Emergency and Critical Care Medicine Department Head)**
- 2. Ayalew Zewde (Associate Professor of ECCM, Academic of Emergency and Critical Care Medicine)**
- 3. Eyoel Berhan (BSc, MPH)**

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Name of investigators	Dr. Tadesse Belachew
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Address of investigators	Cell phone - 0920190709 or 0908324514
	Email – med.hruh@gmail.com
Name and address of advisors	Dr Tesfaye. Dr Ayelew and Mr. Eyoel

Declaration

I have declared that, this is my original work has never been presented in this or any other university and all the source material used for this thesis have been fully acknowledged.

Name: Dr. Tadesse Belachew (Final year EMCC Resident)

Signature: _____

Place: Addis Ababa, Ethiopia

Date of Submission: 10/25/2022

This thesis has been submitted for examination with my approval as a university advisor

Name: Dr. Tesfaye Getachew (Assistant Professor of Emergency Medicine and Critical Care and Department Head)

SPHMMC)

Signature: _____ Date: _____

Name: Dr. Ayalew Zewude (Associate Professor of Emergency Medicine and Critical Care

SPHMMC)

Signature: _____ Date: _____

Name: Mr Eyoel Berhe (Bsc, MPH SPHMMC)

Signature: _____ Date: _____

Abstract

Background: Diabetic keto-acidosis (DKA) was one of the most acute complications of diabetes mellitus. The mortality rate of DKA was higher in developing countries. Diabetes mellitus has life threatening complications which is precipitated by various factors such as infections, trauma, cardiovascular diseases and pregnancy. There was lack of data regarding the clinical pattern, precipitating factors and outcome of DKA at the current study setting.

Objective: The aim of this study was to assess the clinical pattern, precipitating factors and outcome of DKA among patients presented to the adult emergency department at St. Paul's Hospital Millennium Medical College in Addis Ababa, Ethiopia, from January 1st, 2019 to December 31st, 2021.

Methods: Hospital-based cross sectional descriptive chart review at St. Paul's Hospital Millennium Medical College. Diabetic keto-acidosis patients who were admitted from January 1st 2019 to December 31st 2021 were included. Sample size was estimated using single population proportion formula. Data were analyzed using SPSS version 25. Descriptive analysis and bivariable multiple regression analyses were used. Statistical significance was considered for variables with $p < 0.05$.

Results: A total of 261 medical charts of diabetic patients with DKA were reviewed. Patients' median (interquartile range) age was 35 (26–46) years, with male predominance (62.1%). Polydipsia and polyuria were the most frequent presenting symptoms. About 39.1% of diabetes was first time presentation with DKA while infection and insulin discontinuation were the most common precipitating factors. Sixty-four (24.5%) the patients had bad management outcome, with mortality rate of (1.5%). Having moderate and severe DKA [AOR=5.40 (95%CI:(2.51,11.62))] and having a lower GCS score at presentation [AOR=3.49 (95%CI: (1.11,10.99))] were significantly associated with bad management outcome.

Conclusion: Polydipsia and polyuria were the most frequent presenting symptoms. One fourth of DKA patients had bad management outcome. Due focus should be given to raise the awareness of the general public about precipitating factors and overall comprehensive diabetic care.

Keywords; Diabetic ketoacidosis, clinical pattern, precipitating factors, management outcome, Ethiopia.

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List of Abbreviations and Acronyms

AA	Addis Ababa
ABG	Arterial Blood Analysis
AOR	Adjusted Odds Ratio
CNS	Central Nervous System
COR	Crude Odds Ratio
CSII	Continuous subcutaneous insulin infusion
DKA	Diabetic Keto Acidosis
DM	Diabetes Mellitus
EDHS	Ethiopian Demographic Health Survey
EMCC	Emergency and Critical Care Medicine
EOPD	Emergency Outpatient department
GCS	Glasgow Coma Scale+
HCP	Health care professionals
HHS	Hyper Osmolar State
HE	Hyperglycemic Emergencies
IDF	International Diabetes Federation
IQR	Interquartile Range
SPHMMC	Saint Paul's Hospital Millennium Medical College
SPSS	Statistical Package for Social Science
WHO	World Health Organization

1. Introduction

1.1. Background of the Study

Diabetic ketoacidosis (DKA) is an acute, dangerous complication of diabetes mellitus (DM). The majority of DKA instances are seen in people with type 1 diabetes mellitus, however there has been an upsurge in incidence of DKA among people with newly diagnosed type 2 diabetes mellitus, especially in the black community. A systemic infection or other stressful situation is likely to cause DKA in type 2 diabetes, which has a severe reduction in insulin secretion(1).

The burden of diabetes mellitus has increased, with more than half billion world population live with the disease according to the most current International Diabetes Federation (IDF) report, Worldwide. The next thirteen years more, the numbers is increased by than hundred million diabetes will be added. According to a recent estimate, the expense of treating diabetes mellitus for medical treatment has increased by more than three times over the past 15 years. More than six million deaths associated with DM were documented in 2021, or 12 deaths each minute. Additionally, in Africa, people live with known diabetes and undiagnosed as well as economic and mortality burden is growing. it is anticipated that the disease t will be double after 20years(2).

A recent systematic review indicated that 6.5% of Ethiopians had diabetes, with a notable interregional variation. The prevalence of DM was highest (14%) in the Dire Dawa city administration and lowest (2%) in the Tigray area. More than five percent of people also have diabetes mellitus but are unaware of it(3,4).

Similarly, a thorough systemic review of the literature found that incidence and prevalence of DKA was 0–12.1%, 0–26.3% respectively of Type1 diabetes complications. It had a severe clinical course with significantly elevated blood sugar levels(5). DKA and Hypoglycemia were the major acute life threatening complication of diabetes mellitus.(6).

Numerous studies had demonstrated that stress and infections are major risk factors for the onset of diabetic ketoacidosis. Other data from different research had suggested that myocardial infarction, surgery, or trauma are linked to an increased incidence of diabetic ketoacidosis. Studies had shown that there are no known triggering causes in 14–30 percentage of cases.(6,7).

The signs and symptoms of DKA include polyuria, polydipsia and dehydration. Dehydration was usually the result of osmotic diuresis associated with hyperglycemia.

The condition could develop into an irreversible coma if left untreated. When the plasma glucose level was higher than the individual's renal threshold, it causes much glucose to be lost in the urine, with high water deficits (1,6,8).

Electrolyte deficits was common for electrolytes such as potassium, sodium, phosphorous, and magnesium. Marked in total body potassium deficiency was the most important electrolyte disturbance in DKA patients. Kussmaul's respirations (hyperventilation in an attempt to compensate for the acidosis), central nervous system depression, ketonuria, postural dizziness, anorexia, nausea, abdominal pain, thirst, and polyuria are also known symptoms of diabetic ketoacidosis (1,6).

Although much was known about the scientific picture of DKA in other parts of the world, no known in the current study setting. Therefore, this study was designed to capture the clinical pattern, precipitating factors and outcome of diabetic ketoacidosis among patients visiting Emergency department at St. Paul's Hospital Millennium Medical College from December^{1st}, 2019 to January 31st, 2021, Addis Ababa, Ethiopia.

1.2. Statement of the Problem

Numerous consequences of diabetes mellitus had affected human beings, resulting in significant morbidity, mortality and impairment for people all over the world (2). One of the most frequent complications of diabetes mellitus, diabetic ketoacidosis was associated with a high rate of mortality and morbidity worldwide. As new research, technology, and treatments that might enhanced the health and well-being of people with diabetes arise, the area of diabetes care was quickly changing. (2).

Currently, DM-related health problems were one of the complex challenges for the healthcare system. Sedentary lifestyle, infection, trauma to pancreas and family history were among common causes of damage to pancreas which negatively affects insulin production (2,9).

The lack of adequate follow up and medication supply causes were among common factors causing high burden of the disease in Ethiopia (9). Keeping all the aforementioned evidences in view, the current study was targeted at assessing the clinical pattern, precipitating factors and outcome of diabetic ketoacidosis among patients visited Adult Medical Emergency department of SPHMMC.

1.3. Significance of the Study

Over the last few decades, there has been a growing concern among professionals about the high prevalence of chronic diseases such as diabetes-related morbidity and mortality among people of all ages. As a result, hospital admissions and visits for diabetic ketoacidosis patients are on the rise. Diabetes with DKA had been suffering from diabetic ketoacidosis, and other diabetes mellitus complications had also increased. The number of adults admitted to or visiting an emergency room or hospital was growing. While it was uncommon for patients to present to a hospital in the early stages of the disease, late presentation is common. This rising trend of diabetic ketoacidosis has had a significant impact on health and social care services, posing significant challenges. In Ethiopia and study setting study done on diabetic ketoacidosis patient in facility regarding to its, clinical pattern, precipitating factor and outcome was limited. However, the burden of this diabetic ketoacidosis high and was increasing from time to time in alarm rate posing major negative consequence on the life of individuals. So, this study was expected to build knowledge and understanding of health worker about pattern, precipitating factor and outcome of diabetic ketoacidosis to prevent and minimize its negative health impact. The result of this study will help the policy makers to direct health policy related diabetic mellitus and its management. It will also use for health professionals and other stake holders to improve their practice with respect to handling and solving problem on precipitating factors and minimize consequence acute complications of diabetic mellitus.

The aim of this study was to assess factors that is responsible for magnitude types of diabetic ketoacidosis and hence to develop preventive and management strategies. Furthermore, the result of this study will help in filling the gap of knowledge relating to diabetic ketoacidosis particularly those with at high risk. This study will be used as baseline reference for our country and many other developing countries for further study.

2. Literature review

2.1. General Overview

Diabetic ketoacidosis is one of the known complications of type 1 diabetes mellitus. DKA happens when the blood sugar is extremely elevated and produce acidic substances called ketones that get accumulated in the body to dangerous levels (1,10). It happens when the body does not have enough insulin to process and uptake high levels of glucose in the blood. It is less common in people with type 2 diabetes because insulin levels don't usually drop so low. DKA may be the first sign of type 1 diabetes as people with this disease can't make their own insulin (1,10,11).

2.2. Pattern and Etiology of Diabetic Ketoacidosis

Diabetic ketoacidosis (DKA) medical emergency requiring prompt, diagnosis, and treatment. It is acute a life-threatening hyperglycemic state. DKA is described as a feature of type 1 diabetes mellitus. It has an incidence of 0-263/1000 patient-years. Patients with type 2 diabetes may also develop DKA with an incidence rate of around 0.32-2.0/1000 patient per year (2,5,6,8).

According to different literatures, pathogenesis of DKA is characterized by extracellular fluid (ECF) volume depletion. This is caused from hyperglycemia-induced urinary losses of water and electrolyte (1,6). This condition is caused by absolute or relative insulin deficiency and by increased levels of glucagon and other counter-regulatory hormones like catecholamines, cortisol, and growth hormone. These counter-regulatory hormones promote liver glucose production by a process called gluconeogenesis (1,12). Severe insulin deficiency leads to increased activity of hormone-sensitive lipase, which promotes the breakdown accumulated body fatty storage. Free fatty acids are oxidized in the liver to ketone bodies. Both hyperketonemia and hyperglycemia contribute to osmotic diuresis, resulting in volume depletion, hence further exacerbating hyperglycemia(12,13).

2.3. Precipitating Factors and Clinical Features of DKA

Various precipitating factors of diabetic ketoacidosis were identified thus far. These include acute infections like urinary tract infection or pneumonia, omission or errors of insulin therapy, cardiovascular or respiratory event like myocardial infarction and stroke, continuous subcutaneous insulin infusion (CSII) therapy malfunction and trauma.

Pregnancy and various drugs like atypical anti-psychotic agents, cocaine, glucocorticoids, sodium-glucose cotransporter can also precipitate the occurrence DKA (5,10,12–15).

Diabetic ketoacidosis has symptoms like polydipsia, polyuria, weakness, fatigue, nausea, vomiting, abdominal pain, decreased level of consciousness along with the symptoms of precipitating illness if any (1,10,12). On physical examination, hypotension, tachycardia, Kussmaul (deep, labored) breathing, features of dehydration, hyporeflexia, “fruity” breath, abdominal can be seen on patient with DKA. Almost all symptoms of DKA evolve rapidly, usually within the first 24 hours (1,9,10,12,15).

The diagnosis of DKA is usually based on serum bicarbonate ≤ 18 mmol/L, arterial blood pH ≤ 7.3 , anion gap >10 mmol/L, and ketosis. Typically, blood glucose levels in DKA are >13.9 mmol/L (250 mg/dL) (1,12,13). However, DKA with normal or slightly elevated blood glucose levels can occur. For instance, situation like pregnancy, alcohol abuse and liver failure can lead to DKA. Therefore, the degree of hyperglycemia does not necessarily determine the severity of DKA (16). Negative urine ketones, serum ketones, or both do not always exclude DKA. Hence, combined laboratory test and clinical criteria are helpful for the diagnosis of DKA and assessment of its severity (15).

Infections (36.5%) and inadequate insulin dose (22.5%) were the most frequently attributed predisposing factors in the Pakistani diabetic population (17). Likewise, in Bangladesh, Abdu Rahim and other authors reported that infection (45.5%) was the commonest precipitating cause followed by non-adherence to anti-diabetic therapy (31%), acute pancreatitis (5%), acute myocardial infarction (2%), stroke (1%) and surgery (1.5%) (14).

In a prospective, observational study done by Ahuja and colleagues in Pakistani population, the common clinical presentations were severe vomiting (32.2%), abdominal pain (27.9%), and depressed mental state (26.8%)(17). Likewise, in a Nigerian setting, Edo and co-authors observed that the common precipitating factors were poor drug compliance (27.4%), malaria 12 (14.3), urinary tract infection 10 (11.9%), lobar pneumonia 4 (4.8%), and unidentifiable in 34.5% of the Nigerians(18). And very recently, certain studies demonstrated that COVID-19 infection can trigger DKA in both known and newly diagnosed diabetic patients (19).

A hospital-based cross-sectional study conducted in Hawassa University Comprehensive Specialized Hospital, Ethiopia, noted that diabetic ketoacidosis was the leading acute complication of DM (77%), followed by hypoglycemia (14%) and hyperosmolar hyperglycemic state (9%) (11).

A similar retrospective study was conducted to assess predictors and treatment outcome of hyperglycemic emergencies (HEs) by reviewing 163 medical records of patients admitted to Jimma University Specialized Hospital (JUSH) over a three-year period. About two-thirds of the patients had type 1 diabetes, with 93 % of them sustaining DKA. The most common precipitants of HEs were infections, non-compliance to medications, and newly diagnosed diabetes, accounting for 59%, 32.3% and 23.6% of the cases, respectively (20).

In a similar manner, an investigation carried out at Adama Hospital Medical College emergency department and medical wards, Oromia region, Ethiopia concluded that the main reasons for recurrent DKA were infectious illness (69.50%) and insulin discontinuation (14.80%) (21). The previous work of Asres B et al (2017) observed that age and hypertension were found to have significant association with development of diabetic ketoacidosis in southern Ethiopia (11).

Moreover, the above-mentioned study conducted in central Ethiopia noted that majority of them (84.90%) discharged improved. Further, the report also showed DKA patients treated with more than six liters fluid replacement in the first 24 hours had better treatment outcome as compared to those who were given less than three liters fluid replacement. Similarly, it was observed that patients who got more than sixty international unit insulin doses in the first 24 hours had better treatment outcome when compared to less than forty international unit insulin administration. In addition, DKA patients who got supplemental potassium showed better treatment outcome improvement than for those potassium replacements was not done (21).

Also in a retrospective study done in Shashemene Referral Hospital, it was reported that there was a high in-hospital mortality rate, standing at 12% due to correctable causes among patients managed for diabetic ketoacidosis (22). A retrospective study that included 387 diabetic patients with DKA admitted to Debre Tabor General Hospital (DTGH), North Ethiopia from August 2010 to May 31, 2018.

In this study, two-thirds (66.67%) the patients had known precipitating factor, with the most frequent precipitating factor being new onset diabetes mellitus, which was mentioned in 38.8% of the patients. The next two predominant culprits were poor compliance to antidiabetic treatment (14.7%) and infections (13.2%), respectively (23).

2.4. Treatment Outcome and Associated Factors of DKA

Generally, management of patients with DKA include fluid resuscitation, resolution of acidosis, correction of electrolyte imbalances (especially hypokalemia) and correction of hyperglycemia. Identification and treatment of precipitating factors is also important part of DKA management. Priorities of management should be depended to the clinical situation (1,6,12).

DKA patients' clinical management monitoring includes monitoring parameters like blood pressure (BP), heart rate, respiratory rate, and level of consciousness, fluid balance, temperature every, electrolytes; blood gases; blood glucose, serum ketones and urine ketones, or both, at baseline. Serum potassium should also be monitored accordingly based on the derangement (2,7).

The first step in the management of DKA is fluid resuscitation. Estimated total water deficit is ~100 mL/kg or 5-10% of body weight. This should be corrected immediately within 24 to 48 hours. Refilling extracellular fluid volume improves tissue perfusion and lowers blood glucose levels as well as increased urinary glucose losses (1,14,24).

The other management use is preventing ketoacidosis and its production. Insulin plays significant role in reducing hepatic gluconeogenesis and suppressing lipolysis. There is evidence of good outcomes with an initial bolus of IV insulin. Subcutaneous insulin is a safe and effective route for correcting mild to moderate DKA. For critically ill patients' IV infusion of regular human insulin is preferable. It is important to ensure that hypokalemia is corrected before starting insulin; otherwise, insulin will exacerbate hypokalemia. Strict monitoring and adjustment of dosage for insulin is required to avoid hypoglycemia and other complication associated with insulin administration (1,2,6,12,25).

Correction of electrolyte imbalances is one of the crucial steps in DKA management. Potassium deficit in DKA is ~3 to 5 mmol/kg. Initiation of potassium supplementation (oral or IV) once the serum potassium level is <5.0 mmol/L and urine output is established.

It is important to note that IV potassium administration of >15 mmol/h should be performed preferably through a central venous line or through 2 peripheral veins (6). Potassium administration require strict follow up. Severe hypophosphatemia (<0.5 mmol/L) may be associated with complication like rhabdomyolysis and hence should be measured and managed accordingly(1,12) .

Hyperglycemia should be corrected through fluid resuscitation, IV insulin, and resolution or correction of the precipitant (6). Detailed history, physical examination and laboratory test and imaging investigation like complete blood count (CBC), urinalysis, and electrocardiography with or without cardiac enzymes are recommended to identify and manage precipitating factors. During periods of illness patients should be educated on how to adjust their insulin and that it should never be discontinued (1,6,12).

There many complications of DKA and its management depends on the type of complications occurred. Hypoglycemia is cited as the most common complication (31). Other complication includes hyperkalemia, heart failure, cerebral edema, hypokalemia, volume overload, hyperglycemia, hypocalcemia stroke, acute kidney injury, thromboembolic complications and many others (9,22,26).

Mortality from DKA ranges from $\sim 0.65\%$ to 3.3% . Authors from Bangladesh documented the mortality rate was 6.5% in Bangladesh population (14). Mortality is high in patients with recurrent DKA(26).

In a Kenyan study that enrolled 47 patients hospitalized with DKA, fourteen (29.8%) patients died, and the deaths occurred within less than 48 hours of hospitalization and treatment. Of the patients who died, all (100%) had altered level of consciousness at hospitalization, 71.4% had abnormal renal functions, 64.3% were newly diagnosed and an equal proportion of 64.3% were females. The alteration in the level of consciousness was significantly associated systolic hypotension and severe metabolic acidosis. Patients with altered level of consciousness also had poorer renal function (27).

In around 50% of instances, mortality occurs within the first 48 to 72 hours and is generally due to the underlying cause, cerebral edema or electrolyte disturbances (particularly related to potassium) (26). In the above-mentioned Ethiopian study, Mekonen et al., the mean length of hospital stay was 4.64 (± 2.802) days. The majority (370;95.60%) of patients improved and discharged whereas 17 (4.40%) patients died in the hospital (23).

In the previous Ethiopian study, recurrent hyperglycemia, hypoglycemia and ketonuria occurred in 54%, 20.9% and 20.5% of the patients admitted to JURH, respectively. Mean amount of insulin used and duration of treatment till resolution of DKA were 136.85 ± 152.41 units and 64.38 ± 76.34 hours, respectively. The median length of hospital stay was 6 days. Mortality from HEs was 9.8 %. Further, admission serum creatinine >1.2 mg/dL, comorbidity and sepsis were independent predictors of HEs mortality (20).

In summary, the reviewed literature reveals that DKA is a medical emergency in diabetic patients, with complex aetio pathogenesis. Its pattern of presentation, precipitating factors and management outcomes varies across different settings as a result of various factors clinico-demographic characteristics, management protocol, and quality of care. Moreover, it was also noted that the existing literature is more concentrated in other regions of the world, unveiling the presence of knowledge gap in the current study setting as there is scarcity of context-specific, updated data that characterize the clinical profile of the diabetic patients presenting with DKA.

2.5. Conceptual framework

As it can be seen from this conceptual framework, DKA is precipitated by acute infections, trauma, stress, wrong or missed insulin administration. DKA can affect both male, female and all age group of populations. Hypoglycemia most common complication. Other complication includes hyperkalemia, heart failure, cerebral edema, hypokalemia, volume overload, hyperglycemia, hypocalcemia stroke, acute kidney injury, thromboembolic complications and many others. Mortality is high in patients with recurrent DKA, early diagnosis and treatment and Monitoring and evaluation are the best intervention required (1,11,12).

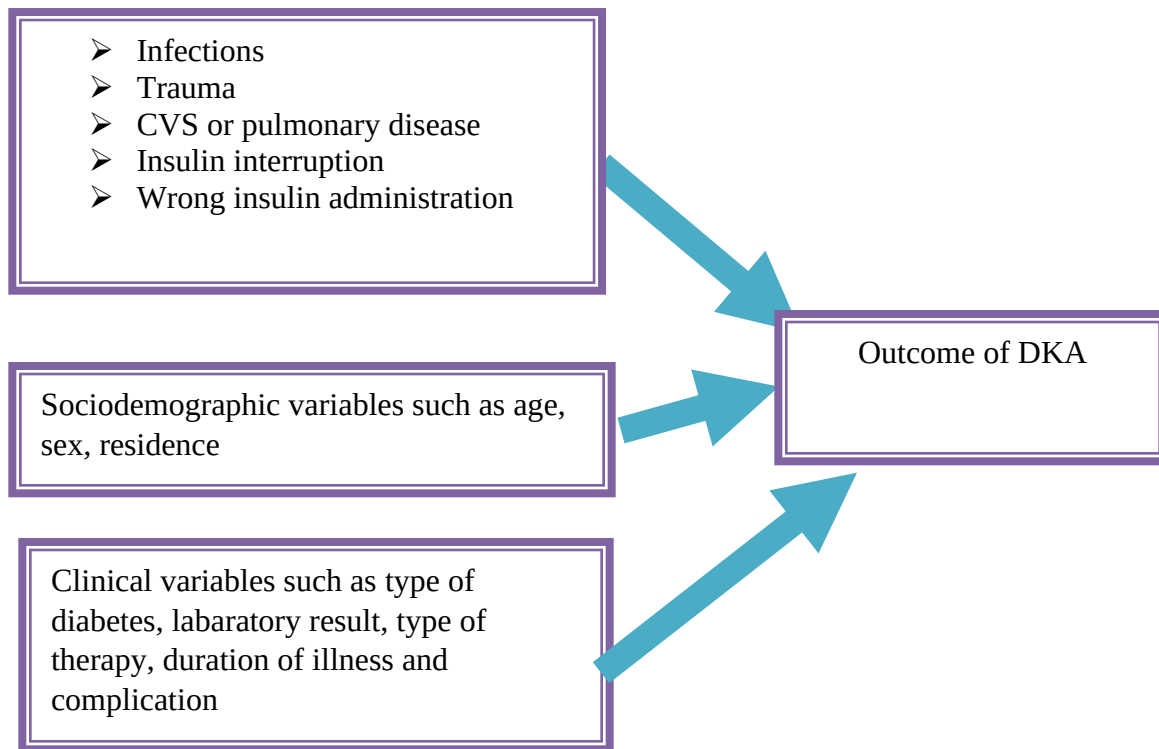


Figure 1. Conceptual framework developed to show the relationships between variables to assess clinical pattern, precipitating factors and outcome of DKA among patients visited St. Paul's Hospital Millennium Medical College from January 1st 2019 up to December 31st 2021 Addis Ababa, Ethiopia

3. Objectives of the Study

3.1. General Objective

- To assess the clinical pattern, precipitating factors and outcome of diabetic ketoacidosis among patients visiting Adult Emergency at St. Paul's Hospital Millennium Medical College from January^{1st}, 2019 to December 31st, 2021, Addis Ababa, Ethiopia

3.2. Specific Objectives

- To describe clinical pattern of diabetic ketoacidosis among patients visiting Adult Emergency at SPHMMC January^{1st}, 2019 to December 31st, 2021, Addis Ababa, Ethiopia
- To identify precipitating factors of diabetic ketoacidosis among patients visiting Adult Emergency at SPHMMC from January^{1st}, 2019 to December 31st, Addis Ababa, Ethiopia
- To determine outcome of diabetic ketoacidosis among patients visiting Adult Emergency at SPHMMC from January^{1st}, 2019 to December 31st, 2021, Addis Ababa, Ethiopia.
- To identify factors associated with outcome of DKA patient visiting Adult Emergency department of SPHMMC from January^{1st}, 2019 to December 31st, Addis Ababa, Ethiopia.

4. Methods and Materials

4.1 Study Setting and Period

The study was conducted in Adult Emergency Department of St. Paul's Hospital Millennium Medical College over two weeks' period from June 1st to 15th, 2022. It established in 1968 by the late Emperor Haile Sillasie as Saint Paul Hospital. It is a specialized teaching hospital located in the north-western part of Addis Ababa, the capital of the country. Its catchment population is well over 7 million, making it one of the largest referral centers in the country. As a tertiary center, it receives patients from every corner of the country, most of whom coming from the central areas of the country (28) .

In 2010, the hospital was advanced to a medical school, through decree of the national council of the ministries, and with this, it attained its current name: then got the name, Saint Paul's Hospital Millennium Medical College (SPHMMC). Being one of the leading tertiary and teaching hospital of the country, SPHMMC has around 250 faculty members, more than 2800 clinical, academic, administrative & supportive staff. While its inpatient capacity is more than 700 beds, the hospital gives a service for an average of 1200 emergency and outpatient clients daily. The hospital's emergency unit gives services for approximately 9000patients per year. The hospital serves as teaching institution for undergraduate and postgraduate medical students, and is a research center. The emergency unit has more than 28 beds red 4, Orange 4, yellow and green 20 including many chairs for yellow and green area. (28)

4.2. Study Design

Hospital-based cross sectional study design was conducted.

4.3. Source Population

All patients with diabetic ketoacidosis who had attended Adult Emergency at SPHMMC.

4.4. Study Population

All patients with diabetic ketoacidosis who visited the Adult Emergency department at SPHMMC from January^{1st}, 2019 to December^{31st}, 2021 and those who fulfilled the inclusion criteria.

4.5. Eligibility criteria

4.5.1. Inclusion criteria

- All patients with biochemically-confirmed DKA regardless of their severity
- Patients age 14 years or more.

4.5.2. Exclusion criteria

- Those patients with lost charts and no clear diagnosis were excluded.

4.6. Sample Size Determination and Sampling Technique

4.6.1. Sample Size Determination

The sample size required for this particular study was estimated using single population proportion formula. I used p value of DKA prevalence rates (40%) from research done on adult diabetes mellitus patients who were admitted to the emergency department of the Hawassa university comprehensive specialty hospital were the subjects of a study on diabetic ketoacidosis.(11),

$$n = \frac{z^2 p(1 - p)}{d^2}$$

n = the required sample size

p = proportion of diabetic patients reported to develop DKA – 40% (11)

$Z_{\alpha/2}$ = the critical value at 95% confidence level = 1.96

d = precision (margin of error) = 5%

N= the total number of diabetes during the study period

Accordingly,

$$n^0 = \frac{(1.96)^2 * 0.4(1 - 0.4)}{0.05^2}$$

$$n^0 = \frac{(1.96)^2 * 0.4(0.6)}{0.05^2}$$

$$n^0 = 369$$

Hence, to compute the final sample size using the correction formula,

$$n = \frac{n^0}{1+(n^0-1)/N}$$

$$n = \frac{369}{1+(369-1)/720} = 244$$

Hence, adding 10% of the calculated sample size for contingency that might happen as a result of lost charts or incomplete reports, the final sample size becomes 261.

4.6.2. Sampling Technique

Sample size and sampling technique Single population proportion formula was used to calculate sample size with the assumption of, 5% margin of error, 95% confidence interval and 40% proportion of DKA from a study conducted in Hawassa university comprehensive specialized hospital emergency department(11). Since the source population was < 10,000, we used a correction formula, adding 10% non-response rate, the final sample size was 261. Systematic random sampling technique was used to select the record of the study subjects. The record of the study subjects was selected based on constant interval $K = 3$ calculated from total DM case admitted at emergency department from January 1st, 2019, to December 31st in chronological order, which were 720 divided by the sample size of the study 261.

4.7. Study Variables

4.7.1 Dependent Variables

- Outcome of patients with diabetic ketoacidosis

4.7.2 Independent Variables

- Age
- Sex of the patient
- Residence
- Mode of presentation
- Duration of the illness

- Precipitating factor
- Type of the diabetes
- Type of treatment modality
- Presence of comorbidities
- Presence of hospital acquired illness
- Serum glyceimic profile at admission
- Serum potassium level at admission

4.8. Operational Definitions

DKA is defined as admission blood glucose >250 mg/dl and presence of ketonemia and/or Ketonuria(1).

Hyperglycemia is defined as random plasma glucose >200 mg/dL(1,12)

Hypoglycemia is defined as a blood glucose level ≤ 70 mg/dL(1,6,12).

Euglycemia DKA is defined as serum random glucose of <250 milligrams/d (1).

Long hospital stay is defined as hospital stay for more than seven days (29)

Mild DKA is defined as those DKA patient with,oriented, alert and fatigued

Moderate DKA is defined as DKA patient with oriented ,sleepy arousable

Severe DKA is defined as DKA patient with depressed respiraton and sleepy not arousable

Short hospital stay is considered if the patient stayed in the hospital for ≤ 7 days. (29)

Treatment outcomes defined as the diabetic ketoacidosis patient's medical complication at the Emergency department and in hospital mortality of diabetic ketoacidosis

Good outcome is DKA patients improved rather than developing complication

Bad outcome is those DKA patients who developed medical complication and dead

4.9. Data Collection Method, Tools and Procedures

Charts of adult patients diagnosed of DKA and who were seen during the three years were collected for all age categories and both sexes. Data extraction format having the specified data variables was used to collect necessary data from hospital register, patient folder, and ER logbooks. Some of checklist was adapted from previous similar studies(11,21,22). It primarily contained sections on sociodemographic characteristics, clinical profiles and laboratory parameters. Data collectors familiar with the study setting were recruited and briefly trained as data collectors while principal investigators supervised the data collection process. Data were first cleaned manually and checklist that did not fulfill minimum criteria for completeness were rejected from entry.

A checklist data collection tool was used and pre-test was conducted among 5% of the sample size and data entered to SPSS version 25 for analysis.

4.10. Data Quality Control

An English version checklist was used to collect data. Brief training for the data collectors (two health professionals) about the process of data collection was given before the process of data collection. Close supervision was maintained during data collection by the principal investigator and filled checklists were double-checked daily for consistency and completeness by data collectors and principal investigator before analysis.

4.11. Data Processing and Analysis

Data entering, coding, cleaning and statistical analysis were performed by using SPSS (Statistical Package for Social Science) version 25. Frequency and cross tabulation were used to check for missed value and variables. The demographic and clinical characteristics of patients were computed by using descriptive statistics such as mean, percentage, frequencies, median (interquartile range and Binary and multiple logistic regression analyses were used to identify clinically pertinent variables associated with the dependent variable (patient outcome). Those variables with p value of ≤ 0.25 in binary logistic regression were taken to multivariable stepwise logistic regression to determine odds ratios and the corresponding 95% confidence intervals were estimated to determine the strength of association. Hosmer and Lemeshow test were used to check the goodness of model fitness. Statistical significance was set at a p-value of < 0.05 . Finally, the study findings were presented using narratives, diagrams, tables and figures.

4.12. Ethical Consideration

The study was conducted after obtaining Ethical clearance from Ethical Review Board of St. Paul's Hospital Millennium Medical College. Right before the data collection process, the Medical Record Room coordinators were briefed on the purpose and importance of the study. As data used for this study is secondary in nature, there was no need to have written informed consent from the patients. After data collection, data were stored and used confidentially only for study purposes.

4.13. Plan of Dissemination of Results

After completion of the study, the document was submitted to Department of Emergency critical care medicine

5. Results

5.1 Socio-demographic Characteristics of Patients

This study included data came from 261 diabetic patients with DKA who visited Adult Emergency department at SPHMMC, after excluding seven patients who didn't fulfill the inclusion criteria. The majority (162; 62.1%) of the patients in the study were males, while 99 (37.9%) were females. Patients ranged in age from 15 to 85, with a median (interquartile range) age of 35 (26-46) years. More than one-fourth of patients (71;27.2%) were between 25 and 34-year-old age range. Majority (155;59.4%) of the patients were documented to be residents of the Addis Ababa while the remaining ones were reported to come from regions such as Oromia, Amhara and others. (Table 1).

Table 1. Distribution of socio-demographic characteristics of patients with diabetic ketoacidosis visiting Adult Emergency department at SPHMMC from January 1st, 2019 to December 31st, 2021 Addis Ababa, Ethiopia

Variable	Frequency	Percent (%)
Age category		
15-24 years	50	19.2
25-34 years	71	27.2
35-44 years	65	24.9
45-54 years	42	16.1
≥55 years	33	12.6
Sex		
Male	162	62.1
Female	99	37.9
Residence		
Addis Ababa	155	59.4
Oromia	93	35.6
Other	13	4.9
Referral status		
No	114	43.7
Yes	147	56.3
Referral source (n=147)		
Health center	105	71.4
Private center	22	15.0
Public hospital	20	13.6
Is treatment given at referring facility		
Yes	62	42.2
No	85	57.8
Type of Treatment (n=62)		
Fluid	56	90
Insulin	19	30.6
Others		

With regard to referral status hundred forty-seven (56.3%) patients came with referral paper. Majority (105;71.4%) of the diabetic patients were referred from a health center. Whereas the next common referred center was private health organizations. Also, from Referred health facility 62(42.2%) got some treatment like fluid and insulin 56(90%),19(30.6%), respectively as detailed in Table 1.

5.2 Clinical Characteristics of Patients

With respect to the presence of comorbidity, a quarter (64;24.5%) had been diagnosed of a certain form of comorbidity. Among these, the most commonly identified coexisting medical condition was hypertension as it was documented in 53 (82.8%) of the patients, followed by renal diseases which occurred in 16 (25%) of the patients (Table 2).

With respect to the time duration since the time of diagnosis of diabetes mellitus, the median (interquartile range) duration was 1 (0–5) year. Diabetes type 1 was a more common type of diabetes as it described in more than half of the patients (135;51.7%). From the studied subjects, more than three-fourths (203;77.8%) had only a single episode of DKA during the study period while 58 (22.2%) had patients had two or more episodes of diabetic ketoacidosis attacks in the specified time of study period (Table 2).

The most commonly observed symptoms among the studied subjects were polydipsia and polyuria, which were 195 (74.7%) and 193 (73.9%) of the patients, respectively. Moreover, the median (interquartile range) duration of symptoms for the presenting symptoms was 7 (2–14) days. On the other hand, most (244;93.5%) of the patients were fully conscious at the time of presentation, with Glasgow Coma Scale (GCS)score of 15. The hospital triage category for the patients were yellow/green, orange and red in 210(80.5%),42(16.1%),9(3.4). Most (223;85.4%) of the patients were diagnosed to have mild DKA while 28(10.7%), 10 (3.8%), had been diagnosed to have moderate and severe DKA, respectively (Table 2).

Table 2. Clinical characteristics of patients with diabetic ketoacidosis visiting Adult Emergency department of SPHMMC from January 1st, 2019 to December 31st, 2021 Addis Ababa, Ethiopia

Variable	Frequency	Percent (%)
Comorbidity		
No	197	75.5
Yes	64	24.5
Type of comorbidity (n=64)		
Hypertension	53	82.8
Renal disease	16	25.0
Cardiac disease	7	11
HIV/AIDS	6	9.4
Duration category		
Newly diagnosed diabetes with DKA	102	39.1
Known DM with DKA	159	60.9
Type of DM		
Type 1	135	51.7
Type 2	126	48.3
Frequency of DKA episode during study period		
Once	203	77.8
Twice or more	58	22.2
Symptoms at presentation		
Polydipsia	195	74.7
Polyuria	193	73.9
Easy fatigibility	99	37.9
Nausea and vomiting	96	36.8
Abdominal pain	94	36.0
Polyphagia	76	29.1
Classic of Triad (polysymptoms)	76	29.1
Weight loss	16	6.1
Headache	7	2.7
Duration of symptoms in days (median+ IQR)	7	2–14
GCS score at admission		
15	244	93.5
9–14	17	6.5
Triage category		
Green/Yellow	210	80.5
Orange	42	16.1
Red	9	3.4
Grade of DKA		
Mild	223	85.4
Moderate	28	10.7
Severe	10	3.8

5.3 Precipitating Factors

About the precipitating factors, new-onset diabetes mellitus identified as having DKA in one hundred and two (39.1%) of the patients. Infection and poor adherence to or omission of taking insulin and hypoglycemic agents were the next most frequently identified precipitating factor, as they were mentioned in 54 (20.7%) and 53 (20.3%) of the patients' medical charts. Among the infectious triggers, the predominant factor identified was pneumonia (31;57.4%), followed by urinary tract infection (21;38.9%) (Figure 2).

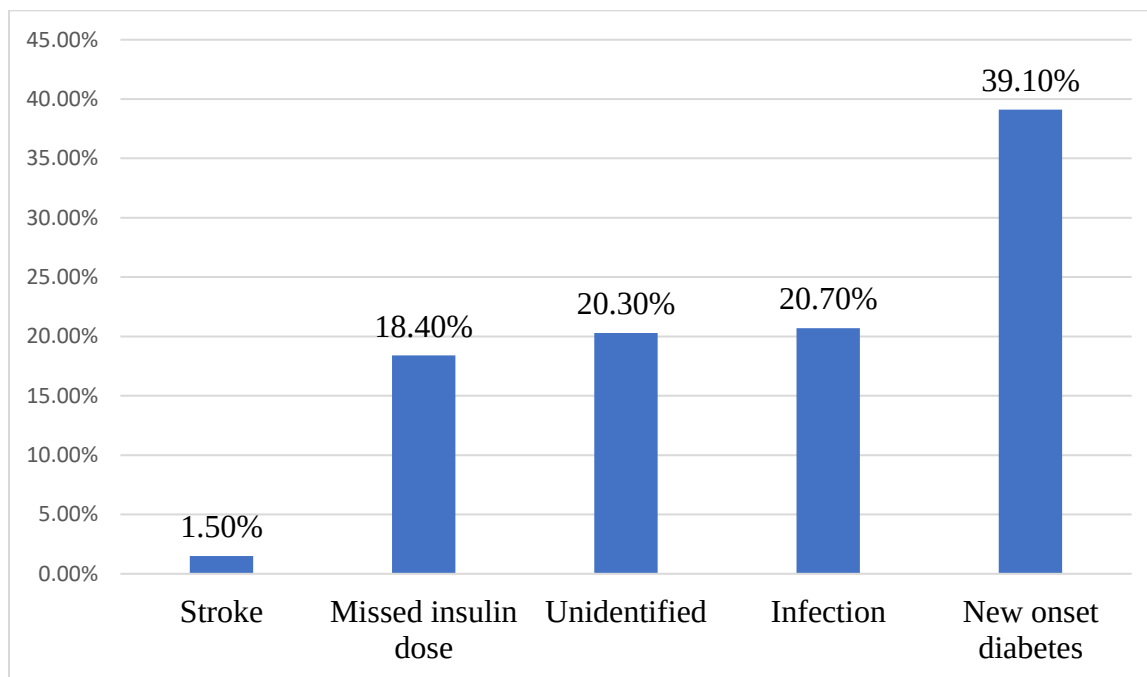


Figure 2. Precipitating factors among patients with diabetic ketoacidosis visiting Adult Medical Emergency department at SPHMMC from January 1st, 2019 to December 31st, 2021 Addis Ababa, Ethiopia

5.4 Laboratory and Management Profiles of Patients

Two hundred twenty-two (85.1%) of the studied patients had their blood glucose measurement that ranged from 250 to 600 mg/dL at presentation. While majority (165;63.2%) of the patients did not have their haemoglobin A1C determined by the time of data collection, most (91;94.8%) of the remaining subgroup had abnormal levels. Further, about half (124;47.5%) of the patients had urinary ketone levels of +3 or +4 on their initial evaluation, as elucidated in Table 3

Table 3. Laboratory and management characteristics of patients with diabetic ketoacidosis visiting Adult Emergency department at SPHMMC from January 1st, 2019 to December 31st, 2021 Addis Ababa, Ethiopia

Variable	Frequency	Percent (%)
Blood glucose at admission		
<250 mg/dL	7	2.7
250–600 mg/dL	222	85.1
>600 mg/dL	32	12.3
Haemoglobin A1C (n=96)		
High	91	94.8
Normal	5	5.2
Urinary ketone at presentation		
Trace	16	6.1
+1	48	18.4
+2	73	28.0
+3	99	37.9
+4	25	9.6
Serum potassium level at admission		
DKA treatment (n=238)		
Normokalaemia	172	72.3
Hyperkalemia	44	18.5
Hypokalemia	22	9.2
Serum potassium level After DKA treatment(n=93)		
normokalaemia	57	61.3
Hypokalemia	23	24.7
Hyperkalemia	13	14
Route of insulin administration(n=225)		
IV injection	217	96.4
IV infusion	8	3.6
Amount of insulin given during DKA Management(n=225)		
<40 IU	46	20.4
40-60 IU	81	36.0
>60 IU	98	43.6
Amount of fluid given during DKA Management		
< 3 liters	11	4.2
3–6 liters	188	72.0
>6 liters	62	23.8
Types of fluid used in during DKA Management		
0.9% NS	260	99.6
DNS	185	70.9
RL	6	2.3

KCL given during DKA Management		
NO	170	65.1
YES	91	34.9
Duration taken to get out of DKA		
≤24 hours	225	86.2
>24 hours	36	13.8
DKA complication		
No	197	75.5
Yes	64	24.5
Death		
No	257	98.5
Yes	4	1.5
Cause of death (n=4)		
Septic shock	2	50
Respiratory failure	2	50
During discharge Anti-diabetes given		
insulin	211	81.2
oral hypoglycemic agent	49	18.8

Majority of DKA patients during management treated by IV insulin injection 217(96.4%). Concerning the amount of insulin administered, 225 (86.2%) patients had their insulin dose recorded in their medical charts. Of these, close to half (98;43.6%) received more than 60 IU of insulin in the first twenty-four hours during their stay at the hospital whereas 81 (36%) patients received between 40 and 60 IU. Majority (188;72%) of the patients were given three to six liters in their first 24 hours following arrival, with almost all (260;99.6%) receiving 0.9% NS during the course of the fluid challenge. Most (225;86.2%) of the patients were observed to get out of the ketotic state in less than the first 24 hours (Table 3).

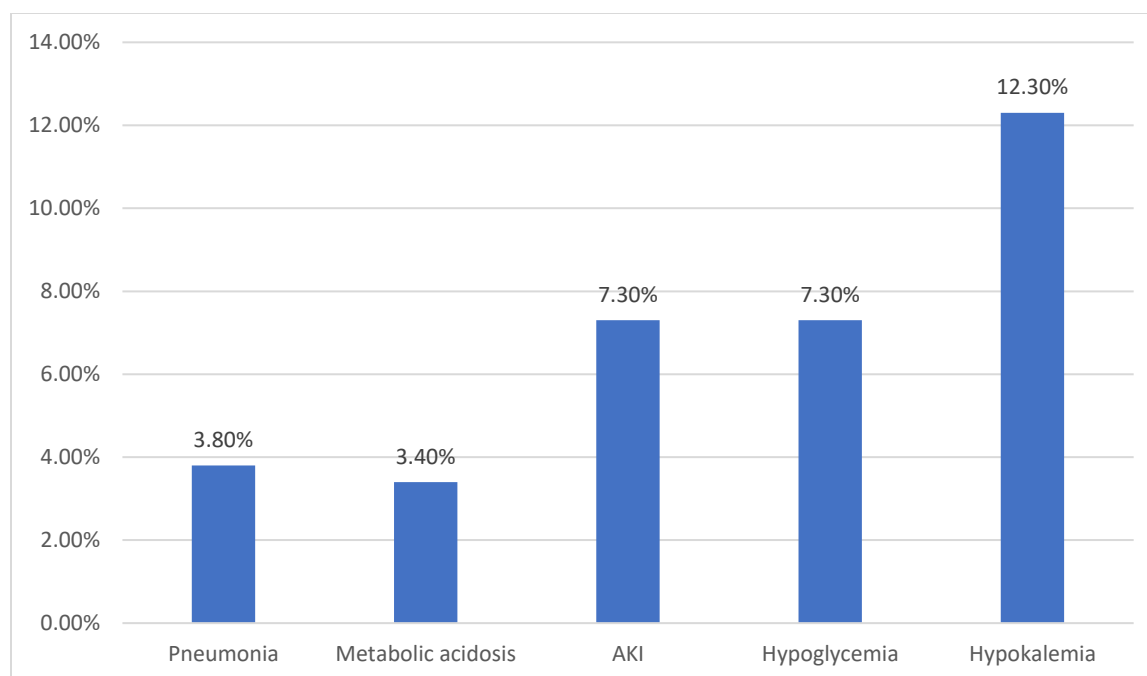


Figure 3. DKA Complications of patients with diabetic ketoacidosis visiting Adult Medical Emergency department at SPHMMC from January 1st, 2019 to December 31st, 2021 Addis Ababa, Ethiopia

With respect to medical complication during their stay at the hospital, a quarter (64;24.5%) of the patients were described to have a certain complication. The most frequent in-hospital complication was hypokalemia, hypoglycemia and acute kidney injury (AKI), which were noted in 12.3%, 7.3% and 7.3% of the patients (Fig. 3). Regarding to complication of DKA patients among complication is hypokalemia, hypoglycemia and AKI (48.4%,29.7% and 20.3%) respectively. Further, only four (1.5%) of the studied patients died in the hospital, with septic shock (50%) and respiratory failure (50%) being responsible for the deaths (Table 3).

5.5 Factors Associated with bad Outcome

In this study, all variables, namely sex, age category, residence, referral status, referral source, presence of comorbidity, type of comorbidity, duration of DM, frequency of DKA episode, GCS score at admission, triage category, grade of DKA, precipitating factors, amount of RBS levels at admission, sites of infection, fluid requirement during DKA management, type of fluid given, route of insulin administration, potassium supplement during management and Length of stay in the ED were considered in the regression analysis.

In order to determine the factors associated with management outcome while controlling possible confounders, independent variables that yielded p value of ≤ 0.25 in binary logistic regression were exported to multiple regression model to compute adjusted odds ratio in determining bad management outcome.

Accordingly, ten variables, namely residence, Comorbidity, Type of diabetes mellitus, Frequency of DKA episode, GCS score at admission, triage category, Urinary ketone at presentation, grade of DKA, Amount of insulin given in the first 24 hours and Amount of fluid given in the 1st 24 hours were observed in the bivariable regression analysis to be associated with management outcome. Following multivariable logistic analysis, the only variables that showed statistically significant association with management outcome were severity of DKA and GCS score at admission (Table 4).

Table 4. Factors associated with management outcome among diabetic ketoacidosis visiting Adult Emergency department at SPHMMC from January 1st, 2019 to December 31st, 2021 Addis Ababa, Ethiopia

Variable	Outcome		COR(95%CI)	AOR(95%CI)
	Good (%)	Bad(%)		
Residence				
Urban	122(78.7)	33(21.3)	1	-
Rural	75(70.8)	31(29.2)	1.53(0.87,2.70)	-
Triage category				
Green/Yellow	169(80.5)	41(19.5)	1	-
Orange/Red	28(54.9)	23(45.1)	2.29(1.12,4.69)	-
Type of diabetes mellitus				
Type 1	97(71.8)	38(28.2)	1.51(0.85,2.67)	-
Type 2	100(79.4)	26(20.6)	1	-
Urinary ketone at presentation				
<+3	114(83.2)	23(16.8)	1	-
$\geq$ +3	83(65.3)	41(34.7)	2.45(1.37,3.39)	-
Amount of insulin given in the first 24 hours				
<40 IU	35(76.1)	11(23.9)	1	-
40-60 IU	62(76.5)	19(23.5)	0.98(0.42,2.82)	-
>60 IU	68(69.4)	30(30.6)	1.40(0.63,3.13)	-

Amount of fluid given in the 1st 24 hours				
<3 liters	11(100)	0(0)	-	-
3–6 liters	153(81.2)	35(18.8)	0.26(0.14,0.48)	-
>6 liters	33(53.2)	29(46.8)	1	-
Comorbidity				
No	150(76.1)	47(23.9)	1	-
Yes	47(73.4)	17(26.6)	1.15(0.61,2.20)	-
Frequency of DKA episode				
Once	155(76.4)	48(23.6)	1.04(0.44,2.45)	-
Twice	15(65.2)	8(34.8)	1.80(0.56,5.77)	-
Thrice or more	27(77.1)	8(22.9)	1	-
Grade of DKA				
Mild	182(66.7)	41(33.3)	1	1
Moderate/Severe	15(39.5)	23(60.5)	6.81(3.27,14.17)	5.40(2.51,11.62)***
GCS score at admission				
15	191(78.3)	53(21.7)	1	1
9–14	6(35.3)	11(64.7)	6.61(2.34,18.70)	3.49(1.11,10.99)*

Only variables with p value <0.25 in bivariable logistic regression are shown here

*P value < 0.05; **P value < 0.01; *** P value < 0.001

Specifically, this study showed that when compared to those who had mild grade of DKA, diabetic patients who had moderate or severe were more likely to have bad management outcome [AOR=5.40 (95%CI: (2.51,11.62)]. Similarly, those with GCS score lower than 15 had significantly higher likelihood of bad management outcome [AOR=3.49 (95%CI: (1.11,10.99)] in comparison to their counterparts who were fully conscious (Table 3).

6. Discussion

The present study aimed to assess the clinical pattern, precipitating factors, outcome of DKA along with identified factors among patients visiting SPHMMC, Addis Ababa, Ethiopia. Subsequently, the study discovered several important findings. Polydipsia and polyuria were the commonly presenting features. It was demonstrated that infection and omission of insulin were the common precipitating factors among diabetic patients. It was revealed that in spite of its low mortality record, DKA has been proved to be an important cause of morbidity as significant portion of DKA patients had bad management outcome. Additionally, it was demonstrated that severity of the disease condition and GCS score at presentation were independently associated with management outcome of patients.

This study found that two or more recurrence of DKA patients to hospital is about 30 %while study done in Adama hospital medical college is 66% Saudi Arabia(43%).This is may be because of Diabetic education but further study must conduct to reason out the reason(21,30).

In particular, polydipsia and polyuria 195(74.7%),193(73.9%) respectively were the commonly presenting features among the diabetic patients. This finding is similar with previous studies done by cross-sectional study conducted in Hawassa University Comprehensive Specialized Hospital, Ethiopia three polysymptoms was 50.3% which is most common symptoms. Retrospective Cross-sectional conducted in shashamane referral showed that the most common clinical presentations were polyuria(96.9%) and polydipsia (92.4% (11,21,22). A similar pattern was documented among Nigerians diabetics presenting with hyperglycemic emergencies (18). The frequent observation of these symptoms among DKA patients could be due to the presence of insulin deficiency and hyperglycemia that results osmotic diuresis which in turn leads to the cardinal feature of polysymptoms: polyuria and polydipsia (1).

This studies shows most of DKA patients were mild DKA 85.4% and moderate and rsevere were 10.7 and 3.8% respectively by clinical presentaion, However retrospective cross sectional studied done in Adama General hospital the most common grade of DKA was severe 49.3% moderate DKA was 37.3% and mild DKA was 13.4%.So in this studies because of most of DKA patient referred from health center(21).

In the current study, infection (20.7%) and non-compliance to insulin and oral hypoglycemic agent (18.4%) were the common frequent precipitants among diabetic patients. This is in keeping with studies retrospective hospital record review in Nigeria was non compliance 14.3% and infection is 10.7% and cross section studied done in 2018 Jimma University Specialized Hospital, southwest Ethiopia studies documented that poor drug compliance 32.3%, and infections 59% ,were the main precipitating factors of hyperglycemic emergencies, this similarity shows both studies similar socio economic status (18,20,23).

The predominance of new-onset diabetes mellitus in this study can be explained by the fact that more than half of the sample population included in this study were diagnosed of type 1 diabetes mellitus which typically present with ketosis symptoms due to absolute insulin deficiency unlike type 2 diabetes mellitus which is known for its insidious onset (1). Further, this finding can be justified by the fact that DKA patient presentation was during COVID-19 outbreak and that the novel was observed to may induce acute onset diabetes and diabetic ketoacidosis in young population (31).

In this study showed that pneumonia (57.4%) was the most common infection that precipitated DKA. This is, in fact, in line with study done by Siregar NN (45.3%) in Indonesia that cited lung infection was most common precipitating factor of DKA (32). Unlike several previous cross sectional studies done in Bangladesh tertiary center (45.5%) Jimma University Specialized Hospital, southwest Ethiopia (64.2%) and Debre tabor hospital in North west Ethiopia (47%) which independently stated that urinary tract infections are the commonest infectious precipitants. This was different finding can be attributed to the fact that, in the current study, majority were males (62.1%) who have lower risk of urinary tract infections while in the previous study, females were more than males (7,20,23). Additionally, this study was done during COVID-19 outbreak, which was described to have diabetogenic potential and manifests itself as a respiratory infection. (19,31,33).

In this study, outcome analysis showed that a quarter of DKA patients developed medical complications such as hypokalemia, hypoglycemia and AKI, with the mortality rate among DKA patients was 1.5%.

This finding is close to the Saudi Arabian study (30), which documented a mortality rate of 1.83%. The death rate noticed in the current study was better than the finding reported in Thailand (16), Bangladesh (14), and Tanzania (34), in which the death accounted for 4.3%, 6.5% and 24.1% of the management outcome, respectively. Similarly, The rate of mortality was far better than the figure (23.6%) reported by Pakistani authors (17). However, the variability can be attributed to the differences in clinico-demographic profile of patients, study design, time of diagnosis and onset of treatment, underlying causes and standards of care. Of importance, the management outcome was confined to the course of patients during their stay at Emergency Department and excluded their subsequent management profile in other units, which might have lessened the death toll associated with DKA.

With regard to factors, this study confirmed that decreased level of consciousness at presentation is associated with poor management outcome among diabetic patients with DKA. This is supported by studies done elsewhere including Indonesia (32) and Kenya (27) which independently reported that altered mental state is associated with severe DKA, which in turn is associated with unfavorable outcomes (35). Further, altered mental status can be a sign of severe acidosis (low pH) and other metabolic derangements characteristic of DKA, which are major risk factors for poor outcome (32). Finally, this study showed that clinical outcome is worse in severe cases of DKA, which is in line with the Indian observation where in mortality rates were significantly higher among those with moderate and severe DKA than those with milder forms (36).

7. Strength and Limitations

7.1 Strength.

- This study assessed the pattern of DKA and major precipitating factors which can help us identify where to tackle the problem in terms of prevention, which is important in the context of this country.
- This is the leading study among diabetic patients in the study setting, particularly after the COVID-19, that tries to show the clinical picture of such patients during time of COVID-19 disease.
- The fact that the study was retrospective chart review in its nature, there was no concern of COVID-19 transmission in the process of data collection.

7.2 Limitations

- The nature of the study design was cross-sectional and hence, inherent to its design, it is difficult to make causal inferences and alternative explanations for the findings.
- The retrospective nature of the study design could not enable to evaluate the exact timing of administration of medications versus the occurrence of complications.
- Another important limitation of the study findings was limited to single center and therefore, findings should be not generalized to other settings.
- The type of DM described in this study were empirical diagnosis and it could not be confirmed by beta-cell function testing or the presence of antibody to insulin, which may have introduced bias into the study.

8. Conclusion and Recommendations

8.1 Conclusion

Polydipsia and polyuria were the most frequent presenting symptoms of DKA among diabetic patients. Infection and omission of insulin were the most common precipitating factors among diabetic patients. One-fourth of DKA patients had bad management outcome, with very low mortality rate. Inadequate metabolic monitoring and iatrogenic hypoglycemia remain areas of concern. Severity of the disease and low GCS score at presentation were independently associated bad outcome.

8.2 Recommendations

Based on the findings of the study, the following recommendations are forwarded.

Health care professionals should provide health education to patients and parents to enhance their knowledge about the precipitating factors including adherence to medications to reduce the occurrence of DKA among diabetic patients. HCP should adhere to the updated treatment protocol to reduce morbidity and mortality in these patients. Given that more than half of the patients were first-time presenters, screening for diabetes mellitus should be considered in the routine clinical care.

Local policy makers and other stakeholders must strengthen strategies that would deliver Equipment like ABG machine and effective educational program for clinical practitioners in adhering to standard clinical care. As significant portion of the studied patients had recurrent episodes of DKA episodes, due emphasis should be given to raise the awareness of the general public about precipitating factors and overall comprehensive diabetic care.

Similar studies in other settings should be done to validate and generalize the current findings, and they should employ stronger designs such as prospective approach.

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Annex I
English version checklist

St. Paul's Hospital Millennium Medical College
Department of Emergency and Critical Care Medicine

i. Serial number_____

ii. Card number_____

Section 1: Demographic data				
S.N.	Question item	Possible answer		
101	Age in years			
102	Sex	1. Male 2. Female		
103	Residence	1. Addis Ababa 3. Amhara 2. Oromia 4. another region		
104	is patient referred	1 yes 2 no		
105	Referral from	1.Hospital 2 health centre 3 private		
106	Treatment gets from referral hospital/health centre	1 fluid 2 insulin 3 metformin 4 kcl 5 no treatemt		
107	Site of triage	1. Green 2 yellow 3 oranges 4 Red		
108	Pre-existing comorbid condition	1. Hypertension 3. Cardiac disease 2. HIV/AIDS 4. Renal disease 5. None 6 others		
Section 2: Clinical data of the patient				
201	Type of DM	1. Type 1	2. Type 2	
202	Duration of DM in years			
203	Previous episodes of DKA in the last one year	1.None 2.Once		

		3 .Twice 4 more than three
204	Symptoms at presentation	1. Polydipsia 2. Polyuria 3. Polyphagia 4. Weight loss 5. Abdominal pain 6. Nausea and vomiting 7. Diarrhoea 8. Easy fatigibility 9. Headache 10. Other (specify)_____
205	Duration of symptoms in days	
206	GCS score at admission	1 15/15 2 9-14 3 less than 8
207	Grade of DKA	1. Mild 2. Moderate 3. Severe 4 not mention
Section 3: Laboratory characteristics at admission		
301	Blood glucose levels (mg/dL)	1 high 2 greater 250 3 less 250
302	HgA1C	1 high 2 normal 3 not done
303	Urinary ketones	1) +1 2) +2 3) +3 4) +4 5) Negative
304	Serum potassium level	1. Hyperkalaemia 2. Normokalaemia 3. Hypokalaemia
Section 4: Precipitating factors		
401	Documented precipitating factor	1. Missed insulin dose (noncompliance)

		2. Inadequate dose of insulin 3. Infection 4. Stroke 5. Myocardial infarction 6. Trauma 7. Diet abuse 8. Substance abuse 9. Unknown 10. Other (specify)_____
402	If precipitating factor is infection	1 pneumonia 2. UTI 2 wound site infection 3 others_____
Section 5: Management profile and outcome		
501	Fluid requirement during DKA management (in L)	
502	Type of fluid given	1.NS 2.DNS 3 RL 4 NS and DNS 5 NS,RL and RL
503	RBS after the first 24 hours	1. <200mg/dL 2 ≥200 mg/dL
504	Urinary ketones after the first 24 hours	Ketones 1. +1 2.+2 3.+3 4.+4 5 free
505	Type of insulin used for the treatment	1 RI 2 NPH 3 BOTH
506	Route of insulin administration in the first 24 hours	1 IV infusion 2 iv injection
507	Amount of insulin given in the first 24 hours (in IU)	
	serum potassium after management	1 hyperkalemia 2 normokalaemia 3 hypokalemia 4 not done
508	During discharge Anti-diabetes given for patient	1 insulin 2 Oral hypoglycemic

509	KCl was given	1.Yes 2. No
510	Length of time taken to get out of DKA	1. less 24hr 2 more than 24hrs
511	Length of stay in the ER	1. less 24hr 2. greater 24hr
512	Is the patient intubated	1 yes 2 NO
513	If yes indication of intubation	1 respiratory failure 2 airway protection-----
514	Days stay on mechanical ventilation	1 less than 7 days 2. greater 7 days
515	DKA medical complications	1 Hypoglycaemia 2 DVT
		3 DKA remission 4 pneumonia
		5 Hypokalaemia
		6 AKI
		7 Cerebral oedema 8 Metabolic acidosis 9 no complication
516	Patient outcome:	1 Recovered: 2 Death: 3 Referred: 4 Others(specify):
517	possible cause of death	1. septic shock 2. respiratory failure 3 hypoglycemia 4 hyperkalemia 5. cerebral edema 6 others