Original Article

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Poor treatment outcome and associated factors among adult diabetic ketoacidosis patients admitted to Amhara regional referral hospitals at Emergency Departments, Northwest Amhara, Ethiopia, 2022; a retrospective cross-sectional study

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ABSTRACT

Background: *Diabetic ketoacidosis (DKA) is a significant public health problem associated with high morbidity, disability, and mortality worldwide. According to the International Diabetes Federation, the true prevalence of DKA is unknown but is estimated at around 24%. Most affected patients live in low- and middle-income countries. In Sub-Saharan Africa, particularly in Ethiopia, mortality remains high among patients who are not promptly diagnosed and treated.*

Objective: *This study aimed to assess treatment outcomes and associated factors among adult DKA patients admitted to emergency departments at Comprehensive Specialized Hospitals in Northwest Amhara, Ethiopia, in 2022.*

Methods: *A multicenter, institution-based retrospective cross-sectional study was conducted from May 14, 2017, to May 15, 2022, including 495 participants selected via systematic random sampling. Binary logistic regression was used to identify factors associated with treatment outcomes. Adjusted odds ratios (AOR) with 95% confidence intervals (CI) were calculated, and statistical significance was declared at $p < 0.05$.*

Results: The proportion of poor treatment outcomes was 5.1% (95% CI: 3.3–7.6%). Factors significantly associated with poor outcomes included being uninsured (AOR = 3.23; 95% CI: 1.14–9.13), receiving less than 3 liters of fluid replacement (AOR = 3.86; 95% CI: 1.17–12.72), not receiving potassium replacement (AOR = 3.84; 95% CI: 1.44–10.22), and prolonged recovery time from DKA (>72 hours) (AOR = 3.93; 95% CI: 1.31–11.81).

Conclusion and Recommendation: *The proportion of poor treatment outcomes was lower than in previous studies. Lack of health insurance, inadequate fluid or potassium replacement, and prolonged recovery time were associated with poor outcomes. Prompt fluid and potassium replacement, along with strategies to reduce recovery time and increase community awareness of health insurance, are recommended to improve DKA management.*

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1. Introduction

Diabetic ketoacidosis (DKA) has been recognized as a devastating and severe complication of diabetes mellitus. It is a potentially fatal emergency disease and is characterized by a biochemical triad of hyperglycemia, acidosis, and ketone bodies. [1, 2] Diabetic ketoacidosis is commonly associated with type one diabetes mellitus. However, it has been reported to affect patients with type two diabetes mellitus, if they have persistent hyperglycemia for a long period or they are under the effect of a stressor. [3-6] It is a major community health problem associated with significantly high healthcare costs, disability, morbidity, and mortality worldwide. [7, 8]

Globally, about 422 million people are diagnosed with diabetes. The majority of patients live in low- and middle-income countries. According to the International Diabetes Federation, the true prevalence of DKA is unknown. However, in 2011, it was estimated to be around 24%. [9]

DKA is responsible for more than 500,000 hospital days per year and costs an estimated 2.4 billion dollars. [10, 11] In Africa, Institution-based studies show that DKA is a major cause of disability, morbidity, and mortality and accounts for 0.6 to 24.1% of poor treatment outcomes in studies conducted in Tanzania and Libya. [12, 13] Likewise, in Ethiopia, DKA-related poor treatment outcomes range from 4.4 to 15.1%. [14-16]

Diabetic ketoacidosis is one of the most public health challenges, which is often associated with a high number of emergency visits, intensive care unit admissions, disability, shortened life expectancy, and excessive healthcare expenses in all societies (17). According to studies conducted worldwide, several factors have been reported. These are older age, inadequate insulin therapy, smoking, greater than 6 liters of fluid replacement within 24 hours, duration of diabetic mellitus greater than five years, having had chronic kidney disease, infection, severe hypokalemia, and frequency of DKA per year among the most common identified associated factors. On the other hand, potassium replacement, insulin administration greater than 60 international units, and the use of a comorbidity drug (metronidazole) with other concurrent medications contribute to good treatment outcomes in DKA. [1, 3, 14, 15, 18-20]

Diabetic Ketoacidosis management requires a multidisciplinary approach. Previous studies have established that for effective treatment of diabetic ketoacidosis, it is necessary to prevent associated morbidity, disability, and mortality. Effective treatment of DKA involved rapid restoration of adequate circulation and perfusion with isotonic intravenous fluids and correction of depleted electrolyte levels. Similarly, insulin reverses ketosis and hyperglycemia. In addition, regular monitoring of clinical signs and laboratory tests is necessary to detect and treat complications. [10, 21]

Although studies were conducted in Ethiopia, they were single-center studies, and factors such as health insurance, anemia, and renal function tests were not addressed. It makes it difficult for healthcare workers and policymakers to enhance healthcare and prevent poor treatment outcomes. Based on my best search, no similar study has been undertaken to date in the study areas.

Therefore, this study aimed to assess treatment outcomes and associated factors among adult patients with diabetic ketoacidosis admitted to the Emergency Department at comprehensive specialized hospitals in northwest Amhara, Ethiopia

2. Methods and Materials

Study design and setting

A multicenter, institution-based, retrospective, cross-sectional study design was used from May

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14, 2017, to May 15, 2022, in five Northwest Amhara regional referral hospitals, including the University of Gondar and Tibebe Ghion comprehensive specialized teaching hospitals, and the comprehensive specialized hospitals of Felege Hiwot, Debre Markos, and Debre Tabor. In these hospitals, the emergency department is equipped with noninvasive hemodynamic monitoring devices, ECG, defibrillators, and infusion pumps. Moreover, nurses, general practitioners, residents, neurologists, and other professionals work in the emergency department, where the nurse-to-patient ratio ranges from 1:4 to 1:7.

Population and sampling

The source population for this study comprised all adult patients with diabetic ketoacidosis admitted to the Emergency Departments of Amhara Regional Referral Hospitals during the study period. The study population consisted of all adult patients with diabetic ketoacidosis who were admitted and managed in the Emergency Departments of these referral hospitals from May 14, 2017, to May 15, 2022.By using a systematic random sampling technique, adult DKA patients (aged ≥18 years) treated in the emergency department at comprehensive specialized hospitals in northwest Amhara, Ethiopia, for at least five years were included, and DKA patients referred to other institutions due to different reasons, and charts with missed outcome variables or date of outcome variables were excluded.

The Sample size calculation for the second objective was performed using Epi Info Stat Cal Software, considering different factors from Shashemenie [15] and the following assumptions. Confidence level (Za/2) = 95%, Margin of error (d2) = 0.05, and Power (ZB) = 80%. Accordingly, the minimum sample size was 495, considering 10% incomplete data. Finally, 450 patient charts that fulfilled the inclusion criteria were included in the analysis.

Variables of the study

The dependent variable was the Treatment Outcome of DKA (poor, good), whereas the independent variables were Socio-demographic variables (sex, age, residence, and health insurance), Clinical variables(duration with DM, the complication of DM, DM Comorbidity, type of diabetes, type of DM treatment at admission, precipitating factor of DKA, complications of DKA, vital signs, signs, and symptoms of DKA, and severity of DKA), Baseline laboratory variables (Random blood glucose, urine PH, Urinary ketones, renal function test, Serum sodium, Serum potassium, WBC count, RBC count, Hemoglobin, and Platelets), Treatment protocol variables (Type of IV fluid bolus, Type of fluid maintenance, Total fluid replacement in the first 24 hours, Insulin dose in the first 24 hours, time taken to be DKA free, Potassium replacement, and Admitted to ICU)

DKA was defined as those patients with hyperglycemia (>13.9mmol/L (>250mg/dl)), pH < 7.3 or bicarbonate <18mmol/L, urine dipstick ketone level ≥ +1(21-23). It is classified as Mild DKA (plasma blood glucose >250mg/dl, PH 7.25-7.3or bicarbonate 15-18mmol/L, and urine ketone positive (1+) (24)), Moderate DKA (plasma blood glucose >250mg/dl, PH 7-7.24or bicarbonate 10-15mmol/L, and urine ketone positive (+2) (24)) and Sever DKA(plasma blood glucose >250mg/dl, PH <7or bicarbonate <10mmol/L, urine ketone positive (3+), and mental status is stupor/coma (24)). A good treatment outcome was defined as patients who showed improvement at discharge with euglycemia (70–180 mg/dl), urine pH>7.3 or bicarbonate level >18mg/dl, and ketone body-free. [17, 36] Poor treatment outcome was defined as patients who not show improvement with the

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left against medical advice, died in the hospital, and survived with disability [14, 15], and an adult patient was defined as patient aged ≥ 18 years. [25]

Data collection procedure and quality control

All relevant data were collected retrospectively from the patient's chart. The questionnaire was adapted from the different literature (14-16, 20). The data were extracted from the registration book and patient charts.

The data collection tool was tested on 5% of the total sample size (23 patient charts) at the University of Gondar specialized teaching hospital to ensure the availability of variables on the patient's chart, and its Cronbach's alpha result was 0.747. Before data collection, the relevance of the variables in the instrument was verified by consulting the experts working in the emergency department. The data were collected by 5 trained BSc Nurses and 2 MSc nurse supervisors, who were trained for 1 day before the study to ensure a common understanding of the data collection process. Daily communication was made between the principal investigator, the supervisor, and the data collectors throughout the data collection period. The collected data were reviewed for accuracy, completeness, clarity, and consistency before being exported into the data analysis software. Data cleaning was checked for any missing values and data errors.

Data processing and analysis

Data were entered into EpiData version 4.6 and exported to SPSS version 20 for analysis. Descriptive statistics were used to summarize the result using a table, graph, and percentage for frequency, mean with standard deviation (SD) for normally distributed data, and median with interquartile range (IQR) for skewed distributions/outliers whereas categorical variables were expressed by proportions, chi-square test was used to determine adequate cell counts for each categorical variable, model fitness test was checked by using Hosmer-Lemeshow test statistics (p=0.584) and variance inflation factor was used to assess the multicollinearity. Binary logistic regression models were fitted to identify associated factors with treatment outcomes. Factors that were statistically significant in bivariable logistic regression at p-values of 0.25 or less were carried over to multivariable logistic regression. An adjusted odds ratio with 95% CI was computed, and statistical significance was declared at $p<0.05$.

3. Result

Description of study participants

About 2830 adult DKA patients admitted to Emergency were treated between May 14, 2017, and May 15, 2022, in northwest Amhara referral hospitals. Based on our sample size determination, 490 medical charts were included, of which 40 were excluded due to missing charts or incomplete outcome variables.

Socio-demographic characteristics of Diabetic ketoacidosis patients

The response rate of this study was 450(91%). Among study participants, 235(52.5%) were males. The median age of the study participants was 31, with an IQR of 24-41 years. Regarding residency, 148(32.89%) of the study participants were rural dwellers. On the other hand, 186(41.33%) of the study participants didn't have health insurance (Table 1).

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Table 1. Socio-demographic Profile of Adult Diabetic Ketoacidosis Patients at Emergency Departments of Comprehensive Specialized Hospitals, Northwest Amhara, Ethiopia, 2022 (N = 450)

Variables	Frequency	Percent
Sex		
Male	215	47.8
Female	235	52.2
Age (years)		
18–30	223	49.6
31–40	105	23.3
41–50	94	20.9
>51	28	6.2
Residence		
Rural	148	32.9
Urban	302	67.1
Health insurance		
Yes	264	58.7
No	186	41.3

Clinical factors of DKA patients

Out of the study participants, 424(94.2%) had type 1 diabetes mellitus. More than half (54.2%) of the respondents had a duration of diabetes mellitus of less than 1 year, and 287 (63.8%) participants were on insulin treatment. Regarding diabetic complications, 76(16.9%) had one or more of the chronic complications of DM. On the other hand, the majority of participants (67.3%) had one episode of diabetic ketoacidosis per year. The main reasons for recurrent diabetic ketoacidosis were inappropriate insulin therapy (48%), followed by Infection/sepsis of any origin (26.9%). Most of the study participants, 366 (81.33%), presented with polyuria/polydipsia. More than half of the study participants (56.22%) experienced signs of dehydration (Table 2).

Table 2 Clinical factors among adult DKA patients admitted to Emergency department at comprehensive specialized hospitals northwest Amhara, Ethiopia2022 (N=450).

Variable	Category	Frequency (n)	Percentage (%)
Types of diabetes	Type-1	424	94.2
	Type-2	26	5.8
Duration of DM since diagnosis	<1 year	244	54.2
	1–5 years	143	31.8
	>5 years	63	14.0
Type of DM treatment at admission	Oral antidiabetic only	8	1.8
	Injectable/Insulin only	287	63.8
	Both oral and insulin	47	10.4
	Not on treatment	108	24.0
Retinopathy	Yes	76	16.9
	No	374	83.1
Foot ulcer	Yes	27	6.0
	No	423	94.0
Stroke	Yes	5	1.1
	No	445	98.9
Ischemic heart disease	Yes	6	1.3
	No	444	98.7
Variable	Category	Frequency (n)	Percentage (%)

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Frequency of DKA attack per year	Once	303	67.3
	Twice	77	17.1
	≥ three times	70	15.6
Precipitating factor of DKA	Infection	121	26.9
	Inappropriate insulin therapy	216	48.0
	Newly diagnosed DM	113	25.1
Vital sign	**Mean ± SD**		
SBP	110.53 ± 20.26 mmHg		
DBP	71.96 ± 12.17 mmHg		
PR	91.06 ± 15.87 beats/min		
RR	22.67 ± 4.36 breaths/min		
Temperature	36.296 ± 0.77 °C		

Other symptoms include: Loss of appetite, Fatigability, Headache, weight loss

Comorbidity of DM

Of a total of 450 patients, 75 (16.67%) had a comorbidity of DM; of which hypertension was 42(9.33%) and heart disease 13(2.89%) were the most common (figure 1).

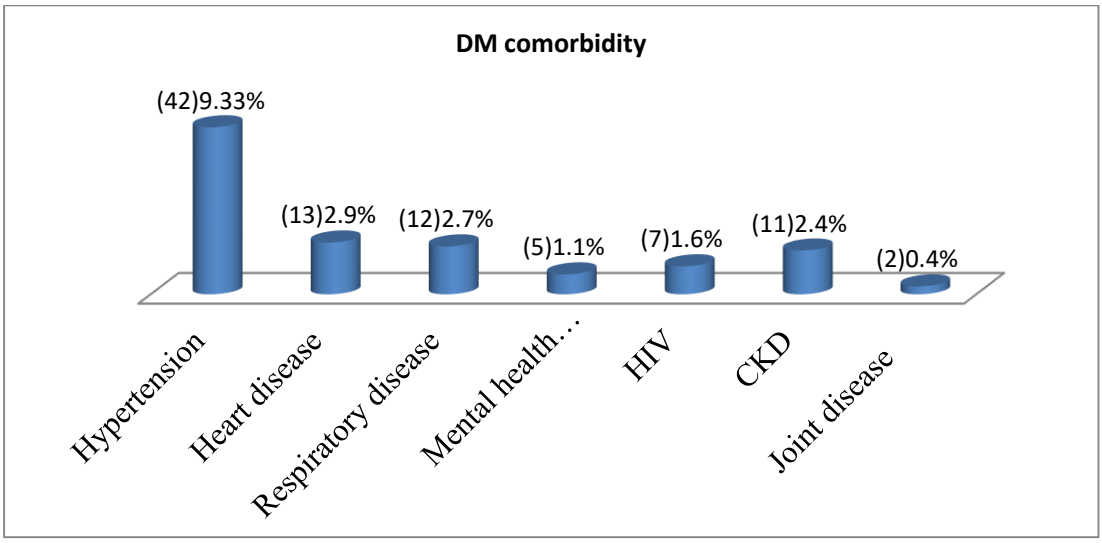

Figure 1: Comorbidity of DM patients admitted to Emergency department

Complications of DKA patients: From a total of 450 patients, 77 (17.11%) had DKA complications; of which shock 23(5.1%), hypokalemia 22(4.9%), and acute kidney injury 17(3.8) were the most common complications (Figure 2).

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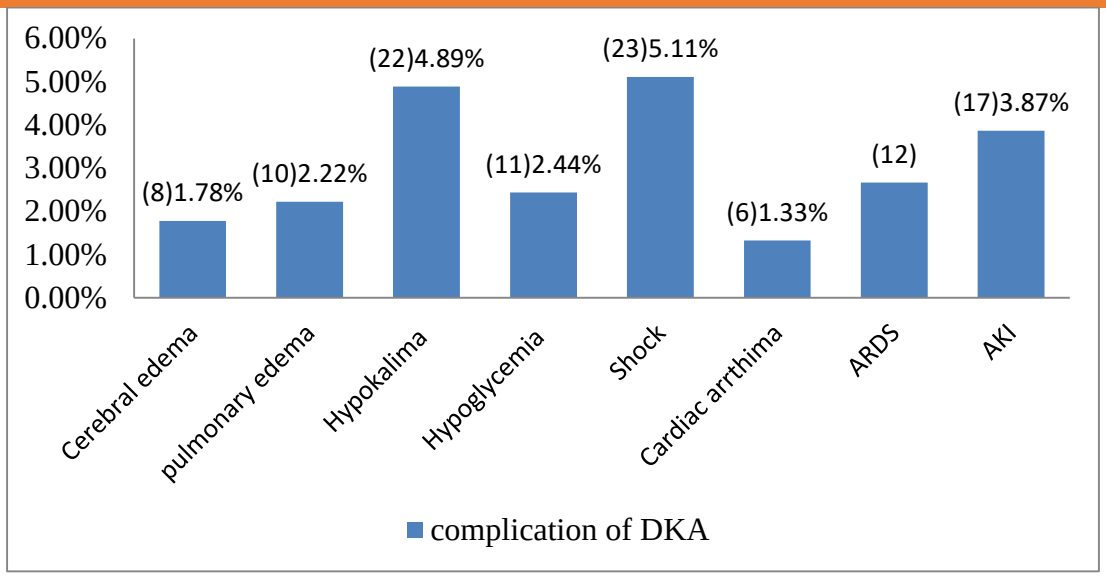

Figure 2: Complication of DKA patients admitted to Emergency department

Baseline laboratory factors

The mean with a standard deviation of random blood glucose was 452.3±101.9 mg/dl, Serum creatinine (0.9±1.2), Serum sodium (137.4±6.4 meq/l), Serum potassium (3.9±0.8 meq/l), Hemoglobin (13.4±2.9 g/dl), RBC count (5.3 ± 6.9), respectively. The median with an interquartile range of WBC count was 7.396(4.8-8.8), PH 7(6-7), Serum urea 21(16.2-26) mg/dl, and Platelets 230(173-286) microliter respectively (Table 3).

Table 3: Baseline laboratory factors of adult DKA patients admitted to Emergency department at comprehensive specialized hospitals northwest Amhara, Ethiopia2022 (N=450).

Variables	Categories	Frequency	Percent
Urinary ketones	1+	125	27.8
	2+	126	28.0
	3+ and above	199	44.2
PH	7.25-7.3	125	27.8
	7-7.24	126	28.0
	<7	199	44.2
Serum creatinine level	Normal	211	46.9
	Low	190	42.2
	High	49	10.9
Serum urea level(mg/dl)	Normal	202	44.9
	Low	2	0.4
	High	246	54.7
Serum potassium (mEq/L)	Normal	307	68.2
	Hypokalemia		126
	Hyperkalemia	17	3.8
Serum sodium (mmol/L)	Normal	224	49.8

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	Hypernatremia	188	41.8
	Hypernatremia	38	8.4
WBC count(x109/L)	normal	289	64.2
	Low	96	21.3
	High	65	14.4
Hemoglobin (g/dl)	Non anemic	401	89.1
	Anemic	49	10.9
Platelet count (microliter)	Normal	377	83.8
	Thrombocytopenia	57	12.7
	Thrombocytosis	16	3.6

Severity of DKA

Patients admitted to the emergency department at Northwest of Amhara comprehensive specialized hospitals who were found to have severe, moderate, and mild DKA were 44.2%, 28%, and 27.8%, respectively (Figure 3).

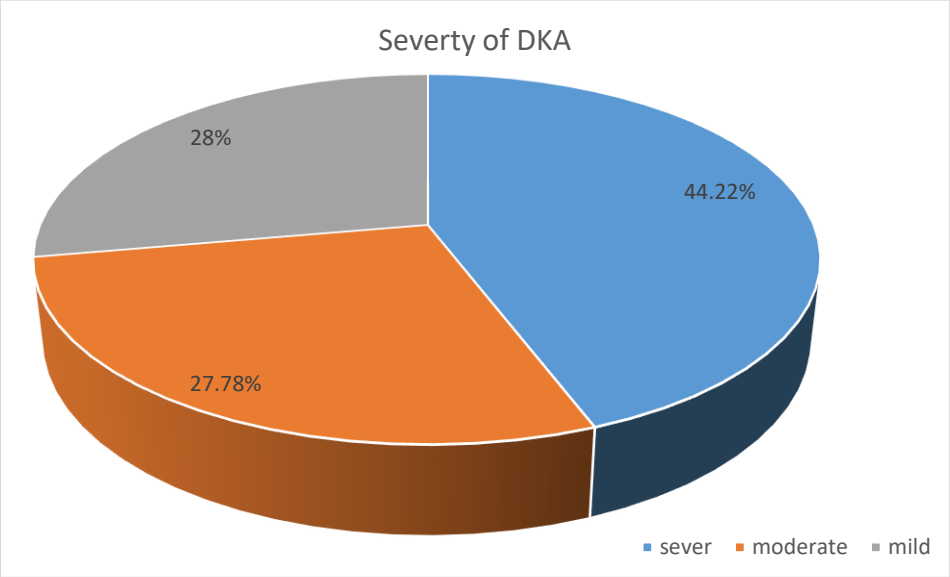

Figure 3: Severity of DKA episode adult patients admitted to Emergency department

Treatment protocol among adult Diabetic ketoacidosis patients

Regarding management protocol, the most commonly used fluid was normal saline (92%). The Total fluid replacements in the 1st 24 hours of less than 3 liters were 21.8%, and greater than 6 liters were 45.76%, with an average amount and standard deviation of fluid of 7±6.174 liters. Greater than 60IU insulin administered in the first 24 hours was 46% with a mean and standard deviation of 48.22±18.966 IU. In addition, Potassium chloride replacement was 70%. Moreover, patients free from DKA for less than 24 hours were 37.55% with a mean and standard deviation of 45.69±26.72hrs. Patients admitted to the ICU were 8% (Table 4).

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Table 4: Treatment protocol among adult DKA patients admitted to Emergency department at comprehensive specialized hospitals northwest Amhara, Ethiopia2022 (N=450).

Variables	Categories	Categories	Frequency	Frequency	Percent
Type of IV fluid bolus given	NS	NS	411	411	91.3
	RL	RL	5	5	1.1
	Not given	Not given	34	34	7.6
Type of fluid maintenance used	Type of fluid maintenance used	Type of fluid maintenance used	Type of fluid maintenance used	Type of fluid maintenance used	Type of fluid maintenance used
Normal saline	Yes	414	414	92.0	92.0
	No	36	36	8.0	8.0
Ringer lactate	Yes	20	20	4.4	4.4
	No	430	430	95.6	95.6
Dextrose 5% in water	Yes	36	36	8.0	8.0
	No	414	414	92.0	92.0
Dextrose normal saline	Yes	80	80	17.8	17.8
	No	370	370	82.2	82.2
Total fluid replacement in the 1st 24 hours	≤3Liters	98	98	21.8	21.8
	3-6Liters	145	145	32.2	32.2
Total fluid replacement in the 1st 24 hours	>6Liters	206	206	45.8	45.8
	<40IU	190	190	42.2	42.2
Total regular insulin dose in the first 24 hours	40-60IU	153	153	34.0	34.0
	>60IU	207	207	46.0	46.0
Did Potassium replacement done when <5.5meq/l	Yes	315	315	70.0	70.0
	No	135	135	30.0	30.0

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Time to free from DKA	<24hour	170	170	37.8	37.8
	24-72hour	168	168	37.3	37.3
	>72hour	112	112	24.9	24.9
Was the patient Admitted to ICU	Yes	36	36	8.0	8.0
	No	414	414	92.0	92.0

ICU: intensive care unit, NS: Normal saline, RL: Ringer lactate, IU: international unit

The proportion of the treatment outcome

The overall poor treatment outcome of adult DKA patients admitted to the emergency department at Northwest of Amhara National Regional State comprehensive specialized hospitals was 5.1% (95% CI: 3.3% - 7.6%) (Figure 4).

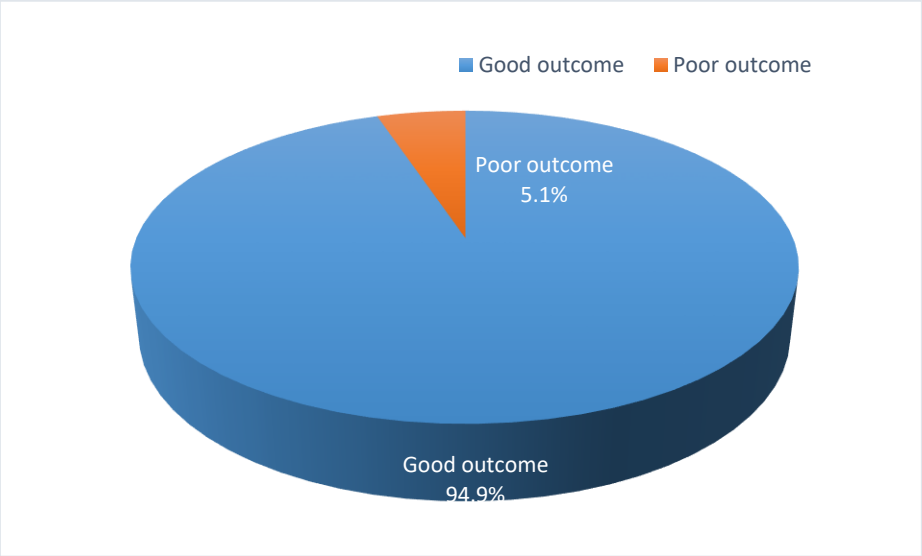

Figure 4: Treatment outcome of adult Diabetic ketoacidosis patients admitted to Emergency department

Factors associated with poor treatment outcome

The bivariable analysis results show that place of residency, health Insurance, fluid replacement, potassium replacement, time to free from DKA, and total regular insulin were factors associated with poor treatment outcome of DKA at p-values <0.25.

However, in multivariable logistic regression analysis, health insurance, fluid replacement, potassium replacement, and time to be free of DKA were found to be statistically significantly associated with poor DKA treatment outcomes (p <). Accordingly, the odds of poor treatment outcomes in DKA were 3.2 times higher (AOR=3.23; 95% CI: 1.14-9.13) among adult DKA patients who did not use medical insurance compared with those who did. Similarly, patients who received less than 3 liters of fluid replacement in the first 24 hours had 3.9 times (AOR=3.86; 95% CI:1.17-12.72) the odds of poor treatment outcomes among adult DKA patients as compared to those

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who received greater than 6 liters of fluid replacement. Likewise, the odds of poor treatment outcomes among adult DKA patients who did not receive potassium replacement were 3.8 times higher (AOR=3.84; 95% CI: 1.44-10.22) than among those who did. Moreover, DKA patients who remained DKA-free for> 72 hours had 3.9 times (AOR=3.93; 95% CI: 1.31-11.81) the odds of poor treatment outcomes compared with those who remained DKA-free for < 24 hours (Table 5).

Table 5: Logistic regression analysis of factors associated with treatment outcome among adult Diabetic ketoacidosis patients admitted to Emergency department at comprehensive specialized hospitals northwest Amhara, Ethiopia2022 (N=450).

Variables	Categories	Poor (n=23)	Good (n=427)	COR (95%CI)	P-value	AOR (95%CI)	P-value
Residence	**Rural**	13	135	2.81(1.20-6.57)	0.017*	2.52(0.97-6.53)	0.058
	Urban	10	292	1		1	
Having Insurance	**No**	17	169	4.33(1.67-11.19)	0.003*	3.23(1.14-9.13)	0.027*
	Yes	6	258	1		1	
Fluid replacement	**<3Liters**	11	87	4.24(1.518-11.82)	0.006*	3.86(1.17-12.72)	0.026*
	3-6Liters	6	139	1.45(0.457-4.58)	0.530	0.88(0.240-3.22)	0.846
	>6Liters	6	201	1		1	
Total regular insulin	**<40IU**	17	173	3.41(0.975-11.91)	0.055*	3.41(0.821-14.17)	0.091
	40-60IU	3	150	0.69(0.14-3.50)	0.658	0.760(0.135-4.29)	0.756
	>60IU	3	104	1		1	
Potassium replacement	**No**	15	120	4.80(1.98-11.61)	0.001*	3.84(1.44-10.22)	0.007*
	Yes	8	307	1		1	
Time to DKA free	**>72hour**	13	99	3.05(1.17-7.88)	0.022*	3.93(1.31-11.81)	0.015*
	24-72hour	3	165	0.418(0.106-1.65)	0.212*	0.54(0.12-2.34)	0.409
	<24hour	7	163	1		1	

COR-crud odds ratio, AOR-adjusted odds ratio, CI-confidence interval

4. Discussion

This study found that the proportion of poor treatment outcomes among adult patients with diabetic ketoacidosis treated at the northwest Amhara comprehensive specialized hospitals was 5.1% (95% CI: 3.3%-7.6%). This study was in line with the study conducted in Thailand [26] and

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Debre Tabor. [16] In Thailand, the possible explanation is the similarity between the study design and sampling technique. While in Debre tabor, the similarity of study setting, socio-economic status, health care delivery system, study design, and sampling technique were the main reasons. However, higher than the studies done in Saudi Arabia (20) and Libya. [12] The reason for this discrepancy could be differences in treatment protocols (they lacked unified protocols), sample size, population characteristics, and the quality of healthcare services. [12, 20] This may lower the proportion of poor treatment outcomes.

In contrast, this finding was lower than those reported in studies conducted in South Africa, Malaysia [27], Damascus [19], Tanzania [13], Adama [14], and Shashemenie. [15] Possible reasons for this inconsistency include differences in study design, study period, study population, and the sociodemographic characteristics of the study participants. In Damascus, the study population was >12 years old, whereas in Tanzania, there were all age groups. Adama and Shashemenie used a single-centered study area and lacked routine electrolyte tests (serum potassium). This may increase the proportion of poor treatment outcomes.

This study was the first to see the association between health insurance and treatment outcomes among adult DKA patients. In the present study, lack of health insurance was significantly associated with poorer treatment outcomes among adult DKA patients. The odds of having poor treatment outcomes of DKA were 3.2 times higher among those who didn't have health insurance than among patients who had health insurance. The possible explanation is that the rising cost of healthcare can be managed with a health insurance plan that covers costs associated with care, hospitalization, a free health checkup, and pre- and post-hospitalization charges (28). But a lack of health insurance reduces access to recommended care, results in poorer-quality care, and leads to worse health outcomes than among insured adults. [29]

In this study, total fluid replacement in the 1st 24 hours was associated with poor treatment outcomes among adult DKA patients. Patients who received less than 3 liters of fluid replacement in the first 24 hours had 3.9 times the odds of poor treatment outcomes compared with those who received more than 6 liters. This study was supported by the WHO Diabetes guideline (30) and a study conducted in Adama. [14] A possible reason could be the loss of 6 to 9 L of body fluid due to the large amount of glucose entering the renal tubules, which pulls a large amount of water. This causes the kidneys to produce a large amount of urine and leads to dehydration, volume depletion, hypovolemic shock, and death. Therefore, replacing approximately half of the total volume lost during the first 8 to 12 hours and the remaining within 24 to 36 hours is necessary for tissue perfusion and resolution of the associated metabolic abnormalities. [21, 31]

This study also found that potassium replacement was significantly associated with poor treatment outcomes among adult DKA patients. The odds of poor treatment outcomes among adult DKA patients who didn't receive potassium replacement were 3.8 times higher than among those who did. This study was supported by a study conducted in Adama. [14] Possible reasons include a lack of potassium testing, a shortage of KCL, inappropriate potassium supplementation, and the use of insulin, all of which can cause potassium to move intracellularly and result in hypokalemia. [32] Hypokalemia in patients with DKA is the most common electrolyte imbalance due to renal loss and intracellular shift secondary

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to insulin effect, correction of acidosis, and fluid therapy volume expansion, which decreases serum potassium concentrations. [33] It has a significant impact on neuromuscular and cardiopulmonary systems, which predisposes patients to respiratory failure, cardiac arrhythmias, and potentially death. [30]

Moreover, the time to DKA freedom was significantly associated with poor treatment outcomes. DKA patients who remained> 72 hours to be DKA-free had 3.9 times the odds of poor treatment outcomes compared with those who remained < 24 hours. It was supported by a Saudi Arabian study (20). This is supported by studies showing that patients who took >72 hours to be DKA-free had higher rates of nosocomial infections and complications. [34, 35]

The limitation of the study was that it was conducted using secondary data; sociodemographic data (income, educational status, marital status, and Occupation) and crucial laboratory test results (such as bicarbonate) were left out, and it also didn't address behavioral characteristics like smoking and alcohol.

Conclusion

The Proportion of poor treatment outcomes among adult DKA patients in this study was lower than in previous studies. Not having health insurance, fluid replacement (< 3 liters), not replacing potassium, and time to recover from DKA (> 72 hours) were associated with poor treatment outcomes of diabetic ketoacidosis.

Abbreviations

AKI: Acute Kidney Injury
AOR: Adjusted Odds Ratio
ARDS: Acute Respiratory Distress Syndrome
BSC: Bachelor of Science
BUN: Blood Urea Nitrogen
CI: Confidence Interval
CKD: Chronic Kidney Disease
DKA: Diabetic Ketoacidosis
HTN: Hypertension
IDF: International Diabetic Federation
MSc: Master of Science
SPSS: Statistical Package for Social Science
USD: United States Dollar
WHO: World Health Organization

Author Contributions

Data collection, formal analysis, fund acquisition, resources, software, validation, visualization, the investigation, methodology, supervision, conceptualization, analysis, and interpretation of writing a detailed review, editing, and preparing manuscript: ZGR, MGA, MGH, CDA, GBR. Finally, all the authors have approved the manuscript for submission.

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Competing interests

All authors declare that they have no competing interests in the final content of the manuscript.

Data Availability

Upon reasonable request, you can obtain the data used for the current analysis from the corresponding Author.

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