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Impact of Evidence-Based Practice Nursing Guideline on Clinical Outcomes in Children with Diabetic Ketoacidosis: A Quasi-Experimental Study

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Abstract **Background:** Diabetic Ketoacidosis (DKA) is a potentially life-threatening complication of diabetes and it is one of the most common causes of death in children with Type 1 Diabetes Mellitus (T1DM). While international management protocols are available, Iraq lacks a standardized local nursing guideline for children with DKA. **Objective:** To evaluate the effectiveness of Evidence-Based Practice (EBP) nursing guidelines on clinical outcomes in children with DKA. **Method:** A quasi-experimental design was conducted for the study between May 2025 to January 2026. A total of 60 children, aged 6–16, diagnosed with DKA, were allocated into two groups of 30. One group, the control, received routine hospital care and the other, the intervention group, was managed using an EBP nursing guideline. The outcome measures included biochemical recovery, the duration to DKA resolution, the length of hospitalization, complications and the assessment after two months of discharge. **Results:** Compared to the control group, the intervention group showed a significantly greater reduction in blood glucose (mean difference: -166.93 mg/dL; $p<0.001$) and shorter DKA resolution time (median: 18 Vs 27 hours; $p<0.001$, $r = 0.636$), shorter hospital stays (2 Vs 3 days, $p<0.001$), lower persistent acidosis (16.7% Vs 80.0%; $p<0.001$) and fewer multiple complications (30.0% Vs 63.3%; $p<0.007$). Finally, the readmission rates were significantly lower in the intervention group (34.5% Vs 65.5%; $p<0.019$). **Conclusion**: The findings showed that implementing an EBP nursing guideline for pediatric DKA resulted in enhanced metabolic recovery, a decrease in complications and a reduction in readmission rates. According to these results, using structured nursing care and supported by EBP nursing guidelines in emergency settings positively affects the clinical outcomes of children with DKA.

Key Words Diabetic Ketoacidosis, Clinical Outcomes, Nursing Guideline, Evidence-Based Nursing, Children

INTRODUCTION

Diabetic Ketoacidosis (DKA) is a serious, potentially life-threatening acute complication of diabetes mellitus, primarily affecting individuals with Type 1 Diabetes (T1D) [1-3]. It is characterized by hyperglycemia, metabolic acidosis and ketosis, which result from an absolute or relative deficiency of insulin, as a consequence of ß-cell destruction and a parallel increase of counterregulatory hormones induced by stress, such as catecholamines, glucagon, cortisol and growth hormone [4,5].

DKA affects 30-40% of children, in a retrospective study conducted among children at their initial diabetes diagnosis. Also, systematic reviews on the prevalence of DKA in young people with T1D found it rose from 35.3% in 2010 to 40.6% in 2016 [4]. The global increase in DKA has prompted public health campaigns aimed at raising awareness of T1D among parents, educators and Healthcare Professionals (HCPs). These initiatives facilitate early diagnosis in children, preventing misdiagnosis and reducing mortality associated with DKA [6].

In the world, the DKA occurrence among newly diagnosed T1D is estimated to be 15-89% and this range looks high. While in developed countries, 6%–44% of children younger than 15 years with T1D present with DKA at diagnosis [7,8]. Arab countries recorded higher incidence rates of T1D as compared to others and DKA incidence in the Arab region is almost 46.7% [9]. Data from Iraq shows a substantial increase in the prevalence of T1D in the pediatric population under 15 years old, progressing from 7.8 per 100,000 individuals in 1995 to 14.2 per 100,000 in 2000 and reaching 24.7 per 100,000 in 2014 [10].

This acute condition of DKA accounts for most of the morbidity and mortality among children [11]. Prior to the discovery of insulin, DKA was associated with a 100% mortality rate, but after insulin and proper management, it has decreased. Recently, the overall mortality rate ranges between 0.15 to 0.35% in developed countries, while it is higher in developing countries, ranging from 3.4 to 13.4% [4]. The highest mortality rate is related to the occurrence of Cerebral Edema (CE) [1]. It can pose a significant challenge for healthcare providers, especially in children, where it leads to concerns manage diabetes [2].

The clinical signs of DKA include dehydration, abdominal pain, nausea and/or vomiting. Abdominal pain may lead to acute abdominal conditions, thrombotic events, drowsiness, brain swelling and coma. Brain swelling in a severe form is associated with 20-30% mortality, although it is uncommon [11]. The metabolic and electrolyte alterations and critical systemic conditions that emerge from severe DKA can lead to multi-organ failure and mortality if medical staff provide inadequate manageably by not classifying it as an emergency. However, the mortality rate in developed countries is relatively low, but when complications occur, this mortality rate increases significantly. CE in DKA children has a mortality rate of 6.4% compared to 0.1% in those without CE. Acute Kidney Injury (AKI) is a common complication encountered during DKA management, evident in approximately 30-64% of cases [12].

Clinical Care Pathways (CCPs) are structured multidisciplinary plans of care with interventions that provide guideline translation and EBPs into patient care. Standardized CCPs have been shown to decrease hospital costs and length of stay without an increase in readmission rates [13]. Adherence to clinical guidelines in EDs will reduce morbidity and mortality for DKA children [14].

Worldwide, established international guidelines for DKA management exist; however, their implementation in clinical practice can exhibit variability [15]. Despite having guidelines, significant variation can be experienced in initial therapy for DKA children in hospitals. The changes occur mostly regarding fluid administration, insulin dosing, route of administration and some other features of the initial resuscitation and stabilization [16]. This is also true in Iraq, where there is no agreed local protocol or guideline on managing children with DKA and especially no nursing guideline for DKA. This makes a substantial difference in nursing practices among nurses in different hospitals. Recognizing the crucial role of well-established nursing guidelines, aligned with international recommendations, treat DKA in children, the researcher undertook adapting an international guideline for auditing and implementation in the hospital's EDs.

Effective DKA management depends on skilled and knowledgeable nurses. Nurses' knowledge and practice can be improved through educational and EBP protocol interventions, which are associated with better patient outcomes in DKA care [17]. Pediatric clinical nurses show high acceptance, satisfaction and confidence in DKA clinical practice guidelines, contributing to improved clinical outcomes and supporting their implementation and sustainability in practice [18].

In addition, nurses play an important role in the prevention and treatment of DKA in emergency and Intensive Care Units (ICUs). The main things include treating hyperglycemia, correcting electrolyte abnormalities, fluid resuscitation, ongoing management and continuous follow-ups [19]. Despite extensive research on DKA, nursing guidelines, especially in Iraq, still have significant areas needing attention. Hospitals lack adequate guidelines and nursing procedure policies, among them pediatric cases and especially DKA management in EDs. These gaps are the main reason behind conducting this study, which highlights the need for applying EBP nursing guidelines for children with DKA.

However, our country lacks precise research on how EBP nursing guidelines can support children with DKA and few studies globally examine their impact on clinical outcomes like acidosis correction, complication rates and hospital stay duration. Addressing this gap is essential to strengthen nursing roles, enhance EBP care for children with DKA and reduce the burden of DKA-related morbidity and mortality in children. To address these deficiencies, this research intends to assess whether implementing EBP nursing guidelines leads to better clinical outcomes in children, such as faster DKA symptom resolution, improved biochemical recovery, shorter hospital stays and fewer readmissions. We intend to examine group data from both before and after guideline implementation to identify the best strategies for lowering DKA rates and improving patient outcomes.

METHODS

Study Design and Setting

A quasi-experimental study design was conducted to determine the influence of EBP nursing guidelines on the clinical outcomes for children with DKA. The study conducted at the Raparin Pediatric Teaching Hospital (RPTH), Erbil, Iraq, between May 2025 and January 2026.

Participants and Sampling

Sixty children aged 6-16 years who were admitted to the ED and diagnosed with DKA according to BSPED criteria were eligible to be included in the study. Children with comorbid illnesses (e.g., congenital heart disease or renal failure), those referred to the ICU because of critical conditions and children with readmissions during the same period of data collection were excluded.

G*Power analysis version 3.1 was used to determine the required sample size. With an estimated medium to large effect size from prior intervention studies on pediatric clinical outcomes, the calculation used an alpha of 0.05 and 80% statistical power. To detect significant differences between the study groups, the analysis showed that a minimum sample of 60 children was required as participants [20].

The purposive sampling technique was used. They divided the children into two equal groups of 30. To minimize contamination by bias, the researcher recruited children in the control group first and provided them with routine hospital care. Subsequently, the intervention group was recruited. Children in the intervention group were managed according to EBP nursing guidelines.

Intervention and Assessment Tools

The structured assessment tool was used to collect data and EBP nursing guidelines that were developed from the BSPED 2020 protocol and supported by suggestions from the International Society for Pediatric and Adolescent Diabetes (ISPAD). Study Assessment tool included bio-demographic and clinical characteristics, self-care practices, nutritional assessment, GCS, assessment of dehydration, complication monitoring and caregiver satisfaction.

The interventional tool included an EBP nursing guideline comprising seven parts: initial assessment, fluid management, insulin therapy, monitoring and reassessment, ongoing management, complication monitoring and clinical outcomes evaluation. The validity of the tool's content was established through review by a panel of 10 experts in pediatric nursing and pediatric endocrinology.

Data Collection Procedure

The researcher collected data at multiple time points, considering the child's clinical status and treatment progression. The researcher was present in the hospital from morning to evening, eight hours a day, for four days a week. When necessary; the researcher stayed at the hospital for gathering information and applying EBP nursing guidelines for the intervention group.

Researcher obtained baseline demographic and clinical data using study assessment tools, direct observation and medical record reviews. We also collected data from children or caregivers when they needed additional clarification. Data collection for each assessment phase took 30 minutes to complete. To ensure correct and comprehensive data collection, they allocated additional observation time when evaluating self-care practices. The EBP nursing guideline was used as both an intervention and a structured framework for data collection. The researcher, along with ED nurses, pediatric residents and pediatric endocrinologists, applied the guideline when necessary.

Pilot Study and Reliability

Before the main study, researcher performed a pilot test on ten percent of the study sample to assess the internal consistency and reliability of the questionnaire items. We assessed the feasibility and accuracy of the tools and made necessary modifications to the study instrument.

The pilot test occurred in May 2025. Cronbach's alpha was used to calculate the internal consistency of the items. A Cronbach's alpha of 0.81 was computed, demonstrating a very good level of internal consistency and reliability for use [21].

Outcome Measures

Primary Outcomes: Clinical Recovery Outcomes: The primary outcomes of this quasi-experimental study were clinical recovery in children diagnosed with DKA. These results encompassed biochemical parameters (blood glucose level, venous blood pH, serum bicarbonate, urine ketones), neurological assessments and DKA severity status during hospitalization. Additional results included DKA related complications, time to DKA resolution and length of hospital stay. The primary outcomes measured the effectiveness of the clinical nursing guideline in improving recovery in the intervention group compared to the control group receiving routine care.

Secondary Outcomes: Clinical Progress Measures and Treatment Response

The outcomes focused more on the treatment responses of children and their progress throughout the hospitalization. These measures involved monitoring vital signs, fluid balance, electrolyte levels, neurological status and response to insulin and fluid therapy. The frequency of treatment related adverse events, such as hypoglycemia and electrolyte imbalances, is being checked. In addition, any deterioration and changes in laboratory findings during treatment were monitored to determine the extent to which nursing guidelines contribute to improving metabolic control and clinical stabilization.

Follow-up Outcomes: Post discharge Health Status

After two months, children were assessed to evaluate sustained recovery and children's overall health status. The outcomes encompassed readmission rates to DKA, any new complications and the general health status of the children. The frequency of readmission was assessed to determine the long-term effectiveness of the clinical nursing guideline and education advice during the hospitalization period.

Outcome Assessment and Comparative Evaluation

Standardized clinical tools were used to assess outcome measures, nursing records, lab results and follow-up evaluations. Initially, we gathered data upon admission and subsequent assessments throughout the hospital stay and a follow-up after two months. Researchers compared outcomes within and between intervention and control groups to determine how well the evidence-based practice guideline improved clinical recovery, enhanced treatment response and reduced complications.

Ethical Consideration

The Research Ethics Committee at the College of Nursing/Hawler Medical University, granted ethical approval (Approval No: 2414). Retrospectively, the researcher registered the study at ClinicalTrials.gov (Identifier: NCT07467616). Administrative approvals were provided by the General Directorate of Health, Ministry of Health.

Before enrollment, their parents gave written informed consent. We explained the study objectives and procedures to

ensure their right to accept or refuse participation or even withdraw from the study at any stage without affecting the care provided. Throughout the study, researcher maintained confidentiality, privacy and anonymity for participants. They kept all collected data aligned with ethical research standards.

Statistical Analysis

Categorical variables, such as sociodemographic characteristics, clinical features, DKA severity, dehydration level, complications and caregivers' satisfaction, were presented as frequencies and percentages. While Continuous variables like blood glucose level, serum ketones, pH, bicarbonate level, Glasgow Coma Scale score, duration of hospitalization and anthropometric measurements were reported as means and SDs, or medians and IQRs, depend on data distribution assessed using the Kolmogorov-Smirnov test.

Categorical variables were analyzed using chi-square goodness-of-fit tests. For normally continuously distributed variables, the independent sample *t* test and non-normally distributed continuous variables, the Mann-Whitney U test, Wilcoxon signed-rank test was employed to compare the study groups.

To determine predictors associated with clinical recovery outcomes, linear and multivariable logistic regression analyzes were performed. The strength of these associations was calculated using the Odds Ratio (ORs) with 95% Confidence Intervals (CIs). When needed, the effect sizes were calculated to assess the effects among study participants. All statistical tests were two-tailed and analyzes were conducted using IBM SPSS Statistics version (25.0; IBM Corp). A $p<0.05$ was considered statistically significant and a $p<0.001$ was considered highly statistically significant.

RESULTS

Baseline Socio-Demographic and Socioeconomic Characteristics of Participants and their Parents by Study Group (Control Vs Intervention)

Baseline sociodemographic and socioeconomic characteristics of participants showed no significant differences across most variables Table 1. Most participants in both groups were school-aged children, with an identical mean age of (10.53±2.3) in the control group and (10.53±2.19) in the intervention group. The distributions of sex, child educational status, nationality, maternal education, economic status and residency were similar between groups (all $p>0.05$).

Table 1: Baseline Socio-Demographic and Socioeconomic Characteristics of Participants and their Parents by Study Group (control Vs Intervention)

Variables	Type of variable	Group Classification		p.value
		Control Group F (%)	Interventional Group F (%)	
Age Group	School age	23 (76.7)	25 (83.3)	0.51[a]
	Teenagers	7 (23.3)	5 (16.7)	
	Mean ± SD	10.53±2.3	10.53±2.19	
Sex	Male	6 (20.0)	10 (33.3)	0.24[a]
	Female	24 (80.0)	20 (66.7)	
Birth Order	First	8 (26.7)	6 (20.0)	0.88[b]
	Second	9 (30.0)	12 (40.0)	
	Third	6 (20.0)	5 (16.7)	
	Fourth	3 (10.0)	4 (13.3)	
	Fifth	3 (10.0)	1 (3.3)	
	Sixth	1 (3.3)	1 (3.3)	
	Seventh	0 (0.0)	1 (3.3)	
Educational Status of Child	Not enrolled	2 (6.7)	2 (6.7)	0.04[b]
	Left School (Dropout)	1 (3.3)	0 (0.0)	
	Basic School	26 (86.7)	20 (66.7)	
	Preparatory School	1 (3.3)	8 (26.7)	
Nationality	Kurdish	29 (96.7)	26 (86.7)	0.23[b]
	Arabic	0 (0.0)	3 (10.0)	
	Turkoman	1 (3.3)	1 (3.3)	
Father's Level of Education	Illiterate	1 (3.3)	8 (26.7)	0.03[b]
	Primary School (or read and write)	14 (46.7)	7 (23.3)	
	Intermediate School	10 (33.3)	8 (26.7)	
	High School or Vocational	2 (6.7)	5 (16.7)	
	Diploma (institute)	1 (3.3)	0 (0.0)	
	Bachelor Degree (College)	1 (3.3)	2 (6.7)	
	Master (High diploma)	1 (3.3)	0 (0.0)	
Mother's Level of Education	Illiterate	7 (23.3)	13 (43.3)	0.48[b]
	Primary School (or read and write)	13 (43.3)	9 (30.0)	
	Intermediate School	2 (6.7)	4 (13.3)	
	High School or Vocational	2 (6.7)	1(3.3)	
	Diploma (institute)	4 (13.3)	2 (6.7)	
	Bachelor Degree (College)	2 (6.7)	1(3.3)	
Level of Economical Status	Low	19 (63.3)	13 (43.3)	0.12[a]
	Middle	11 (36.7)	17 (56.7)	
Residency	Urban	12 (40.0)	15 (50.0)	0.66[b]
	Suburban	15 (50.0)	11 (36.7)	
	Rural	3 (10.0)	4 (13.3)	

Note: Values are presented as frequency (percentage). Chi-square tests were used for categorical variables. No test was computed for Religion because of constant values, and statistical significance was set at $p<0.05$. [a]Pearson chi-square test, [b]Fisher exact test

Table 2: Clinical and Diagnostic Characteristics of Children by Study Groups (Control Vs Intervention Group)

Variables	Categories	Group Classification		p.value
		Control Group F (%)	Intervention Group F (%)	
History of Diabetes	Known Case	24 (80.0)	23 (76.7)	1.00[a]
	New Diagnosis	6 (20.0)	7 (23.3)	
Age (Diabetes is diagnosed)	Toddler	3 (10.0)	0 (0.0)	0.208[b]
	Preschool	3 (10.0)	5 (16.7)	
	School Age	24 (80.0)	25 (83.3)	
	Mean ± SD	7.2 ± 2.51	7.67±2.26	
Level of Glycemic Control	Good <7.5%	0 (0.0)	1 (3.3)	0.50[b]
	Poor 7.6-9%	7 (23.3)	4 (13.3)	
	Very poor > 9%	23 (76.7)	25 (83.3)	
Frequency of Glucose Monitoring	Multiple time/Day	26 (86.7)	19 (63.3)	0.017[b]
	Daily	3 (10.0)	5 (16.7)	
	Weekly	1 (3.3)	0 (0.0)	
	Rarely	0 (0.0)	6 (20.0)	
Continuous Glucose Monitoring	Yes	2 (6.7)	0 (0.0)	0.49[b]
	NO	28 (93.3)	30 (100.0)	
Type of Treatment Using	Insulin only	16 (53.3)	10 (33.3)	0.26[b]
	Insulin and diet	8 (26.7)	13 (43.3)	
	New diagnosis	6 (20.0)	7 (23.3)	
Type of Insulin	Only long acting	1 (3.3)	0 (0.0)	1.00[b]
	Short and long acting	23 (76.7)	23 (76.7)	
	New diagnosis	6 (20.0)	7 (23.3)	
Frequency of Insulin Administration	Twice/Day	1 (3.3)	0 (0.0)	1.00[b]
	Triple/Day	2 (6.7)	2(6.7)	
	> Three times/Day	21 (70.0)	21 (70.0)	
	New diagnosis	6 (20.0)	7 (23.3)	
Adherence to Insulin Therapy	Adherent	16(53.3)	16(53.3)	0.93[a]
	Non-adherent	8(26.7)	7(23.3)	
	New diagnosis	6(20.0)	7(23.3)	
Knowledge of DKA symptoms	Yes	16(53.3)	23(76.7)	0.10[a]
	NO	14(46.7)	7(23.3)	
Frequency of DKA Episodes	First episode	9(30.0)	7(23.3)	0.56[a]
	2-3 Episodes	9(30.0)	13(43.3)	
	>3 Episodes	12(40.0)	10(33.3)	
Have Recurrent Infection	Yes	18(60.0)	13(43.3)	0.30[a]
	NO	12(40.0)	17(56.7)	
Have Other Chronic Disease	Yes	4(13.3)	2(6.7)	0.67[b]
	NO	26(86.7)	28(93.3)	
Chronic Disease Types	None	26(86.7)	28(93.3)	0.61[b]
	Epilepsy	1(3.3)	0(0.0)	
	Hyperthyroidism	1(3.3)	1(3.3)	
	Asthma	2(6.7)	0(0.0)	
	Celiac Disease	0(0.0)	1(3.3)	

[a]Pearson chi-square test, [b]Fisher exact test

Father's level of education was the only variable showing significance at baseline (p = 0.03), where fathers in the intervention group had a higher level of illiteracy (26.7%) than in the control group (3.3%). whereas primary education was more prevalent among fathers in the control group (46.7% Vs 23.3%).

Clinical and Diagnostic Characteristics of Children by Study Groups (Control Vs Intervention Group)

Finding from Table 2 showed that Clinical and diagnostic characteristics distributed comparably between the control and interventional groups and the researchers observed only one significant difference in the frequency of glucose monitoring. The control group had a higher proportion of children who monitored glucose multiple times daily compared with the interventional group (86.7 and 63.3%). Participants in both groups mostly had a prior diabetes diagnosis (80.0 Vs 76.7%) and both groups predominantly exhibited poor glycemic control (76.7 Vs 83.3%). Adherence to insulin therapy was similar between groups, with nearly half of participants (53.3%) classified as adherent to insulin therapy. The age at which diabetes is diagnosed showed no statistically significant difference (p = 0.20), with most children diagnosed at school age (80.0 and 83.3%), the mean was similar (7.2±2.51 Vs 7.67±2.26). Results of having recurrent infections were more frequent in the control group 60.0% and 43.3% in intervention group. Similarly, other chronic diseases did not differ significantly (p = 0.67), with most children having no comorbid conditions (86.7% control, 93.3% intervention).

Impact of the Clinical Nursing Guideline on Biochemical Recovery and Clinical Outcomes in Children with DKA

The study founds in Table 3 a statistically significant different among all biochemical parameters for the interventional group after clinical nursing guideline implementation. The reduction in blood glucose was significantly higher in the interventional group (-333.16±73.19 Vs -166.23±143.35; p<0.001), with a greater improvement in pH level (0.25±0.09 intervention, 0.14±0.10 control; p<0.001).

Table 3: Impact of the Clinical Nursing Guideline on Biochemical Recovery and Clinical Outcomes in Children with DKA

Variables	Groups	Mean ± SD/Median (IQR)	Mean Differences	Mean Ranks	95% CI	Test Statistics	p-value
Blood Glucose	Control	-166.23±143.35	166.93		(107.67, 226.19)	t (5.68)	<0.001***
	Intervention	-333.16±73.19					
PH	Control	0.14±0.10	-0.11		(-0.16, -0.06)	t (- 4.46)	<0.001***
	Intervention	0.25±0.09					
$HCO3^-$	Control	6.27±4.19	-3.69		(-5.44, -1.94)	t (- 4.25)	<0.001***
	Intervention	9.96±2.25					
Serum Ketones	Control	2 (1.0)		40.8		U (141.0)	<0.001***
	Intervention	0.00 (1.0)		20.2			
Duration of DKA signs resolved	Control	27.0 (24)		41.58		U (117.5)	<0.001***
	Intervention	18.0 (6)		19.42			
Hospital Stay Duration	Control	3.0 (0.5)		41.35		U (124.5)	<0.001***
	Intervention	2.0 (0.6)		19.65			
Neurological Assessment	Control	1.0 (3.25)		31.65		U (415.5)	0.595
	Intervention	1.0 (2.25)		29.35			

***p<0.001 is statistically extremely significant, t: independent samples t -test, U: Mann-Whitney U test, df: degrees of freedom, SD: Standard Deviation, IQR: Interquartile Range

Table 4: Outcomes of Complications and Total Complication Burden across Study Groups

		Group Classification				
		Control Group F (%)		Intervention Group F (%)		
Variables	Type of variable	Yes	No	Yes	No	p. value
Complications	Cerebral edema	3 (10.0)	27 (90.0)	1(3.3)	29(96.7)	0.61[b]
	Acute Kidney injury	10 (33.3)	20 (66.7)	5(16.7)	25(83.3)	0.136[a]
	Hypoglycemia	5 (16.7)	25 (83.3)	5(16.7)	25(83.3)	1.00[a]
	Persistent acidosis	24 (80.0)	6 (20.0)	5(16.7)	25(83.3)	<0.001[a]***
	Hypokalemia	10 (33.3)	20 (66.7)	5(16.7)	25(83.3)	0.136[a]
	Hyperkalemia	4 (13.3)	26 (86.7)	4(13.3)	26(86.7)	1.00[b]
	Fluid overload	2 (6.7)	28 (93.3)	1(3.3)	29(96.7)	1.00[b]
	Thrombosis	1(3.3)	29(96.7)	0(0.0)	30(100.0)	1.00[b]
	Cognitive impairment	14(46.7)	16(53.3)	8(26.7)	22(73.3)	0.108[a]
Overall complications	No complication	3(10.0)	27(90.0)	13(43.3)	17(56.7)	0.007[a]**
	Single complication	8(26.7)	22(73.3)	8(26.7)	22(73.3)	
	Multiple Complication	19(63.3)	11(36.7)	9(30.0)	21(70.0)	

**p<0.01 is statistically very significant; ***p<0.001 is statistically extremely significant, [a]Pearson chi-square test; [b]Fisher exact test

Table 5: Multivariable Linear Regression of Predictors Associated with Hospital Stay Duration

Variable	B (Unstandardized)	Standardized β	95% CI for B	p-value
Intervention group (Study vs Control)	-0.235	-0.63	(-0.311, -0.158)	<0.001***
DKA Severity	0.055	0.219	(0.003–0.106)	0.038*
Adherence to insulin therapy	0.059	0.256	(0.004–0.114)	0.035*
Recurrent infection	0.003	0.008	(-0.072–0.078)	0.937
Self-care level	-0.009	-0.101	(-0.029–0.012)	0.400
Age group	0.046	0.098	(-0.053–0.144)	0.355
Constant	0.234	—	(0.020–0.448)	0.033*

*p<0.05 is statistically significant; ***p<0.001 is statistically extremely significant, B: unstandardized coefficient; β (beta): standardized coefficient

Bicarbonate levels increased significantly in the intervention group (9.96±2.25) compared to the control group (6.27±4.19; p<0.001). In addition, serum ketone levels were significantly lower in the interventional group compared with the control group (U = 141.0, p<0.001).

A statistically significant difference was observed when comparing the median resolution period for DKA children, with the interventional group experiencing a shorter duration than the control group (18.0 Vs 27.0 hours; p<0.001). A similar reduction in hospital stay duration occurred (2.0 Vs 3.0 days; p<0.001). In contrast, neurological assessment results showed no significant differences (p = 0.595).

Outcomes of Complications and Total Complication Burden across Study Groups

The complication outcomes in Table 4 showed a significant association for persistent acidosis among the groups. When most of the children in the control group (80.0%) had persistent acidosis compared with the intervention (16.7%), with a value of p<0.001. In contrast, the remaining complications were similarly distributed between groups without statistically significant differences. Complication rates in children differed significantly between the groups (p<0.007). More than half (63.3%) had multiple complications in the control groups while only (30.0%) in the intervention group. The interventional group showed a higher proportion of children with no complications (43.3%) compared with the control group (10.0%).

Multivariable Linear Regression of Predictors Associated with Hospital Stay Duration

Table 5 finding showed that multivariable linear regression analysis revealed a strong association between the intervention group and a shorter hospital stay compared to the control group (B = -0.235, β = -0.630, 95% CI: -0.311-0.158, p<0.001). Longer hospitalizations were associated with DKA severity.

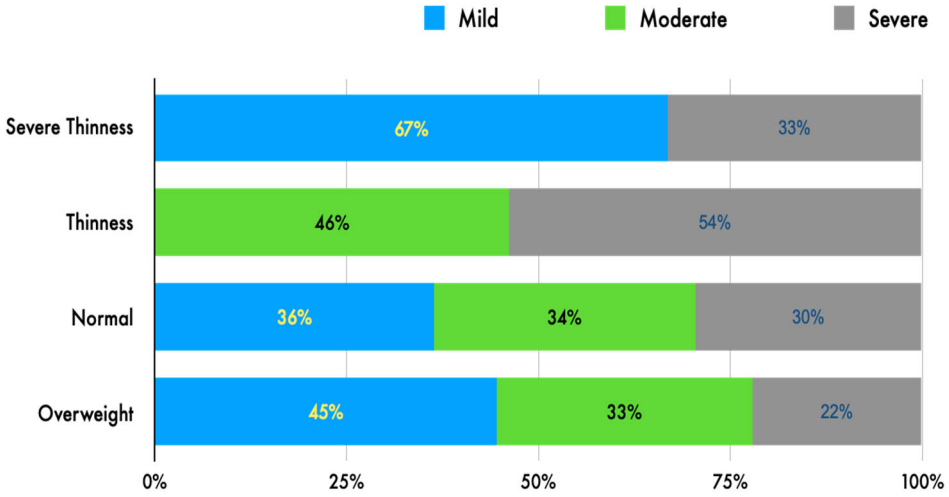

Figure 1: Proportional Distribution of DKA Severity by WHO BMI z-Score Categories

Poor adherence to insulin therapy was also significantly associated with increased hospital stay duration (B = 0.059, β = 0.256, 95% CI: (0.004-0.114), p<0.035). In addition, after adjustment, we observed no statistically significant association for recurrent infection, self-care level and age group.

Figure 1 showed the distribution of DKA severity according to WHO BMI Z-score in children showed that severe thinness children had high rate of mild DKA 67.0%, followed by severe DKA 33%, without observing of moderate DKA. In children of thinness, more than half 54.0% were of severe DKA. In the normal BMI children, the distribution was nearly similar, with mild DKA 36.0%, moderate 34.0% and severe at 30.0%. The overweight children had higher rate of mild DKA 45.0%, followed by moderate and severe.

DISCUSSION

This study used quantitative research, a quasi-experimental study design. The study aimed to evaluate how EBP nursing guidelines affected the clinical outcomes for children with DKA. According to the study's main findings, children treated with this guideline showed considerably better biochemical outcomes, quicker resolution of DKA symptoms, shorter hospital stays, lower complication rates and fewer readmissions compared to children who received standard hospital care.

Biographical data from the current study show that the age distribution of the children aligns with prior DKA research. Most participants were school-aged children, with a mean age of 10.53 years in both groups. Similarly, [22] reported in his results the mean age of 8.9±4.7 years in children admitted with DKA, while another study included 209 children with DKA and reported a mean age of 10.12±3.56 years. These findings suggest that DKA commonly occurs during late childhood and early adolescents [23,24].

Females predominated over males in both groups during this study, a finding consistent with research across 13 countries on three continents, which showed a higher proportion of girls with DKA than boys [25]. A systematic review of 90 studies in Germany examining sex differences in DKA revealed females had a higher likelihood of presenting with DKA at diagnosis compared to males [26].

Parental education is determined as an important determinant of health literacy, diabetes knowledge and treatment adherence, with early recognition of DKA symptoms. This finding is comparable with studies by [27] and [28], where they found that lower parental education is associated with poorer diabetic outcomes.

The study results showed a relatively comparable between the control and intervention groups regarding clinical and diagnostic characteristics at baseline, with no statistically significant differences among variables. Most children in both groups were previously diagnosed with T1D and approximately one fifth of children were newly diagnosis cases. This finding tells us that children can have DKA at both times of previously diagnosed and new diagnosis cases. This is inconsistent with the study by [29], were more than half of children of newly diagnosed children had DKA at initial presentation, but it is agrees with the study by [30], done in Kuwait were nearly one fourth of children had DKA presentation of T1D.

A notable finding was that the level of glycemic control showed a predominance between groups. A very poor glycemic control in over three quarters of each group was recorded, showing difficulty in maintaining adequate metabolic regulation. This makes increasing a risk factor for having recurrent occurrences of DKA, as continuous hyperglycemia is one risk factor for acute metabolic decompensation. This agrees with a global review of pediatric studies on the level of HbA1c, estimating an average level of 9.07%, with most of the children worldwide not reaching <7.5% levels [31]. In Sudan, a study found that the mean HbA1c was 10.4% and only 6.2% achieved adequate control. While, [32] in a study done in Iraq found the mean level of HbA1c was 9.9%.

One of the most important findings of this study was the significant improvement in biochemical recovery and clinical outcomes among children in intervention group managed using the EBP nursing guideline. Including the reduction in blood glucose level, improvement in pH level,

bicarbonates and lower serum ketones, as compared to children who received hospital-based routine care. These finding showed a more rapid correction of the underlying metabolic abnormalities of DKA, including hyperglycemia, ketosis and metabolic acidosis. The application's study of the Ahmedi continuous nursing model in 120 children with DKA conducted in China also found the same findings, where the observation group corrected biochemical recovery significantly faster than the control group [33].

This shows the importance of nursing guidelines, which emphasize frequent monitoring of biochemical parameters, includes; blood glucose monitoring, serum electrolytes, timely administering of insulin and fluid therapy and follow-up assessments of treatment responses. These are central components in evidence-based DKA management and contribute to restoring metabolic homeostasis. Many other studies regarding the use of DKA guidelines that focused more on nurse education regarding improvements in patient outcomes found a significant effect and achieved marked improvement in guideline compliance [17,34]. The observed superior biochemical recovery in the intervention group shows that nursing care plays a critical role manage pediatric DKA.

Another major finding of this study was the significantly shorter duration of DKA resolution and hospitalization among children managed according to EBP nursing guidelines. Resolving DKA in intervention group achieved a significant mark approximately 9 hours earlier than the control group and reduced one full day in hospital stay. These findings are in line with a study done in Saudi Arabia, after implementing clinical practice guidelines, which found the mean Length of hospital Stay (LOS) to decrease from 107.4 hours to 68.6 hours. Also, a study done in UK found the mean reduction from 22.0 hours to 10.2 hours [35,36]. This improvement in hospital stay duration and shorter resolution time of recovery had important implications for resource allocation, healthcare expenditures, bed occupancy and family burden. Therefore, it yields both and economical outcomes.

The current study showed a significant reduction in the intervention group regarding the overall complication burden. A higher proportion of children in the intervention group experienced no complications during hospital admission and particularly persistent acidosis was less frequent than in the control group. Persistent acidosis shows slow metabolic recovery, increasing the likelihood of further complications. It shows the effectiveness guideline in achieving metabolic stabilization in the intervention group.

Complications like CE, AKI, hypokalemia, hyperkalemia, fluid overload, thrombosis and cognitive impairment occurred less frequently in the intervention group, but these differences did not reach statistical significance. The low recurrence of these complications or the relatively small sample size may explain this. Myers *et al.* [37] had found that in an extensive study of fluid trials on 1359 DKA episodes, AKI occurred in 43% of children and was associated with subtle cognitive impairment and lower IQ months later. Our findings also showed a higher incidence of acute cognitive impairment among the control groups than was observed in the intervention group.

The hospital stay duration in the intervention group as an independent predictor was shorter after analysis using multivariable regression; conversely, DKA severity and poor adherence to insulin therapy were associated with prolonged hospitalization. Studies had found the same result as our study. Multiple studies have shown that more severe DKA is related to longer hospitalizations. In a retrospective study done in Ethiopia on 387 patients, the results found severe DKA was associated with a longer hospital stay, while mild/moderate DKA notably had shorter stays with an average of 4.6 days of hospital stay. Studies in other areas found severe DKA is associated with a longer hospital stay duration [38-40].

Poor adherence to insulin therapy was another predictor of longer hospital stays in this study. Children with poor adherence were significantly associated with longer hospital stays. It is a major precipitant of DKA admissions and recurrent admissions in children. Research conducted in Brazil concerning DKA complications among children and adolescents revealed a link between insufficient adherence and recurrent DKA, while LOSs were not mentioned [41]. The same studies done in Turkey and Ethiopia found that non-adherence was related to frequent admissions of DKA children [42,43]. It implies that no studies have documented a link between insufficient adherence and prolonged hospitalization. The results introduce a novel aspect to our research, as our study discovered poor adherence to be a predictor of prolonged hospitalization.

CONCLUSION

The present study concluded that implementing an EBP nursing guideline significantly improved clinical outcomes among children with DKA. Children who received nursing care based on guidelines experienced faster correction of metabolic abnormalities, shorter DKA resolution time, decreased LOS, had fewer complications and lower readmission rates when compared with those children who received hospital routine care.

These findings provide evidence that a structured EBP nursing guideline intervention can improve the quality and effectiveness of pediatric DKA management.

Limitations

This study's strengths include the following points. First; it is the first study of its type in Iraq to evaluate the impact of EBP nursing guidelines on the clinical outcomes of children with DKA. Secondly; the study assessed different outcomes, including biochemical recovery indicators, DKA resolution time, LOS, complication rates and readmission rates after two months. This provides a comprehensive evaluation of the intervention's effectiveness. Two groups, a control group and an intervention group, allowed for a direct comparison between routine care and guideline-based nursing care.

We should acknowledge some limitations in the study, even though it has strengths. Bias in selection and causal inference may have been difficult to manage since randomization was not part of the quasi-experimental design. Researcher might not generalize the findings to other healthcare settings because the study occurred in a single

tertiary pediatric hospital. The small sample size could have limited the detection of less common complications. Limiting follow-up appointments to two months following discharge prevents a comprehensive assessment of long-term results and the sustaining of the intervention's effects. It is recommended that future multicenter studies involve more participants, randomization and longer observation periods.

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Trial Registration

Registered retrospectively at ClinicalTrials.gov (NCT07467616).

Availability of Data and Materials

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Funding

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Trial Registration

Registered retrospectively at ClinicalTrials.gov (NCT07467616).

Ethical Statement

The Research Ethics Committee of the College of Nursing at Hawler Medical University granted ethical approval (Approval No. 2414). Written informed consent was obtained from the parents or legal guardians of all participants.

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