



CLINICAL ENDOCRINOLOGY

Treatment Outcome and Associated Factors among Type 1 Diabetic Children Admitted with DKA in Bahir Dar City Public Referral Hospital, Northwest, Ethiopia: A Cross-Sectional Study

Fentahun Meseret^{1*}, Silenat Muluken², Tilaye Gebru¹ and Tsegasew Embiale³

¹School of Nursing and Midwifery, College of Health and Medical Science, Haramaya University, Harar, Ethiopia

²Department of Pediatrics and Child Health Nursing, College of Medicine and Health Sciences, Bahir Dar University, Bahir Dar, Ethiopia

³Department of Pediatrics and Child Health Nursing, Dire Dawa University, Deri Dewa, Ethiopia

*Corresponding author: Fentahun Meseret Wubalem, Department of Pediatrics and Child Health Nursing, College of Health and Medical Sciences, Haramaya University, P.O. Box 235, Harar, Ethiopia



Abstract

Background: Length of hospital stay, complication and mortality are the primary outcomes that should be measured during diabetic ketoacidosis management. However, data associated with the length of stay, complications, and mortality rate due to diabetic ketoacidosis remains limited in Ethiopia. In addition, nonfiction is very scarce about factors associated with treatment outcomes starting from its initial presentation and the overall management process. Therefore, this study was aimed to assess the treatment outcomes of children admitted with diabetic ketoacidosis at the Felege Hiwot comprehensive referral hospital, North West, Ethiopia.

Methods: A cross-sectional study was conducted among children admitted with diabetic keto acidosis between 2016 and 2021. Data were collected using the data abstraction tool. Then, stored in Epi-dataversion 4.6 and exported into STATA 14.0 statistical software for analysis. Catagorical variables were described using proportions and compared using the Chi-square test; Whereas, continuous parametric variables with median and standard deviations were compared using parametric(t-test). Model goodness of fit and assumptions were checked. The association between independent variables and length of hospital stay was assessed using binary logistic regression. Finally, variables with p-value < 0.05 were considered as statistically significant.

Result: The median length of hospital stay was 8 ± 6.2 days. 59.3% of the patients had along hospital stay (> 7 days). The majority of patients (97.5%) improved and were

discharged with 14.2% complications and 4(2.5%) died in the hospital. Factors that affected longer hospital stay were Residence (aOR = 4.31; 95CI = 1.25-14.80), family history of diabetes (aOR = 0.12; 95% CI = 0.02-0.64), glycemia at addmision (aOR = 1.01; 95% CI = 1.00-1.02), insulin skipping (aOR = 0.08; 95% CI = 0.01-0.98), abdominal pain (aOR = 4.28; 95% CI = 1.11-15.52) and time in which the patient get out of diabetic ketoacidosis (aOR = 6.39; 95% CI = 1.09-37.50).

Conclusion: Majority of patients showed improvement and were discharged to their homes after a long hospital stay and with a very low mortality rate followed by complications (14.2%). The time in which the majority of patients got out of diabetic ketoacidosis were between 24-48 hours. Thus, to achieve intended treatment outcome early in time, clinicians and other stakeholders should focus on diabetic ketoacidosis presentation and precipitating factors with possible multicenter studies.

Keywords

Type 1 Diabetes Mellitus, Diabetic Ketoacidosis, Treatment outcome, Children, Ethiopia

List of Acronyms

ADA: American Diabetic Association; BGM: Blood Glucose Monitoring; BMI: Body Mass Index; CIRI: Continuous Intravenous Regular Insulin; DKA: Diabetic Keto Acidosis; ESPE: European Society for Pediatric Endocrinology; FBS: Fasting Blood Glucose; HIV: Human Immunodeficiency Virus; IDF: International Diabetic Federation; IVF: Intravenous Fluid; ISPAD: International Society of pediatrics

Citation: Meseret F, Muluken S, Gebru T, Embiale T (2023) Treatment Outcome and Associated Factors among Type 1 Diabetic Children Admitted with DKA in Bahir Dar City Public Referral Hospital, Northwest, Ethiopia: A Cross-Sectional Study. Int Arch Endocrinol Clin Res 9:034. doi.org/10.23937/2572-407X.1510034

Accepted: December 28, 2023; **Published:** December 30, 2023

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and Adolescent Diabetes; NCDs: Non-Communicable Disease; RBS: Random Blood Glucose; SSA: Sub Saharan Africa; T1DM: Type one Diabetes Militus; TLC: Total Leukocyte Count; TB: Tuberculosis

Introduction

Type 1 diabetes militus (T1DM) is the most common endocrine metabolic disorder in children; TDM is a serious, chronic and progressive disease that occurs when the pancreas does not produce enough insulin [1]. Almost one in 300 children develop T1DM [2]. These findings have been documented in many countries including both developed and developing countries [2,3]. It has been reported that, the incidence of T1DM is increasing by 3-4% per year globally in light of geographical variation with a high correlation between this incidence and socio-economic factors [4,5].

Diabetic ketoacidosis (DKA) is an expensive acute complication of T1DM that can occur when there is a comparative or complete decrease in circulating insulins [6]. The magnitude of DKA among children with diabetes has increased over the past 3 decades [7]. DKA has become the most common sticky situation of T1DM in children with an incidence of 1-10% per year and 30 to 70% prevalence in both high and middle-income countries [7-9]. It is the most common reason for hospitalization, morbidity and mortality in children with an admission rate of 16.5-78% in hospitals [10]. The pooled mortality for DKA is estimated to the range of 2-5% in developed nation and 6-24% in developing countries [11-14].

The prevalence of DKA at the time of diagnosis in sub-Saharan Africa is between 70% and 80% [15]. The proportion of children diagnosed with DKA in Addis Ababa, Ethiopia, was high (35.8%) [10]. Likewise, in Gojjam, Ethiopia, the overall incidence rate of DKA was 2.27 per 100 children/month of observation [16].

Insulin deficiency, dehydration and hormone increments such as cortisol, adrenaline, glucagon, and growth hormone are some of the clinical features of children admitted with DKA [17]. The biochemical criteria for the diagnosis of DKA are hyperglycemia (blood glucose level > 200 mg/dl, venous pH less than 7.3 or serum bicarbonate level less than 15 mEq/L and ketonemia (blood β -hydroxybutyrate concentration > 3 mmol/L) or moderate or severe ketonuria [6,18,19].

Patients can be dramatically ill, and the severity of presentation can be graded based on the degree of acidosis; Mild DKA: venous pH from 7.2-7.3 or serum bicarbonate < 15 mmol/L; Moderate DKA: venous pH from 7.1-7.2 or serum bicarbonate < 10 mmol/L; Sever DKA: venous pH < 7.1 or serum bicarbonate < 5 mmol/L [19]. And as severity increases, the need for pediatrics intensive care as well as the risk of morbidity and mortality increases [20]. However, with proper management, most patients recover rapidly [7].

It has been identified that, poor glycemic control, comorbidities, younger age, and low socio-economic status have been associated with an increased risk of developing DKA; but, it is unclear if this risk factor influences patient outcomes in pediatric management centers [21].

Higher mortality rates among children admitted with DKA were reported with an increased incidence of cerebral edema, sepsis, shock, cerebral injury, altered levels of consciousness, respiratory failure with hyposphoemia, renal failure, and delayed diagnosis both in developed and developing countries [11,14,22-26]. DKA could be the principal source of death, mainly when complicated by cerebral edema/injury with an estimated mortality rate of 20 to 50%, and 15-35% of survivors are left with permanent neurologic deficits [12,27,28]. Acute complications of DKA can be also accompanied by malnutrition, parasitic infections, and microbial infections with tuberculosis and HIV [28]. Overlapping of these conditions contributes to the increased morbidity and mortality rates. The inability of patients to afford insulin treatment leads to poor glycemic control. As a result, patients may seek alternative treatment from traditional healers or use herbal remedies further complicating the management process [29].

During DKA treatment, the administration of insulin hinders the production of ketoacidosis and facilitates its metabolism, thereby helping correct the acidosis [17]. Effective treatment requires the replacement of insulin, fluids, and electrolytes. Applying the novel approach of early diagnosis and treatment by multidisciplinary diabetic care teams can also ensure good outcomes [24,30-32]. Length of stay, complications, and overall mortality among children with DKA during management are the foremost outcomes that should be measured. This is because, it is highly trusted to improve T1DM and DKA-management related complications. However, data associated with length of stay, complications following management, and rate of mortality due to DKA remain limited in Ethiopia.

Therefore, the current study aimed to determine treatment outcomes of children admitted with DKA at Felege Hiwot comprehensive referral hospital in Amhara region, Northwest, Ethiopia.

Method

Study area and period

The study was conducted in the Bahir Dar city; placed 565 Km far from Addis Ababa, the capital city of Ethiopia, in Amhara region, Northwest Ethiopia., has two public referral hospitals, one primary hospital, ten health centers, and four private hospitals. This study was conducted at Felege Hiwot's comprehensive specialized referral hospital (FHCSH). This hospital is expected to serve more than 10 million people from the

catchment area. This hospital currently has a total of 1431 manpower in each discipline with 500 formal beds, 11 wards, and 39 clinical and nonclinical departments/units/providing Diagnostic, curative, Rehabilitation, and preventive services both in outpatient & inpatient bases.

Apart from other services, the hospital provides diabetic treatment services by nurse practitioners, pediatric residents, and pediatricians. The study period addressed from 1st January, 2016 to February 30 /2021.

Study design

An institution-based retrospective cross-sectional study was employed.

Source and study population

Source population: All pediatric T1DM patients who were on follow-up at Felege Hiwot comprehensive referral hospital were the source of population in this study.

Study population: All pediatric T1DM patients who were admitted with DKA during the study period.

Sample size and sampling technique

Randomly selected Pediatric cases (< 15-years-old) T1DM clients admitted with DKA in the period from January 1st 2016 to February 30, 2021 (5-years) were included. To determine the sample size, the following assumptions were considered: 80.95% of clients were discharged with an improvement in Jimma with a 95% confidence level and 5% marginal error [12]. The sample size was calculated using Raosoft software (http://www.raosoft.com/sample_size.html). Because the total population is < 10,000, we used the correction formula. Yields the final sample size 176.

Sampling procedure

The study participants were selected from the registration book. The medical profiles of children admitted with DKA between January 1st, 2016, and February 30, 2021, were selected. Finally, cards that fulfilled the criteria were reviewed.

Inclusion criteria: Children aged less than 15 years and diagnosed with DKA from January 1/2016 to February 30/2021 were included.

Exclusion criteria: Children's charts that had incomplete information and were lost during the study period.

Study variables

Dependent variables: Length of stay, complication, and mortality of children admitted with DKA.

Independent variables: Socio-demographic (age, sex, residence, and educational status of the children including weight and height); diabetes-related variables/clinical and biochemical variables (family

history of T1DM, type of T1DM, the severity of DKA, admission blood glucose readings, duration of chief complaint, sign and symptoms of client presentation, comorbidities, all vital signs, DKA precipitating factors, frequency of DKA episode during the study period, electrolyte disturbance, ketone, and urine glucose level and treatment related-variables and/or medication-related variables (co-medication and a therapeutic class of co-medication).

Operational definitions

Diabetic ketoacidosis (DKA): Is defined as an admission of blood glucose > 250 mg/dl and the presence of ketonemia and/or ketonuria [6,18,19].

Hyperglycemia: Is defined as a random plasma glucose level > 200 mg/dl and hypoglycemia is defined as a blood glucose level ≤ 70 mg/dl [20].

Euglycemia: Is defined as serum glucose between 100 and 200 mg/dl [33].

Normoglycemia: Is defined as a blood glucose level between 90 mg/dl and 130 mg/dl [19].

A longer hospital stay: Was defined as a hospital stay for > 7 days and a short hospital stay was considered if the patient could stay in the hospital for ≤ 7 days [34].

Poor glycemic control: Blood glucose level for age group (5-12): < 80 or > 180 mg/dl; And for age group (13-18 years) < 90 or > 130 mg/dl and HbA1c > 7.5% irrespective of their age category [1,19].

Treatment outcome: The length of hospital stay, complications following treatment, and mortality of DKA were the measures of treatment outcome in the context of the present study.

Definitions of terms

Chief complaint: This was the main reason for the patient to visit the hospital.

Co-morbidity: Implies concomitant diseases that are not the complications of T1DM and/or DKA.

Co-medication: Co-medications are concurrent drugs prescribed for the treatment of diseases, or deficiencies, other than antihyperglycemics.

Diabetic ketoacidosis: Implies patients with positive urine and/or serum ketones and with plasma glucose greater than 250 mg/dl.

Category of DKA [35]

Mild DKA: Urine and/or serum ketone positive with plasma glucose > 250 mg/dl, arterial pH 7.25-7.30, and an alert level of consciousness.

Moderate DKA: Urine and/or serum ketone positive with plasma glucose > 250 mg/dl, arterial pH 7.0-7.24 with an alert or drowsy level of consciousness.

Sever DKA: Urine and/or serum ketone positive with

plasma glucose > 250 mg/dl, venous pH less than 7 with stupor or coma.

Insulin defaulters: Are known type one diabetes patient who discontinued insulin treatment because of different reasons.

Client characteristics: Implies different clinical characteristics and biochemical finding of the patients.

Data collection methods

Medical records of patients with DKA admitted to the hospital were drawn from patient logbooks and a card room. The selections of medical records for sampling were based on the physician's confirmed diagnosis on patient logbooks. Participants included in the study were all TDM patients with DKA admitted to Felege Hiwot comprehensive referral hospital with age < 15-years-old and whose medical records confined compliant client data.

Data quality control

The data were collected by trained data collectors using structured and pre-tested data extraction tools. Data were collected on patient's demographics, presenting symptoms, precipitating causes of DKA, vital signs, biochemical profiles (admission blood glucose, admission urine ketone, urine glucose) at presentation to the inpatient department, time from presentation to the resolution of urine ketones, length of hospitalization and treatment outcomes.

Data processing and statistical analysis

Data were entered into Epidata version 4.6 software for cleaning and exported to STATA version 14.0 for analysis. Tables and text were used to present the findings. Categorical variables were described using proportions, and continuous parametric variables with median and standard deviation. Categorical variables were compared using the Chi-square test and fisher's exact test, whereas, continuous variables were compared using parametric (t-test). Binary logistic regression was done to determine the factors that affect length of hospital stay and mortality.

Result

Sociodemographic characteristics

One hundred seventy-six (176) medical records were reviewed; of which, fourteen (7.95%) patient's charts were not included in the study due to important variables being missing there. Accordingly, 162 patients medical record were investigated with 92.05% of response rate.

The median age of the study participants was 8 ± 4.7 with 2.4 years mean duration of diabetes. And almost 48.8% of them were within the age range of 11-14 years.

Greater than half of the patients were males (51.2%)

Table 1: Socio-demographic characteristics among T1DM children admitted with DKA, Bahir Dar, Ethiopia, 2021 (n = 162).

Variable	Category	Frequency (%)
Age group in years	< = 5	33(20.4)
	> 5-10	50(30.9)
	> 10-14	79(48.8)
Sex	Male	83(51.2)
	Female	79(48.8)
Resident	Urban	54(33.3)
	Rural	108(66.7)
Educational status of children	KG/not started	49(30.3)
	Primary school	96(59.3)
	High school	17(10.5)
Primary caregiver	Mother	80(49.4)
	Father	27(16.7)
	His/her self	25(15.4)
	Other	30(18.5)

Other-includes sisters, brothers and another primary caregiver (guardian) in the home

and the majority of the patients (66.7%) were from rural areas. (Table 1).

Clinical characteristics

Out of the investigated patients, 129(80.6%) were newly diagnosed cases and the remaining 31(19.4%) were known T1DM patients. The majority (103[63.6%]) of the patients were on mixed insulin (regular and lent) treatment and the other patients were on either regular and NPH (30[18.6%]) or NPH alone (29[17.9%]) with an average insulin dose of 16.5 ± 10.7 u/day. Greater than half of the patients had T1DM for more than three years (86[53.1%]).And many of the patients had a history of comorbid illness (108[66.7%]) (Table 2).

Frequency of DKA episode severity and its precipitating factors

The rate of DKA reoccurrence was assessed and showed that, majority of the patients encountered on it at once (116[71.6%]), 31[19.1%] had two episodes, 12[7.4%] and 3[1.9%] of the patients had three and four episodes of DKA recurrence during their follow up period respectively. And 29(17.9%) of the patients were on severe DKA, whereas 61(37.7%) and 72(44.4%) of the patients had moderate and mild DKA during their presentation. The most common precipitating factor was found to be infection (91[56.2%]).Other precipitating factors are shown in Figure 1 and Table 3).

Clinical presentation and laboratory results of clients admitted with DKA

In this study, most of the patients were presented with polyuria (144[88.9%]) and polydipsia (137[84.6%]).

Table 2: Clinical characteristics among T1DM children admitted with DKA, Bahir Dar, 2021 (n = 162).

Variable	Category	Frequency (%)
Diagnosis	Newly	130(80.2)
	Known	32(19.8)
Body mass index (BMI)	< 16 kg/m ²	89(54.9)
	16-25 kg/m ²	71(43.8)
	> 25 kg/m ²	2(1.2)
Family history of diabetes militus	Yes	25(15.4)
Duration of DM (years)	<= 3	76(46.9)
	> 3	86(53.1)
Insulin regimen	Regular & lent	103(63.6)
	Regular & NPH	30(18.5)
	NPH alone	29(17.9)
Insulin dose	<= 7 u/day	75(46.3)
	> 7 u/day	87(53.7)
Frequency of glycemc control	< 3	50(30.9)
	>= 3	112(69.1)
History of comorbidity	Yes	108(66.7)
Autoimmune disease	Yes	39(1.9)
Hypertension (HTN)	Yes	2(1.2)
Cardio vascular disease (CVD)	Yes	1(0.6)
Wasting	Yes	49(30.2)
Stunting	Yes	13(8)
Pneumonia	Yes	26(16)
Urinary tract infection (UTI)	Yes	24(14.8)
Upper respiratory tract infection (URTI)	Yes	10(6.2)
Tuberculosis (TB)	Yes	3(1.8)
Acute gastroenteritis (AGE)	Yes	17(10.5)
Meningitis	Yes	5(3.1)
Hepatitis	Yes	4(2.5)
Malaria	Yes	7(4.3)
Anemia	Yes	10(6.2)
Fungal infection	Yes	17(10.5)
Other comorbidities	Yes	8(4.9)

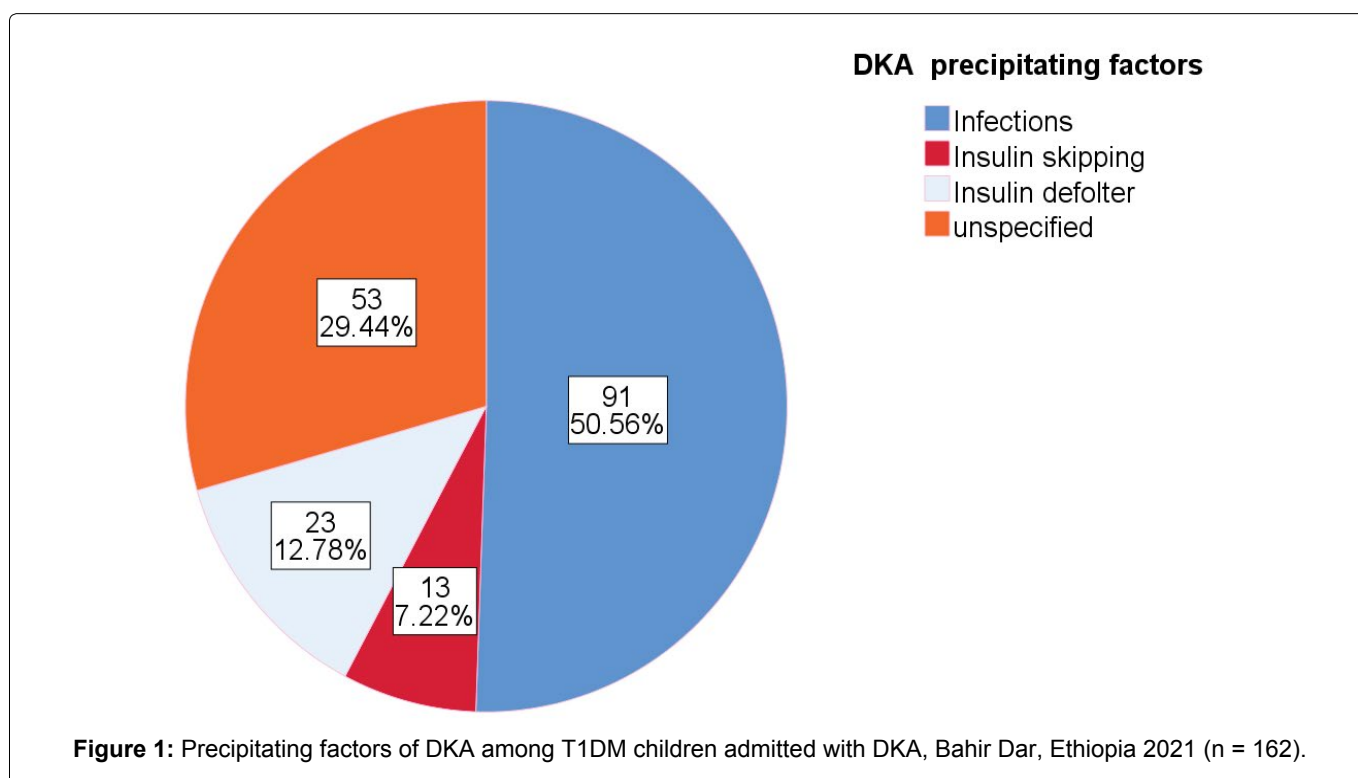
Table 3: Frequency of DKA episode, severity, precipitating factors, clinical presentation and Laboratory results among T1DM children admitted with DKA, Bahir Dar, 2021(n = 162).

Variable	Category	Frequency (%)
Frequency of DKA episodes in the study period	Once	116(71.6)
	Two times	31(19.1)
	Three times	12(7.4)
	Four times	3(1.9)
Severity of DKA	Mild	72(44.4)
	Moderate	61(37.7)
	Severe	29(17.9)
Precipitating factors	Infection	91(56.2)
	Insulin skipping/omission	13(8.1)
	Insulin defaulter	23(14.2)
	Inappropriate insulin storage	15(9.3)
	Unspecified/not documented	38(23.5)

Location of admission	Emergency only	24(14.8)
	Intensive care unit(ICU)	11(6.8)
	Pediatrics ward	127(78.4)
Polyuria	Yes	144(88.9)
Polydipsia	Yes	137(84.6)
Polyphagia	Yes	61(37.6)
Abdominal pain	Yes	51(31.5)
Nausea/vomiting	Yes	63(38.9)
Fatigue	Yes	63(38.9)
Cough	Yes	23(14.2)
Weight loss	Yes	47(29)
Respiratory distress	Yes	37(22.8)
Confusion	Yes	25(15.4)
Blurred vision	Yes	6(3.7)
Fever	Yes	8(4.9)
Others	Yes	6(3.7)
PR (beats/min)		115 ± 22.1
RR (breath/min)		31.1 ± 10.3
Temperature (°C)		36.6 ± 0.9
Duration of chief complaint in day		14.1 ± 16.1
Glycaemia at admission (mg/dl)		508.7 ± 101.8
Ketone level (mmol/l)		2.7 ± 0.9
Urine glucose level (mmol/l)		2.4 ± 0.8

PR: Pulse Rate; RR: Respiration Rate; Others include diarrhea; headache; and dizziness

NB: The most common infection that precipitates DKA includes UTI, URTI, acute gastroenteritis, pneumonia.... See above in [Table 2](#).



In addition to these, nausea/vomiting (63[38.9%]), polyphagia (61[37.7%]) and abdominal pain (51[31.5%]) were reported. Regarding vital signs, the mean value of pulse rate was 115 ± 22.1 beats/min, respiration rate

was 31.1 ± 10.3 breath/min, and body temperature was 36.6 ± 0.9 °C. [Table 3](#) shows the details regarding clinical presentation and some laboratory results.

Table 4: DKA management protocol, comedications and treatment outcome among T1DM children admitted with DKA, Bahir Dar, 2021 (n = 162).

Variable	Category	Frequency (%)
Types of IV fluid bolus	Normal saline (NS)	161(99.4)
	Ringer lactate (RL)	1(0.6)
Amount of IV fluid bolus in milliliter (Mean ± SD)		362.2 ± 348.4
Types of MF used in the management	NS only	63(38.9)
	NS&D5W	75(46.3)
	NS&D10%	6(3.7)
	NS,D5W&D10%	2(1.2)
Rate of MF in ml/hr. (Mean ± SD)		89 ± 14
Insulin administration rate (u/hr.)		9.6 ± 4.3u
Regular insulin		162(100)
Potassium replacement		56(34.6)
Comedication	Yes	110(68)
Antibiotics	Yes	81(73)
Anti-parasitic drugs	Yes	17(15.5)
Antifungal drugs	Yes	4(3.6)
Other drugs	Yes	5(4.6)
Time in which the patient gets out of DKA in hours	< 24	33(20.4)
	24-48	58(35.8)
	48-72	38(23.5)
	> 72	33(20.4)
LOS in category	<= 7	66(40.7)
	> 7	96(59.3)
LOS (median ± SD)		8 ± 6.2 days
Minimum LOS		1 day
Maximum LOS		35 days
Not improved/died	Yes	4(2.5)
Improved	Yes	158(97.5)
Complication	Yes	23(14.2)
Types of complications	Hypokalemia	11(6.8)
	Hyperkalemia	2(1.2)
	Hypernatremia	4(2.5)
	Hyponatremia	5(3.1)
	Neurologic sequeli	4(2.5)
	Hyperchloremia	3(1.9)
	Hypochloremia	1(0.6)
	AKI	3(1.9)

Where-Where-MF: Mantanance Fluid; SD: Standard Deviation; D5W = Dextros 5%; IV: Intera Venus; Other drugs include-antiviral & analgesics LOS: Length of stay; AKI: Acute Kidney Injury; SD: Standred Deviation

Management protocol, co-medications and its treatment outcome

In this study, the most commonly used type of fluid bolus was found to be 0.9% normal saline/NS 0.9% normal saline (161[99.4%]) with an average volume of 362.2 ± 348.4 milliliters. Maintenance fluid was carried

out mostly with normal saline (0.9%NS) and D5W (75[46.3%]). The average rate of fluids in the majority of the patient was 89 ± 14 ml/hour. Regular insulin was the only insulin drug administered to all DKA patients with an average rate of 9.6 ± 4.3u every 2-4 hours and then every 6 hours, till the patients were free from ketone (start standing dose). However, only 56(34.6%) of the

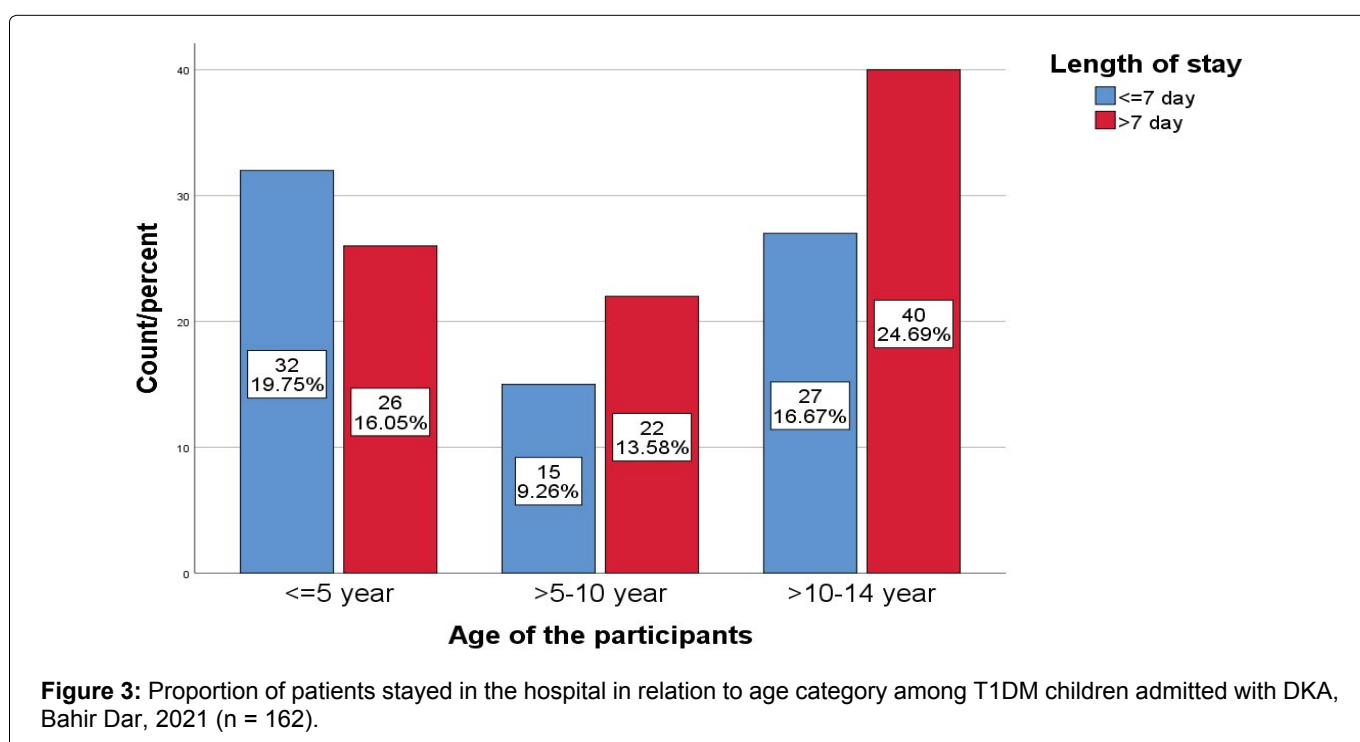
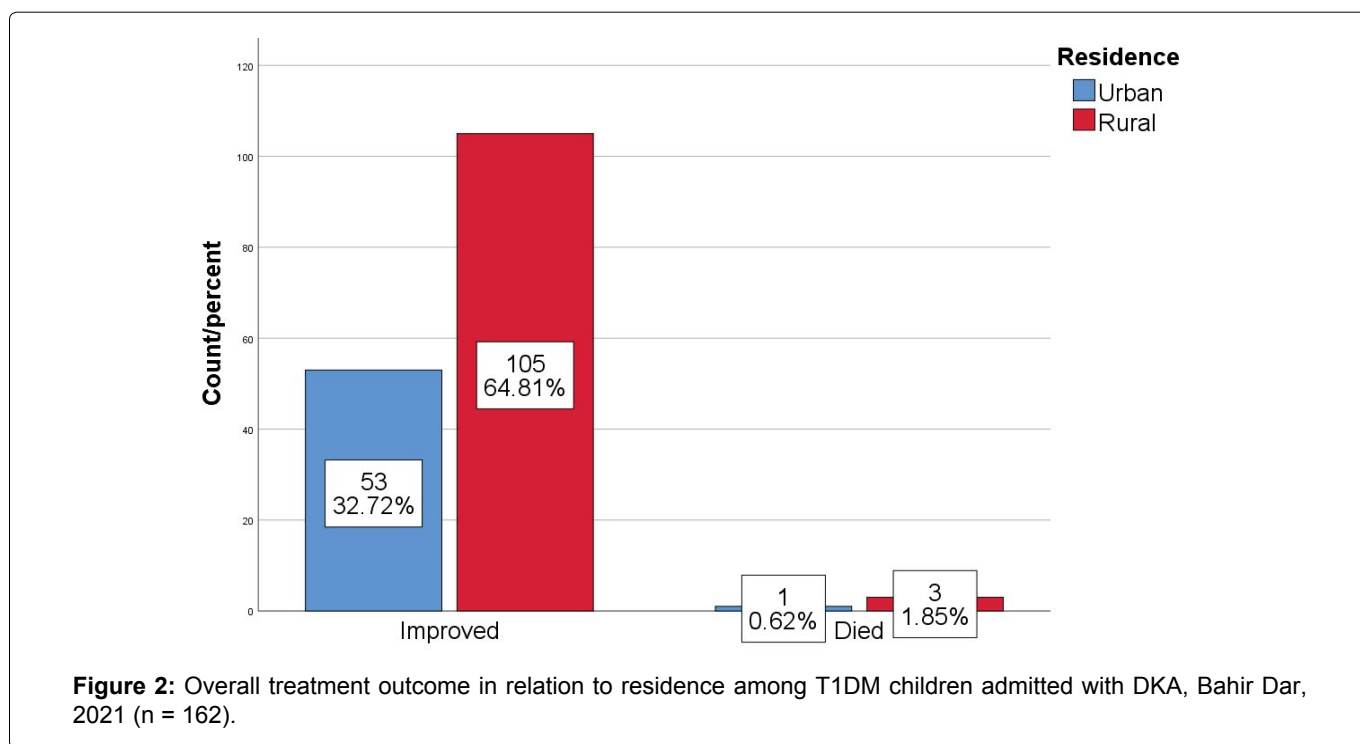
patients were repeated with potassium chloride with 68% of concomitant drug use, mainly antibiotics (73%) (Table 4).

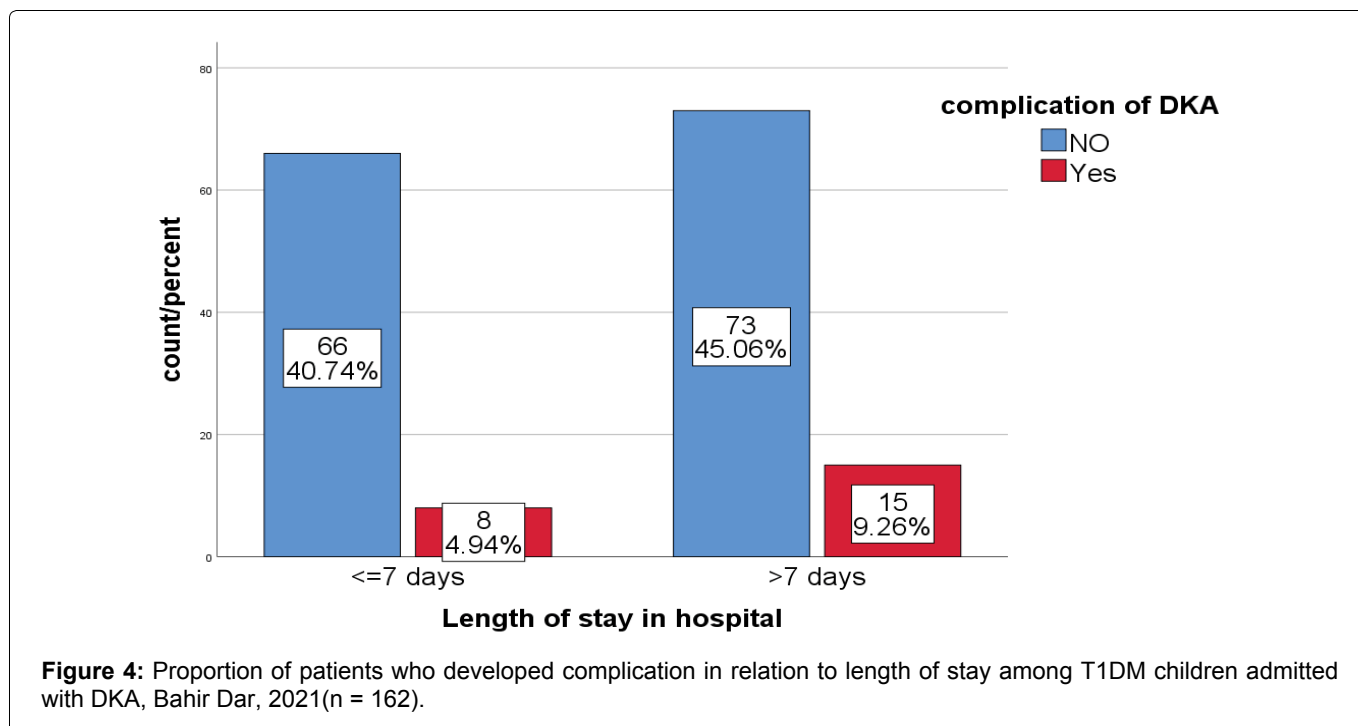
The majority of patients were free from/got out of DKA between 24 and 48 hours (58[35.8%]). More than three-quarters of the patients (139[85.8%]) did not develop any type of complication; However, hypokalemia (11[6.8%]) and hyponatremia (5[3.1%]) were found to be the most common complication followed by a neurologic sequel and hypernatremia both accounting four cases (4[2.5%]), 4[2.5%]).

The median time stayed in hospital was 8 ± 6.2

days; Where, majority of patients (96[59.3%]) stayed in the hospital for more than the expected duration (> 7 days). Concerning the overall treatment outcome, only (4[2.5%]) patients died; whereas the other patients (158[97.5%]) revealed improvement and discharged to their homes (Table 4).

Overall, treatment outcomes including length of stay, treatment associated-complications, and mortality in relation to other variables among T1DM children admitted with DKA, Bahir Dar, 2021(n = 162) showed in the perspectives figure and Table below (Figure 2, Figure 3, Figure 4 and Table 4).





Factors that determine long hospital stay among type 1 diabetic children admitted with DKA

The independent variables such as age, residence, client educational status, BMI, duration of chief complaint, family history of T1DM, frequency of DKA episode during the study period, the severity of DKA, DKA precipitating factors, the clinical presentation of DKA like polydipsia, abdominal pain, cough and confusion, location of admission, glycemia at admission, body temperature, having a history of comorbidity such as UTI, URTI, fungal infection, Comedication, time in which the patient get out of DKA and management complication were significantly associated with long hospital stay at the point less than 0.25 level of significance from the bivariable analysis.

However, residence, family history of T1DM, glycemia at admission, DKA precipitating factors, DKA presentation with abdominal pain, location of admission, and time in which the patients could get out of DKA were found to be significantly associated with long hospital stay in the multivariable logistic regression model less than 5% level of significance.

The existence of interactions among independent factors was checked but there was no significant interaction.

Consequently, after adjusting other covariates, the odds of longer hospital stay among the rural resident patients were greater by 31% as compared with the urban resident group of the patients (aOR = 4.31, 95% CI = 1.25-14.80, p-value = 0.020).

Likewise, DKA presentations with abdominal pain among patients were associated with longer hospital stay by 28% compared to patients with no abdominal pain (aOR = 4.28, 95% CI = 1.11-15.52, p-value = 0.035).

Which means, the time of improvement/recovery time from DKA and to be discharged from hospital among patients with abdominal pain was significantly longer compared with patients with no abdominal pain during their presentation.

Furthermore, those patients who get out of DKA after 72 hours had more likely to be stayed in the hospital by 6.39 times as compared to patients who get out of DKA for less than 24 hours (aOR = 6.39, 95% CI = 1.09-37.50, p-value = 0.040).

However, patients with DKA precipitated by the omission of insulin had less likely to be stayed in the hospital by 92% as compared to DKA patients precipitated by infection (aOR = 0.08, 95% CI = 0.01-0.98, p-value = 0.048) (Table 5).

Discussion

The purpose of this study is to determine the treatment outcome of children < 15-years-old admitted with DKA in Bahir Dar city Felege Hiwot comprehensive referral hospital.

In this study, the majority (97.5%) of admitted DKA patients were showed improvement and discharged to their homes with 8-day median length of hospital stay. This finding is much higher than the study conducted at South Asia and Jimma University Hospital in Ethiopia, where only 80.5% and 84% showed improvement and were discharged to their home respectively [13,33].

In this study, the magnitude of mortality rate is 2.5% which is higher than the previously reported mortality rate from developed nations (0.15%-0.31%) [14] and the mortality rate testified in Sudan which was 1.7% [36] the reason might be due to the high prevalence of infection (56.2%) and comorbidities (66.7%) as well as

Table 5: Factors that determine long hospital stay among T1DM children admitted with DKA, Bahir Dar, 2021 (n = 162).

Variables	cOR(95%CI)	aOR(95%CI)	p
Age group			
<= 5 [®]			
> 5-10	1.66(0.68-4.02)	2.93(0.63-13.66)	0.171
> 10-14	2.31(1.01-5.29)	5.51(0.92-33.02)	0.062
Residence			
Rural	3.17(1.61-6.24)	4.31(1.25 -14.80)	0.020 [*]
Urban [®]			
Diagnosis			
known diabetes	0.46(0.21-0.99)	0.51 (0.13- 2.02)	0.334
Newly diagnosis [®]			
Family history of diabetes			
Yes	0.48(0.20-1.14)	0.12(0.02-0.64)	0.013 [*]
NO [®]			
Glycaemia at admission	1.01(1.00-1.02)	1.01(1.00 -1.02)	0.008 [*]
Severity of DKA			
Mild [®]			
Moderate	1.70(0.84-3.44)	0.72(0.21-2.44)	0.599
Sever	1.46(0.61-3.53)	0.41(0.08-2.06)	0.281
DKA Precipitating factors			
Infection [®]			
Insulin skipping/omission	0.18(0.05-0.68)	0.08(0.01-0.98)	0.048 [*]
Insulin defaulter	0.38(0.16-0.95)	1.19(0.14-10.06)	0.871
Not documented	0.68(0.33-1.37)	1.46(0.35-6.05)	0.603
DKA presentation during admission			
Abdominal pain			
Yes	1.58(0.79-3.16)	4.28(1.11 -15.52)	0.035 [*]
NO [®]			
Time in w/h the patient get out of DKA			
< 24 hr [®]			
24-48 hr	2.86(1.18-6.94)	0.86(0.28-3.79)	0.847
48-72 hr	2.68(1.02-7.02)	1.04(0.22 -4.84)	0.964
> 72 hr	5.47(1.88-15.88)	6.39 (1.09-37.50)	0.040 [*]

Where; [®] =Reference group; ^{*} = significantly associated variables at a point less than 0.05

treatment complications (14,2%) in this study. However, lower than the study reported in India (8.75-12.8%) [11,27] and other developing countries like Kenya and including the Tigray region in Ethiopia (3.4-13.4%) [11,14,37].

Concerning hospital stay, although no clear cut-off point is set about when to say, there is a long hospital stay for patients admitted with DKA, most clinical experts have a common conscience for a longer hospital stay, if and only if, the patient stayed/admitted for more than seven days in the hospital with successful treatment by prompt correction of hyperglycemia, diabetic acidosis and electrolyte disturbances [34]. Therefore, the findings of this study pointed out a longer hospital stay (8 medians) days to be discharged from the hospital as compared to the study conducted in the united states (2.5) days [32], Al-Azhar University in Gaza (5.88 ± 2.55) days [35], and 3.7 to 3.4 days in another study; Even some clients can be discharged within 24 hours of hospital stay despite, the case is with sever DKA [7,38].

However, the finding was found to be equivalent to the study reported in Kenya (8 medians) days [22]. This discrepancy in treatment outcome; inpatient recovery, mortality rate, and length of hospital stay can be due to differences in treatment protocol implemented by each health care institution and population characteristics, sample size, study design, and overall healthcare system including resource allocation.

Regarding determinant factors, residence of the participants was found to be significantly associated with length of hospital stay. The study showed that, patients from the rural area had 4.31 times more likely to stay in the hospital for a longer time as compared to those patients living in an urban area (aOR = 4.31, 95% CI = 1.25-14.80). This can be due to the shortage of emergency service transportation to access immediate medical management [13,11], which again complicates the case [11]. And the finding is supported by the study conducted in Turkey [39].

Those patients having a family history of diabetes

mellitus had 88% less likely to stay in the hospital for a longer time as compared to patients with no family history of diabetes mellitus (aOR = 0.12, 95% CI = 0.02-0.64). And the reason behind this is not inclusive yet.

The amount of serum glucose at admission was also significantly associated with longer hospital stays. Length of hospital stay increases by one day, as the serum glucose value increases by one unit (aOR = 1.01, 95% CI = 1.00-1.02). This could be due to severe hyperglycemia leading to severe acidosis/dehydration, electrolyte disturbances, and later altered sensorium at presentation [11,38,39]. Which again over burdened the situation by increasing the number of patients to undergo further complications as was supported by the findings in this study.

In this study, precipitating factors of DKA by insulin skipping/omission were less likely associated with longer hospital stay by 92% as compared with that patient's DKA precipitated by infection (AOR = 0.08, 95% CI = 0.01-0.98).

This is because, having concurrent infection influences T1DM disease progression with hurt of normal glucose metabolism which can lead worsening of optimal glycemic control. Infection can also reinforce hormones in triggering blood glucose level to be risen and can complicate the management process [29]. The finding is in line with the study conducted in Addis Abeba, Jimma, and Keneya [11,13,22].

A patient with abdominal pain at the time of client presentation is 4.28 times more likely to be stayed in the health institution than patients with no abdominal pain (aOR = 4.28, 95% CI = 1.11-15.52). The finding is similar with study reported in Kenya [22] and Turkey [39].

Similarly, the time in which the patient free from/got out of DKA was associated with longer a hospital stay in this study. Those patients who get out of DKA in greater than 72 hours were 6.39 times more likely to stay in hospital compared to those patients who get out of DKA for less than 24 hours (aOR = 6.39, 95% CI = 1.09-37.50). This might be due to differences in hyperglycemia state, clinical presentation, and delay in management [37,40].

In general, this study can bring out positive implications for clinical care, health service management, and research in the area of diabetic specialization. Clinically, the health care worker can identify predictors associated with longer hospital stay among type one diabetic children admitted with DKA at clinical setup. Health care managers can access current evidence about overall treatment outcomes of DKA among T1DM children and take remedial action to strengthen service delivery by clinicians. Researchers can also be motivated to conduct further research in this area by taking this study as preliminary findings.

Conclusion

Management protocol was generally administered according to Ethiopian standard treatment guideline; However, poor practice of serum potassium assessment as well as potassium supplementation was noted. In this study, the majority (97.5%) of admitted DKA patients were showed improvement and discharged to their homes within 8-day median length of hospital stay and with very low mortality rate and high management complications (14.2%). The study also suggests that, the times in which the majority of patients get out of DKA were between 24 and 48 hours.

Residence, family history of T1DM, glycemia at admission, DKA precipitating factors, and DKA presentation specifically, abdominal pain, and time in which the patients got out of DKA were significantly associated with a long hospital staying the multivariable logistic regression model of less than 5% level of significance.

Thus, to achieve the intended treatment outcome early in time, clinicians and other stakeholders should focus on diabetic ketoacidosis presentation and precipitating factors with possible multicenter studies in this regard.

Limitation

Since the data were collected from medical records, the detailed treatment protocol and some of the important laboratory results were not addressed. Another limitation is that this study was conducted in one hospital only, which may be difficult to generalize the findings to another hospital in the region.

Declarations

Ethical approval and consent to participate

In order to conduct this research, we tried to consider the declaration of Helsinki's ethical principles for medical research. Ethical clearance and approval were obtained with ethical review board number (CMHS/IRB number 01-008) decided on the date of February 26, 2021. Written supportive letters, as well as permission and/or informed consent, have been taken from the pediatrics department of the hospital and from the dataset owner to use the information in databases/repositories for this research on behalf of the patients. As this was a retrospective study, informed consent from individual patient was not requested because the authors and data collectors had no physical contact with them and the data were collected from their medical records after their discharge from the hospital. Informed consent from each study participant, for ethics approval, had been waived by the institutional Review Board of ethics committee. Information in the data extraction was anonymous. This study had no danger or negative consequences for the study participants. Medical record numbers were used for the data collections and

personal identifiers of the patients were not used in this research report. Access to collected information was limited to the principal investigator and confidentiality had preserved throughout the time.

Consent for publication

Not applicable.

Data sharing statement

Data will be available upon request from the corresponding author.

Disclosure

The authors report no competing interest in this research work.

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