

Diabetic Ketoacidosis Management and Treatment Outcome at Medical Ward of Shashemene Referral Hospital, Ethiopia: A Retrospective Study

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ABSTRACT

BACKGROUND: Diabetic Ketoacidosis (DKA) is the most common and yet potentially life-threatening acute complication of diabetes that progresses rapidly to death and requires immediate medical intervention.

OBJECTIVE: To assess the DKA management and treatment outcome/in-hospital mortality and its predictors among hospitalized patients with DKA at the Medical ward of Shashemene Referral Hospital (SRH).

METHOD: A retrospective study was conducted at the Medical Ward of SRH from 01 February 2015 to 31 January 2017. A systematic random sampling technique was used to select study subjects based on the inclusion criteria. Thus, of 236 reviewed charts, only 225 patients with DKA fulfilled inclusion criteria. Treatment outcome was considered good for patients who have shown improvement at discharge, while poor for patients who left against medical advice or died in the hospital. Logistic regression analysis was done to determine independent predictors for treatment outcome/in-hospital mortality using SPSS version 20 with statistical significant at $P \leq .05$.

RESULTS: Of 225 patients with DKA, 124 (55.1%) were male. Regular insulin was prescribed to all patients and antibiotics were administered to 87 (38.7%). Potassium supplementation was given only for 28 (12.4%). Non-adherence to insulin treatment ($n = 91$; 40.4%) and infection ($n = 66$; 29.3%) were the principal DKA precipitating factors. Even though 73.8% of hospitalized patients with DKA have shown good treatment outcomes, DKA contributed 12% in-hospital mortality. The result of multivariate logistic regression analysis shown that hypoglycemia is the only independent predictor for in-hospital mortality [$P = .03$]. Moreover, the independent predictors for poor DKA treatment outcome were found to be smoker [$P = .04$], Urinary tract infection (UTI) relative to other co-morbid condition [$P < .001$], severe hypokalemia which increase risk of poor treatment outcome by around 4 times [$P = .02$], and use of Metronidazole as a concurrent medication relative to other concurrent medication [$P = .03$].

CONCLUSION: There was a high in-hospital mortality rate due to correctable causes. This mortality is unacceptable as it was majorly related to the poor practice of potassium supplementation and hypoglycemia due to insulin. Thus, clinicians and stakeholders should have to focus on modifiable factors (hypokalemia, UTI, and hypoglycemia) to reduce poor treatment outcome/in-hospital mortality.

KEYWORDS: Diabetic ketoacidosis, management, treatment, in-hospital mortality, Shashemene Referral Hospital, Ethiopia

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Introduction

Globally, the prevalence of diabetes mellitus (DM) has risen dramatically with approximately 5 million deaths in the last decade. DM contributed to 3% of admission to medical wards in Ethiopia due to acute complications. The acute complications of DM include Diabetic ketoacidosis (DKA), hyperosmolar hyperglycemic state (HHS), and treatment related-hypoglycemia.^{1–5} DKA is the most common and yet potentially a life-threatening acute complication of DM that progresses rapidly to life treating illness, thus, it requires immediate medical intervention. DKA is linked with unrestrained DM, which causes neurologic morbidity and death.⁶ It occurs primarily in patients with type 1 DM and under stressful conditions such as trauma, surgery, and/or infections it can also

occur in type 2 DM.⁷ It is mainly explained by hyperglycemia, ketonemia, and acidemia that can be associated along with a rising counter-regulatory hormone including cortisol, glucagon, and epinephrine.^{8,9} Hence, patients with DKA presents with dehydration, weight loss, polyuria, polydipsia, vomiting, weakness, and change of mental status.¹⁰

DKA severity is categorized as mild, moderate, or severe based on the metabolic acidosis severity, that is, the blood pH, bicarbonate, ketones, and the existence of altered mental status.¹¹ The most commonly utilized DKA diagnostic criteria are fasting plasma glucose greater than 250 mg/dL, arterial pH 7.3, serum bicarbonate less than or equal to 18 mEq/L, an anionic gap greater than 10, and urine dipstick ketone level $\geq +2$.¹¹ The management of DKA includes fluid resuscitation or



recurrent rehydration, electrolyte replacement, insulin therapy, and correction of exacerbating factors.^{6,7,12}

The prevalence of DKA in children and adolescents varies from 18.6% to 43.9% in developed countries such as Canada, United States, Australia, Italy, and France,¹³⁻¹⁸ whereas the overall mortality rate varies from 0.15% to 0.35% in developed countries. However, the mortality rate of children and adolescents with DKA is relatively high in developing countries that account for 3.4% to 13.4% including India, Bangladesh, and Pakistan.¹⁹ Similarly, the cause for mortality varies between developed and developing countries; for instance, cerebral edema is the predominant cause in developed countries while sepsis, shock, cerebral edema, and renal failure are the main causes with high incidences in developing countries.¹⁹

While there has been a great improvement in the knowledge, epidemiology, and management of DKA conditions in the developed worlds, there has been reserved improvement in sub-Saharan Africa.²⁰ Although DM is recognized as one of the health problems in developing countries like Ethiopia, there has been a little guarantee for the successful outcomes and its complications as the setup have not been well-documented.²¹

There is a scarcity of data regarding DKA management practice, treatment outcomes/in-hospital mortality, and its predictors among hospitalized patients with DKA in Ethiopia. Thus, the scant information in the country is a barrier for both clinicians and policymakers, to promote better health service and prevent mortality due to DKA. Therefore, to fill the gaps this study was conducted to assess the DKA management, treatment outcomes/in-hospital mortality, and its predictors among hospitalized patients with DKA at the Medical ward of Shashemene Referral Hospital, Ethiopia.

Methods and Participants

A retrospective study was conducted from February 01 to 15, 2017 based on the cards of patients with DKA who were admitted from 01 February 2015 to 31 January 2017 to the Medical ward of Shashemene Referral Hospital (SRH), Ethiopia. SRH is located in the Oromia region, Kuyera town, and 238 km away to the south of Addis Ababa; the capital city of Ethiopia. Approximately, it provides service for 2.1 million people from the catchment area. The clinical records of all DM patients with ≥ 15 years of age that were diagnosed to have DKA and admitted to the medical ward of SRH with complete information were included in the study. For patients with re-admission (more than 1 admission), the most recent admission data were considered for the study.

Single population proportion formula was used to determine the sample size with a 95% confidence interval within a 5% marginal error (W). $N = 482$ is the total number of patients with DKA admitted within the 2 years (February 01/2015 to January 31/2017). P is the proportion of DKA treatment outcome; we considered 50% to maximize the sample size.

$$n_1 = Z(\partial/2)^2 * \frac{P(1-P)}{W^2} \quad (1)$$

$$= 1.96^2 * \frac{(0.5*0.5)}{0.05^2} 384 \text{ for DKA treatment outcome}$$

Since the sample was going to be taken from a relatively small population (< 10000), then the sample size was adjusted as:

$$n_f = \frac{n}{1 + \frac{n}{N}} = 214, \quad (2)$$

then 10% for incomplete card was added = 236

Where n_1 = the desired sample, n_f is the final sample size after adjustment. The card number of those DKA patients was identified first by checking the registration logbook manually for DKA diagnosis. Then using this logbook, the card number of 236 patients were selected for the study using systematic random sampling (every other card or $482/236 = 2$) starting from the first register (relative to study inclusion period). A total sample size of 236 DKA patient's card was reviewed for analysis, of these study participants' cards, only 225 patient cards were included in the final analysis. The cards of DKA patients that had $> 20\%$ incomplete data were excluded from the study. Thus, the cards of 9 patients were excluded due to incomplete data from the final analysis. The collected data includes socio-demographic characteristics, baseline clinical data, and DKA management information or medication-related information, and treatment outcome of DKA, using a checklist. This data was collected by 2 trained, fifth-year Pharmacy students.

Statistical analysis, operational definitions, and ethical clearance

The data were cleaned, coded, and entered into SPSS, then analyzed using SPSS version 20 software. To determine independent predictors of in-hospital mortality, binary logistic regression analysis results with $P < .25$ were entered into multivariate logistic regression. Then $P \leq .05$ was considered statistically significant.

The following operational definition was considered for the current study purpose. Good treatment outcome: those patients who showed improvement after treatment at discharge. Poor treatment outcome: those patients who left against medical advice or died in the hospital. Mild DKA: arterial pH level of 7.25 to 7.3 and serum bicarbonate level of 15 to 18 mEq/L. Moderate DKA: arterial pH level of 7.0 to 7.24 and serum bicarbonate level of 10 to 14.9 mEq/L. Severe DKA: arterial pH level of less than 7.0 and a serum bicarbonate level of less than 10 mEq/L. Hypoglycemia: Blood sugar of less than 70 mg/dL. Severe hypokalemia is a plasma potassium level of < 2.5 mmol/L.

Table 1. Initial clinical presentation and precipitating factor for the development of DKA.

CLINICAL PRESENTATION	FREQUENCY (%)	PRECIPITATING FACTORS	FREQUENCY (%)
Polyuria	218 (96.9)	Non-adherence to insulin treatment	91 (40.4)
Polydipsia	208 (92.4)	Infection	66 (29.3)
Polyphagia	87 (38.7)	Others	13 (5.8)
Generalized body weakness	45 (20.0)		
Weight loss	37 (16.4)		
Loss of consciousness	22 (9.8)		
Vomiting	18 (8.0)		
Abdominal pain	20 (8.9)		

Ethical clearance was obtained from the Ethical Review Board of Ambo University, College of Medicine, and Health Science with a referral number of phar/64/2009. Permission was sought from the medical director of SRH before reviewing the patient's cards. Confidentiality of the information was assured and privacy was maintained. The ethical review board waived informed consent owing to the nature of the retrospective study design.

Results

Socio-demographic characteristics of the study participants

The study included 225 complete cards of DKA patients (95.3% response rate) with a mean \pm SD age of 28.15 ± 12.9 years. The studied sample included 124 (55.1%) male and 101 (44.9%) female DKA patients. Based on the patient's lifestyle, 71 (31.6%) were Khat (*Catha edulis*) chewers. Majority of the patients ($n=114$, 50.7%) were Muslim and single ($n=126$, 56%). The average weight of the patients in this study was 54 kg. Regarding the type of DM, the majority of study subjects ($n=141$, 62.7%) had known type I with DKA followed by newly diagnosed type I DM with DKA ($n=56$, 24.9%).

Clinical characteristics and co-morbid conditions of the study participants

Majority of the patients ($n=156$; 69.3%) were admitted within 24 hours after DKA sign and symptom onset followed by 24 to 48 hours ($n=53$; 23.6%). The median time from symptom onset to hospital admission was 24 hours. The most common clinical presentation reported were polyuria ($n=218$; 96.9%), polydipsia ($n=208$; 92.4%), and polyphagia ($n=87$; 38.7%) (Table 1).

About 81 (36%) of the studied patients had no known documented precipitating factors of DKA in the patient's chart while 144 (64%) of the patients had precipitating factors for DKA. The principal precipitating factor of DKA, as shown in Table 1, was non-adherence to insulin treatment ($n=91$;

Table 2. Co-morbid disease and concurrent infections/complication identified in hospitalized DKA patients and anti-diabetic medications prescribed during hospital discharge.

CO-MORBID DISEASE AND CONCURRENT INFECTIONS/COMPLICATION	FREQUENCY (%)
Community-acquired pneumonia	52 (23.1)
Hypertension	23 (10.2)
Urinary tract infection	9 (4.0)
Diabetic foot ulcer	6 (2.7)
Others	9 (4.0)
Anti-diabetic medications used for the treatment of type 1 and 2 diabetes	
RI + NPH 0.5 units/kg/day BID	102 (45.3)
Metformin 500 mg PO BID	8 (3.6)
Glibenclamide 5 mg PO daily	3 (1.3)
Metformin 500 mg PO BID + Glibenclamide 5 mg PO daily	9 (4.0)
NPH 0.5 units/kg/day BID	44 (19.6)

Abbreviations: BID, bis in die or twice a day; KG, kilogram; NPH, neutral protamine hagedorn, it is intermediate-acting insulin; PO, per os or peroral; RI, regular insulin, it is short-acting insulin.

40.4%). Infection accounted for precipitating DKA in 66 (29.3%) cases. The median time from hospital admission to initiation of fluid and insulin therapy was half-hour and 1.5 hours, respectively. Of the 225 DKA patients, most ($n=130$; 57.8%) of them were diagnosed as moderate followed by mild ($n=60$; 26.6%) and severe DKA ($n=35$; 15.6%).

Among 225 study participants, 99 (44%) of them have co-morbid and concurrent infections. Community-acquired pneumonia ($n=52$; 23.1%) was identified as the major concurrent infection while hypertension ($n=23$; 10.2%) was the major non-infectious co-morbid condition in the hospitalized DKA patients (Table 2).

Table 3. Concomitantly used medications for DKA patients in-hospital.

TYPE OF CONCURRENTLY USED DRUGS IN MEDICAL WARD		FREQUENCY (%)
ACE inhibitors	Enalapril 5 mg per oral daily	27 (12.0)
Antibiotics	Ceftriaxone 1 gm IV BID and Azithromycin 500mg	36 (16.0)
	Ceftriaxone 500mg IV BID	27 (12.0)
	Metronidazole 500mg IV TID	11 (4.9)
Others	β-blockers, Calcium channel Blockers & Diuretics	9 (4.0)

Abbreviations: BID, bis in die or twice a day; IV, intravenous; TID, ter in die or 3 times a day.

Management of hospitalized DKA patients

Insulin therapy was administered to all patients. All the DKA patients (n=225; 100%) received Regular insulin (RI) 10 units IV and 10 units IM stat at time of admission while 95 (42.2%) and 130 (57.8%) DKA patients were administered RI 5 units subcutaneous every hour and RI 0.1units per kg per hour, respectively until urine becomes free of the ketone. Then, RI 4 to 16 units IV (n=177; 78.7%) were given every 5 hours during the sliding scale. Modified insulin therapy was also administered including RI + NPH 0.5units/kg/day (n=188; 83.6%) and NPH 0.5units/kg/day (n=37; 16.4%) BID until discharged.

The most commonly used fluid replacement per hospital stay was 0.9% normal saline solution, which accounts for 178 (79.1%) and administered for those patients with blood glucose levels greater than 250 mg/dL. On the other hand, 5% dextrose in 0.9% normal saline was administered to those DKA patients whose blood glucose level is below 250 mg/dL (n=28; 12%). The median amount of fluid replacement was 5 L per hospital stay. Potassium supplementation was given only for 28 (12.4%) patients in the form of KCl injection (n=19; 8.4%) and tablet (n=9; 4.0%) and supplementation was not prescribed for 197 (87.6%) patients.

Among the studied hospitalized DKA patients, only 166 (73.8%) were discharged with insulin and oral hypoglycemic agent. Among these, 45.3% were discharged with RI + NPH and 4% were metformin and glibenclamide (Table 2).

About 126 DKA patients (56%) had no concurrent medication. Out of the total concurrent medication prescribed, 32.9% of patients prescribed antibiotics followed by Angiotensin-converting enzyme (ACE) inhibitors 12% (Table 3).

Treatment outcome and its predictors for hospitalized patients with DKA

About 166 (73.8%) hospitalized DKA patients have shown an improved treatment outcome (good treatment outcome) at discharge, while 59 (26.2%) patients have shown a poor treatment outcome. Out of the patients with poor treatment outcomes, 32 (14.2%) were left against medical advice and in-hospital mortality was 27/225 (12%). Among the known causes of in-hospital mortality as recorded on the patients' card, severe

hypokalemia (n=14; 52%), hypoglycemia secondary to increased insulin dose (n=7; 26%), and worsening of DKA (n=6; 22%) as the result of the co-morbid condition were the most common reason. However, the result of multivariate logistic regression analysis shown that hypoglycemia was the only independent predictor for in-hospital mortality [$P=.03$]. Moreover, the independent predictors for poor DKA treatment outcome were found to be smoker [$P=.04$], Urinary tract infection (UTI) relative to other co-morbid conditions [$P<.001$], Severe hypokalemia which increase risk of poor treatment outcome by around 4 times [$P=.02$], and use of Metronidazole as a concurrent medication relative to other concurrent medication [$P=.03$], (Table 4).

Discussion

The 2-year hospital-based retrospective study found that mortality due to DKA in SRH was high, which needs urgent attention from stakeholders. Especially in the 21st century, the death of DKA patients due to preventable causes like hypokalemia and hypoglycemia is unacceptable. Because mortality due to DKA in developed countries was almost less than 1%. However, in developing countries including Ethiopia, mortality is high due to different reasons.^{19,22,23} However, the mortality rate in Kenya was even higher than the current study report (29.8%).^{22,23} This finding was consistent with the studies conducted at St Luke's Hospital (Ethiopia) and Jimma University Specialized Hospital (Ethiopia).^{21,23}

Even though DKA is a potentially life-threatening diabetic complication, it is exclusively preventable. But in the current study, it was more prevalent due to different reasons.^{23,24} The most common precipitating factors for DKA in this study were non-adherence to insulin treatment and infection.^{23,25} Pneumonia was identified as the major concurrent infection. This finding was inconsistent with the study conducted at the University of Malaysia in which hypertension was responsible for 54.5%.²⁵ The low prevalence of hypertension could be explained partly due to the difference in mean age (28.15 ± 12.9) of the patients as aging is linked to hypertension.

Insulin therapy was generally administered according to Ethiopian Standard Treatment Guidelines for DKA management.²⁶ The dose could possibly depend on the physicians'

Table 4. Predictors for treatment outcome and in-hospital mortality for DKA patients.

VARIABLES	CATEGORIES	TREATMENT OUTCOME OF DKA		CRUDE ODD RATIO (95% C.I)	ADJUSTED ODD RATIO (95% C.I)	P-VALUE
		GOOD (N=166) (%)	POOR# (N=59) (%)			
Age	16-20	68 (76)	21 (24)	1.8 (0.4, 8.7)	0.6 (0.1, 3.8)	0.59
	21-25	32 (70)	14 (30)	1.4 (0.3, 7.6)	0.8 (0.1, 5.7)	0.84
	26-35	27 (73)	10 (27)	1.5 (0.3, 8.0)	0.7 (0.1, 5.3)	0.74
	36-50	35 (83)	7 (17)	1.8 (0.3, 10.0)	0.9(0.1, 6.1)	0.91
	Above 50	4 (36)	7 (74)	1	1	
Sex	Male	87 (70)	37 (30)	0.8 (0.4,1.4)	1.5 (0.7, 3.0)	0.31
	Female	79 (77)	24 (23)	1	1	
Social history	Chat chewers	61 (86)	10 (14)	1.0 (0.3, 3.5)	1.3 (0.2, 7.0)	0.76
	Smokers	10 (71)	4 (29)	0.1(0.01, 1.5)	18.1 (1,314.5)	0.04*
	Unknown	87 (67)	40 (33)	0.6(0.2, 2.3)	2.5 (0.5, 13.4)	0.28
	Others	8 (67)	4 (33)	1	1	
Marital status	Single	94 (75)	32 (25)	0.9 (0.5, 1.7)	0.8 (0.4, 6.5)	0.65
	Married	72 (73)	27 (27)	1	1	
Occupation	Student	65 (68)	31 (32)	0.6(0.2, 1.4)	1.6 (0.4,6.4)	0.55
	Farmer	55 (81)	13 (19)	0.6(0.2, 1.5)	1.5 (0.4, 5.4)	0.53
	Employed	26 (87)	4 (13)	0.8(0.3, 2.3)	0.8 (0.2, 3.1),	0.73
	Others	20 (61)	11 (39)	1	1	
DM type	Known type I with DKA	118 (84)	23 (16)	0.9(0.4, 2.3)	1.0 (0.3,3.1)	0.95
	Newly diagnosed type I with DKA	36 (64)	20 (36)	0.8(0.3, 2.1)	1.0 (279, 581)	1.00
	Known type II with DKA	15 (54)	13 (46)	1	1	
Co-morbidity	Pneumonia	52 (63)	31 (37)	0.4(0.2, 1.0)	1.9 (0.5, 7.7)	0.39
	Hypertension	23 (77)	7 (23)	2.5(1.0, 6.2)	0.3 (0.1, 1.8)	0.19
	UTI	9 (90)	1 (10)	0.8(0.2, 3.9)	2.2 (1.8, 2.6)	0.00*
	Others	9 (100)	0 (0)	1	1	
Potassium status	Severe hypokalemia	26 (93)	2 (7)	0.4(0.2, 0.8)*	3.5 (1.2, 10.1)	0.02*
	Not severe/unknown result	167 (85)	30 (15)	1	1	
Fluid therapy	0.9%NS	142 (80)	36 (20)	0.6(0.2, 1.6)	1.7 (0.5, 5.5)	0.39
	D5%W	12 (44)	15 (66)	0.8(0.2, 2.7)	1.4 (0.3, 7.0)	0.69
	DNS	12 (60)	8 (40)	1	1	
Drug for co-morbidity	Ceftriaxone + Azithromycin	31 (86)	5 (14)	0.5(0.19, 1.5)	1.5 (0.3, 7.7)	0.63
	Ceftriaxone	25 (93)	2 (7)	0.9(0.3, 2.4)	0.8 (0.3, 2.8)	0.70
	Enalapril	20 (74)	7 (26)	2.5(1.0, 6.6)	1.1 (0.2, 7.2)	0.92
	Metronidazole	8(67)	4 (33)	6.1(1.5, 26.0)*	4.1 (4.1, 4.2)	0.00*
	Other medication	9 (100)	0 (0)	1	1	
Residence	Urban	118 (76)	37 (24)	0.7(0.4, 1.2)	1,5 (0.7, 3.2)	0.28
	Rural	48 (69)	22 (31)	1	1	

(Continued)

Table 4. (Continued)

VARIABLE	CATEGORIES	IN-HOSPITAL MORTALITY		CRUDE ODDS RATIO (95% C.I.)	ADJUSTED ODDS RATIO (95% C.I.)	P-VALUE
		NO (N=198) (%)	YES (N=27) (%)			
Reason for in-hospital mortality	Hypokalemia	13 (48)	14 (52)	0.2(0.1, 1.5)	4.8 (0.6, 41.2)	0.16
	Hypoglycemia	20 (74)	7 (26)	6.8(1.3,36.1)*	0.1 (0.2, 0.8)	0.03**
	Worsening of DKA	21 (78)	6 (22)	1	1	

Abbreviations: C.I, confidence interval; DKA, diabetic keto acidosis; DM, diabetes mellitus; DNS, dextrose in normal saline; D5%W, 5% dextrose; LAMA, left against medical advice; # (LAMA=32 and death=27); 0.9%NS, 0.9% normal saline; UTI, urinary tract infection.

*Significantly associated with treatment outcomes.

**Significantly associated with in-hospital mortality.

concerns about the patients either hypoglycemia or rapid reduction of blood glucose levels. Even though no routine blood chemistry machine for plasma electrolyte study to determine the level of serum potassium as one important DKA treatment protocol in the study area, potassium supplementation was given only for a few patients. This is an indicator of the inappropriate DKA patient management in this hospital. This result was partially supported by the study from St Lukes Hospital, Malta [Ethiopia].²¹ This condition brought a risk of incorrect use of medication for DKA patients which require urgent intervention to save the life of patients. Because almost all of the patients need potassium supplementation, due to Insulin or acidosis induced potassium exchange between extracellular and intracellular.²⁷ Indeed, study confirmed that around 22.7% of DKA patients at admission present with hypokalemia,²² thus, the addition of insulin therapy will exacerbate the condition to be in more severe hypokalemia.^{28,29} In addition, a study from the UK confirmed that patients treated for DKA had hypoglycemia in 27.6% and hypokalemia in 55%.²⁸ Moreover, supplementation of potassium in the absence of serum potassium may lead to death as a result of hyperkalemia or cardiac complication.²⁹

Thus, the higher in-hospital mortality rate in our setting and other parts of the world is the issue that needs urgent attention to improve the quality of DKA care.^{12,24,25,30-32} The most probable reason for such a high mortality rate could be due to lack of appropriate diabetic care, lack of screening for hypoglycemia and hypokalemia, financial constraints for laboratory support and insulin, as well as poor management practice of co-morbidity treatment like hypokalemia and hypoglycemia.²⁷⁻²⁹ Therefore, in developing countries like Ethiopia, there should be free health care for those patients with DM to improve access to quality care.

The current study has shown that hypoglycemia is the only independent predictor for in-hospital mortality. Moreover, the independent predictors for poor DKA treatment outcomes were found to be smokers, UTI, and severe hypokalemia. Similar to this study finding, the studies have shown that the presence of hypokalemia,³³ and presence of infection/fever/

sepsis,^{22,34} were predictors of negative DKA treatment outcome.³³ This study was not without limitations. The first one is the nature of the study design (retrospective) and the second was a single-center study, which may not be representative of the whole DKA patients in Ethiopia. The final limitation was unavailability of routine electrolyte test in the hospital.

Conclusion and Recommendation

There was a high in-hospital mortality rate due to correctable causes. DKA management protocol specifically Insulin therapy was generally administered according to Ethiopian Standard Treatment Guideline. However, the high in-hospital mortality is unacceptable as it was majorly related to the poor practice of serum potassium assessment as well as potassium supplementation and hypoglycemia secondary to the increased insulin dose. Given that these factors are easily preventable, healthcare providers, government of Ethiopia, and stakeholders should set an emphasis on adherence to standard DKA treatment protocol, availability of serum potassium test, routine blood sugar test to avoid hypoglycemia, and insulin to improve adherence, so that we can reduce in-hospital mortality due to DKA.


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Author Contributions

Taye GM: conceived the study, participated in its design. AJ and Taye GM: Did the data collection and statistical analysis. FA and Tefera GM: contributed to study design, data collection, and statistical analysis. MHB, Tefera GM, Taye GM, and AJ: contributed to the drafting of the manuscript, study design, and statistical analysis. All authors read and approved the final manuscript.

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