Effect of an Educational Program on the Nurses' Performance and Patients' Health Outcomes regarding Diabetic Ketoacidosis

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Abstract

Background: Diabetic ketoacidosis is a life-threatening complication of diabetes and is the most common cause of death in patients with diabetes mellitus. The effective management of patients with diabetic ketoacidosis depends on knowledgeable and skillful nurses who play a central role in managing those patients. **Aim of study:** Was to evaluate the effect of an educational program on the nurses' performance and patient's health outcomes regarding diabetic ketoacidosis. **Research design;** A quasi-experimental - design was utilized. **Setting:** This study was conducted at the general intensive care unit at Benha University Hospital. **Subjects:** Convenient sample of all available nurses (70 nurses) who are working in ICU & A convenient sample of 60 patients who attended to ICU within 6 months and assigned to studied nurses. **Tool**s: Three tools for data collection were used as follows: (I) Nurses self-administered questionnaire. (II) Nurses' practice observational checklist. (III) Patients' health outcomes sheet. **Results:** The study shows that highly statistically significant improvement in the total knowledge and practice score of the studied nurses immediately post program implementation, also, there was a positive correlation between knowledge & practice post program implementation. **Conclusion:** Implementation of an educational program had a positive effect in improving nurses' knowledge and practice regarding care of diabetic ketoacidosis patients and improving patients' health outcomes. **Recommendation:** A similar study should be replicated on a large sample and other places to generalize the findings.

Keywords: Diabetic Ketoacidosis, educational program, nurses' performance, patients' health outcome.

Introduction

Diabetic Ketoacidosis (DKA) is acute metabolic complication of diabetes characterized by absolute or relative insulin deficiency resulting in hyperglycemia, hyperketonemia, and metabolic acidosis. DKA is an endocrine emergency that requires immediate treatment and close monitoring for metabolic derangements. It most commonly occurs in patients with a known history of type 1 diabetes; however, patients with type 2 diabetes are also at risk during states of acute illness **(Victor et al., 2022).**

Diabetic ketoacidosis happens when the body isn't producing enough insulin, so carbohydrates can't be used as energy source,

when the body doesn't produce enough insulin, glucose can't go into cells to be used for fuel. Instead, fat is broken down for the body to use as fuel. When the body breaks down fat, it produces an acidic by product called ketones, which can build up in blood and urine. DKA results from rapid ketone production, when ketones are produced too quickly and build up in the blood, they can be toxic because they make the blood acidic **(Modglin, 2022).**

Successful treatment of DKA requires restoration of circulatory volume and tissue perfusion, resolution of hyperglycemia, correction of electrolyte imbalance and acid base disorder, cessation of ketogenesis, and careful search for the precipitating cause of

metabolic decompensation **(Bonora & Defronzo, 2020).**

Nursing care of the patient with DKA focuses on monitoring fluid and electrolyte status as well as blood glucose levels; administering fluids, insulin, and other medications; and preventing other complications such as fluid overload. Urine output is monitored to ensure adequate renal function before potassium is administered to prevent hyperkalemia. The electrocardiogram is monitored for dysrhythmias indicating abnormal potassium levels **(Cooper&Gosnell, 2022)**

Patients' health outcomes concerned with assessment of physiological parameters as: temperature rate, heart rate, respiratory rate, blood pressure, oxygen saturation (SO2), potassium level, blood glucose level, urine ketones level, central venous pressure (CVP), sodium bicarbonate level (HCO3) and PH of the blood level.

Significance of study:

The international diabetes federation (IDF) listed Egypt among the world top 10 countries in the number of patients with diabetes. In Egypt the prevalence of diabetes is around 15, 56% among adults between 20 and 79 years of age, with an annual deaths of 86,478 related to diabetes. The diabetes prevalence in Egypt has increased rapidly within a relatively short time from approximately 4,4 million in 2007 to 7,5 million in 2013, It is expected to jump to 13,1 million by 2035**(Hegazi et al., 2016).**

Despite advancement in self-care of patient with diabetes, DKA accounts for 14% of all hospital admissions of patient with diabetes and 16% of all diabetes related facilities .Almost 50% of diabetes related admissions in young persons are related to DKA. DKA frequently observed in patients with type 1 diabetes mellitus. DKA is also occurring in type 2 diabetes mellitus but it is less common. The

incidence of DKA in developing countries is not known, but it may be higher than in industrial nations. DKA tends to occur in individuals younger than 19 years but it may occur at any age **(Hamdy, 2019).**

Aim of the study

This study aimed to evaluate the effect of an educational program on the nurse's performance and patient's health outcomes regarding diabetic ketoacidosis.

Research Hypothesis:

The following research hypotheses were formulated to fulfill the aim of the study:

H1: Nurses' knowledge and practice scores regarding care for patient with DKA will be positively improved after educational program implementation.

H2: patients' health outcomes will be positively improved after educational program implementation.

Subjects and Methods

Design:

Quasi-experimental research design was used.

Setting:

The study was conducted in general intensive care unit at Benha University Hospital.

Subjects:

The subjects of this study were composed of two groups:

Group A: Nurses: Convenient sample of all available nurses (70 nurses) who are working in general intensive care unit and assigned for caring the patients were included in the study.

Group B: Patients: Convenient sample of (60 patients) with DKA who were admitted to ICU during data collection period. Patients recruited were allocated and classified into two equal groups 30 patients (control group) who received routine care by nurses before educational program implementation and 30 patients (study group) who received nursing care by nurses post educational program

implementation.

Tools for data collection:

Three tools for data collection were used as follows:

Tool I: Nurses self-administered questionnaire (pre- post the educational program): It was developed by the researcher and written in Arabic language based on reviewing recent and related literatures **(Ignatavicius and Workman, 2016; Hinkle and Cheever, 2018; Burns and Delgado, 2019).** It aimed to assess nurse knowledge regarding caring of patients with DKA and included two parts:

Part 1: Concerned with demographic characteristics of nurses including: age, gender, marital status, qualification, years of experience, and attendance of previous training courses about DKA.

Part 2: Concerned with assessment of nurses ' knowledge regarding DKA and their management.

It included three sections:

Section I Covered nurses' knowledge about definition, risk factors, causes, signs and symptoms, diagnosis, complications, management of DKA, and included (12) MCQ questions.

Section II Covered nurses ' knowledge about emergency care for DKA, and medical management for DKA. It consisted of (14) MCQ questions.

Section III Covered nurses ' knowledge about health instruction for patients before discharge. It consisted of (12) MCQ questions.

Scoring system:

The correct answer was given one score and incorrect answer was given zero score. These scores were summed up and converted into percent score. Total knowledge score: 38 score equal (100%).

The total level of nurses ' knowledge score was categorized as follows:

The total score of nurses ' knowledge = 38 score = 100%, score $\geq$ 80% ($\geq$ 29 marks) of total score was considered satisfactory level of knowledge, score < 80 % (< 29marks) of total score was considered unsatisfactory level of knowledge.

Tool II: Nurses ' practice observational checklist (pre- post the educational program) developed by the researcher after reviewing related and recent literatures **(Ignatavicius and Workman, 2016; Ali et al., 2017; Hinkle and Cheever, 2018; Burns and Delgado, 2019; and Shaker et al., 2020).**

It aimed to assess nurses ' practice regarding caring of patients with DKA, and included: Emergency care for patient on admission (33) steps, nursing practice during blood glucose test by using test strip (16) steps, nursing practice during urine ketone test strip (12) step, nursing practice during intravenous fluid infusion therapy (28) steps, nursing practice during intravenous insulin infusion via volume control administration set (22) steps, nursing practice during taking arterial blood gases(ABG) (27) steps, routine care for DKA (15) steps

Scoring system:

The scoring system of nurses ' practice was as the following:

One mark given for each step correctly done and zero mark for incorrectly done and not done.

The total level of nurses ' practice score was 153 scores equal (100%) categorized as follows:

Score $\geq$ 85% (equal $\geq$ 130 score) was considered competent level of practice

Score < 85 % (equal < 130 score) was considered incompetent level of practice

Tool (III) patients ' health outcomes tool (pre-post the educational program):

It was developed by the researcher after reviewing related and recent literatures and included two parts as the following:

Part one: concerned with demographic characteristics of studied patients which included: age, gender, type of diabetes mellitus,

treatment, trigger risk factors, level of consciousness and length of ICU stay.

Part two: concerned with assessment of physiological parameters as: temperature rate, heart rate, respiratory rate, blood pressure, oxygen saturation (SO2), potassium level, blood glucose level, urine ketones level, central venous pressure (CVP), sodium bicarbonate level (HCO3), PH of the blood level.

Educational program booklet:

It was designed by the researcher in Arabic language after reviewing of recent related literatures; scientific references based on nurses' needs: **(Ignatavicius and Workman, 2016; Hinkle and Cheever, 2018; Perrin and Macleod, 2018; Vellanki and Umpierrez, 2018; Burns and Delgado, 2019; and Gort, 2020).** Booklet was color printed and was supported by photos for more illustration and to help the nurses to understand the content. The nurses learning needs were identified and classified into knowledge and practice.

Content validity:

Content validity was established for testing relevance, simplicity, clarity, comprehensiveness, applicability of the question and any ambiguity through a jury, with help of 5 experts in field of nursing (two professor and three assistant professor in Medical Surgical Nursing department, Faculty of Nursing, Benha University), necessary modification was done accordingly.

Tool reliability:

Reliability of developed tools was done statistically to assure that the tools are reliable before data collection. Testing reliability was done through Alpha Crombach test. Reliability for nurses' self-administered questionnaire was (0.735). Reliability for observational checklist was (0.820). Reliability for patient outcomes tool was (0.720).

Ethical considerations:

An official approval was obtained from Ethical Committee of Faculty of Nursing Benha University before initiating the study. An official permission was obtained from hospital administrators to conduct the study. Each nurse was informed about the purpose and significance of the study and all information gathered used only for the purpose of the study. Verbal consent was obtained from each participants enrolled into the study. The research assured maintaining anonymity and confidentiality of objective data. The subjects were informed that they are allowed to choose to participate or not in the study and they have the right to withdraw at any time without any consequences.

Pilot study:

A pilot study carried out prior to data collection on 10% of the study subjects (7 nurses) in order to test the clarity, applicability, feasibility, relevance of the data collection. Based on the finding of the pilot study as expertise opinions, required minor modifications were done in form of adding or rephrased of some questions then the final form was developed. Nurses involved in the pilot study were excluded in the total study subjects.

Field work:

The study was conducted over period of 6 months started from June 2021 to December 2021. Data was collected 4 days (Saturday, Monday, Wednesday and Thursday) per week at morning and afternoon in general intensive care unit at Benha University Hospitals. The tools were filled two times, before the educational program and immediately after the program implementation.

The study was conducted through four phases and it was include:

Phase I: Assessment phase

Preparatory phase: This phase included reviewing the available literature and different studies related to research problem.

For nurses: The researcher visited the ICU and interviewed with all available nurses and explains the purpose and nature of the study in

order to gain their cooperation as well as verbal consent during data collection period. Then the researcher assesses nurses' knowledge and practice.

Nurses self-administered questionnaire **(Tool I)** was used to assess nurses knowledge regarding care of diabetic ketoacidosis patients, it was filled in by nurses and took about 25-30 minute for each nurse.

Nurses were observed by the researcher using observational checklist **(Tool II)** to assess their practice regarding care of Diabetic Ketoacidosis patients, this checklist was filled in by the researcher and took 45-60 minutes for each nurse.

For patients: patients divided into two groups control and study (intervention) group, the intervention group who received care by nurses after the educational program, they assessed by the researcher using patients ' health outcome sheet **(tool III)** to assess the condition of DKA on admission and one week post implementation of the program.

Phase II: Planning phase (educational program development):

Based on finding of assessment phase. Goals and priorities were formulated. The researcher develop the educational program according to nurses' needs and deficiency to improve their knowledge and practice regarding care of patient with diabetic ketoacidosis and improve patient's health outcomes accordingly.

The general objective of the educational program was improving nurses ' performance and patients ' health outcomes regarding DKA.

Content of the educational program divided into two parts: theoretical part and practical part.

Theoretical parts included: Introduction, definition of DKA, causes, signs and symptoms, pathophysiology, diagnosis, complications, medical management, and nursing role for caring DKA patient from

admission to discharge

Practical parts included: measuring blood glucose using glucose test strip, measuring acetone in urine using ketone test strip, administration of intravenous fluid infusion therapy, administration of intravenous insulin infusion via volume control administration set, taking arterial blood gases (ABG), connecting patient to ICU monitor, And suctioning.

Teaching methods included: lecture of simplified instruction followed by discussion, brain storming, and demonstration and redemonstration for practice training.

Media for teaching and training included: booklet, pictures, and videos through laptop or mobile.

Phase III: implementation phase (sessions):

The implementation phase was achieved through theoretical and practical sessions at the period of (12 weeks), the number of sessions were (5) sessions (3 for theoretical part and 2 for practical part). The duration for each session was (35-45 minutes) for theoretical sessions and ranged from (45-60 minutes) for practical sessions.

The researcher divided nurses into groups, each group contain 3 nurses. Orientation to educational program and its processes were presented to them. A brief summary about what has been discussed in the previous session, then the objectives of the new topic using simple Arabic language according to the nurses ' level of education then discussion, motivation and reinforcement during the sessions were used to enhance learning. The content of sessions covered in a booklet, each nurse given a copy of it. At the last session, the researcher informed them that they will be evaluated immediately.

Phase IV: Evaluation phase:

For nurses: After implementation of educational program the post test was administered to evaluate the effectiveness of the educational program through evaluates nurses '

knowledge using (tool I part 2) and nursing practice was observed and checked by the researcher by using **(tool II).**

For patients: the researcher assessed patients (study group) using patients ' health outcome sheet (Tool III).

Comparisons were done between pre and post the educational program to evaluate its effect on the nurses' performance and patients ' outcomes.

Results

Table (1): Shows that, 40% of the studied nurses their age were < 25 years old with mean age of 25.89 ± 0.89 years, 58,6% were females and 50% were single. In relation to qualification, 55,7% were nursing technical institute. Regarding to years of experience, 42, 9% were from 1-<5 years and 92, 9% didn't attended any training courses related to DKA.

Table (2): Shows that the mean score of total knowledge was 19.41±4.30 pre the program implementation, which improved to 33.58±2.64 immediately post program implementation, with highly statistically significant differences among all items of knowledge pre and post program implementation at (p≤0.001).

Table (3): Shows that the mean score of total practice was 85.58±8.20 pre-program implementation, which improved to 137.02±6.17 post program implementation, with highly statistically significant differences among all items of practice pre and immediately post educational program implementation at (p≤0.001).

Table (4): Shows that regarding patients ' age, 53.3%, 46.7% of both control & intervention group respectively were aged 45-<60 years old with mean age of 44.67 ± 0.60, 44.80 ± 0.71respectively, regarding gender 53.3%, 50% of them respectively were males, regarding type of diabetes mellitus 83.3%, 80% of control & intervention respectively had type I diabetes mellitus and 76.7% & 70% of control & intervention group respectively were in insulin

treatment. Concerning trigger risk factors 46.7% &43.3% respectively of control & intervention group had infection, according to level of consciousness 46.7% & 53.3% of both groups were respectively semi-conscious and 70%, 86.7% of them respectively stayed from 1 week to < 2 weeks in ICU. There were no statistically significance differences between control and intervention group which indicates that the two groups were nearly homogenous.

Table (5): Shows that there was no statistically significant difference between both groups on admission at p>0.05 in their health outcomes. while 93.3% of the intervention group had normal ranges of respiratory rate, blood glucose level, and urine ketones level post one week of the educational program compared to 73.3% of the control group with statistically significant difference at p ≤ 0.05. In relation to difference between health outcomes on admission and post one week in the intervention group, there were highly statistically significant differences in temperature rate, heart rate, oxygen saturation, and potassium level, and statistically significant differences in respiratory rate, blood pressure, and central venous pressure at (p ≤ 0.05 and p≤0.001).

Table (6): Shows that, there was a highly significant positive correlation between total nurses' knowledge and their practices regarding patients with DKA after implementing the program where p < 0.001.

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Table (1): Percentage distribution of the studied nurses according to their demographic characteristics (n = 70)

Nurses' Demographic Characteristics	No.	%
Age / years		
< 25 y	28	40.0
25- < 35 y	26	37.2
≥ 35 y	16	22.8
Mean ± SD	25.89 ± 0.89	
Gender		
Male	29	41.4
Female	41	58.6
Marital status		
Single	35	50.0
Married	26	37.1
Divorced	7	10.0
Widowed	2	2.9
Qualification		
Diploma	9	12.9
Specialized nursing diploma	8	11.4
Nursing technical institute	39	55.7
Bachelor of Nursing	14	20.0
Years of Experience		
< one year	16	22.9
1-<5 years	30	42.9
5-< 10 years	10	14.3
≥ 10 years	14	20.0
Mean ± SD	5.31 ± 1.04	
Previous training courses about DKA		
Yes	5	7.1
No	65	92.9

Table (2): Nurses' total knowledge score about diabetic ketoacidosis and its management pre and immediately post implementing the program (n=70)

Knowledge dimensions score	Pre Program X⁻ ± SD	Immediate post X⁻ ± SD	T test	p value
Diabetic ketoacidosis	6.54±1.79	10.41±1.45	- 17.301	<0.001**
Nursing care for diabetic ketoacidosis	6.32±2.06	12.10±1.45	- 22.55	<0.001**
Predischarge nursing instructions for patients with diabetic ketoacidosis	6.57±2.41	11.07±1.05	-15.091	<0.001**
Total knowledge	19.41±4.30	33.58±2.64	- 25.065	<0.001**

Table (3): Nurses' total practice score regarding caring for patient with diabetic ketoacidosis pre and immediately post implementing the program (n=70)

Practice score about	Pre Program $X^- \pm SD$	Immediate post $X^- \pm SD$	T test	p value
Emergency care on admission	18.87±2.55	29.15±2.36	- 27.904	<0.001**
Blood glucose test	7.15±1.55	13.88±1.70	- 26.147	<0.001**
Urine ketone test	7.40±1.52	10.88±1.11	- 17.506	<0.001**
Intravenous infusion therapy	17.41±2.01	26.21±1.72	- 32.359	<0.001**
Intravenous insulin infusion	12.87±1.91	19.80±1.69	- 25.715	<0.001**
Arterial blood gases	14.77±2.64	24.02±1.94	- 25.893	<0.001**
Routine care	7.10±1.62	13.05±1.76	- 26.244	<0.001**
Total Practice	85.58±8.20	137.02±6.17	- 48.646	<0.001**

Table (4): Distribution of the studied patients according to their demographic characteristics, control group (n=30) and intervention group (n= 30).

Demographic characteristics	Control group (n=30)		Intervention group (n=30)		chi square	P value
	(no.)	%	(no.)	%		
Age / years						
30-<45	12	40.0	11	36.7	1.463	0.481 [n.s]
45-<60	16	53.3	14	46.7		
≥60	2	6.7	5	16.7		
Mean ±SD	44.67 ± 0.60		44.80 ± 0.71		t= -0.779	0.439 [n.s]
Gender						
Male	16	53.3	15	50.0	0.067	0.796 [n.s]
Female	14	46.7	15	50.0		
Type of diabetes mellitus						
Type I	25	83.3	24	80.0	0.111	0.739 [n.s]
Type II	5	16.7	6	20.0		
Treatment of diabetes						
Insulin	23	76.7	21	70.0	0.591	0.744 [n.s]
Oral treatment	3	10.0	5	16.7		
No treatment	4	13.3	4	13.3		
Trigger risk factors						
Missed insulin dose	13	43.3	11	36.7	3.204	0.361 [n.s]
Infection	14	46.7	13	43.3		
Imbalanced diet	2	6.7	1	3.3		
Poor access to health care	1	3.3	5	16.7		
Levels of consciousness						
Conscious	0	0.0	1	3.3	1.621	0.655 [n.s]
Semiconscious	14	46.7	16	53.3		
Confused	14	46.7	12	40.0		
Unconscious	2	6.7	1	3.3		
Length of ICU stay						
1 week to < 2 weeks	21	70.0	26	86.7	2.455	0.117 [n.s]
2 weeks to one month	9	30.0	4	13.3		
Mean ±SD	10.30 ± 0.46		10.13 ± 0.34		t= 1.573	0.121 [n.s]

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Table (5): Comparison between control and intervention group according to their health outcomes pre and post one week of program implementation (control group n=30, and intervention group n= 30)

Patient's health outcomes	Control group (pre program implementation) (n=30)				Intervention group (post program implementation) (n=30)				X² Test P value (1)	X² test P value (2)	X² test P value (3)
	On admission		Post one week		On admission		Post one week				
	Normal No (%)	Abnormal No (%)	Normal No (%)	abnormal No (%)	Normal No (%)	abnormal No (%)	Normal No (%)	Abnormal No (%)			
Temperature rate (36.4°C-37.5°c).	10 33.3	20 66.7	15 50.0	15 (50.0	13 (43.3)	17 (56.7)	24 (80.0)	6 (20.0)	0.635 0.426 n.s	5.934 0.015 *	15.000 <0.001* *
Heart rate (60-100b/min).	10 (33.3	20 (66.7	15 (50.0	15 (50.0	14 (46.7)	16 (53.3)	24 (80.0)	6 (20.0)	1.111 0.292 n.s	5.934 0.015 *	15.000 <0.001**
Respiratory rate (12-20 breath/min).	12 40.0	18 60.0	22 73.3	8 26.7	13 43.3	17 56.7	28 93.3	2 6.7	0.069 0.793 n.s	4.320 0.038 *	4.000 0.046*
Blood pressure (120±20/80±15) mmhg.	11 36.7	19 63.3	16 53.3	14 46.7	12 40.0	18 60.0	24 80.0	6 20.0	0.071 0.791 n.s	4.800 0.028 *	9.853 0.002*
Oxygen saturation (95-100%)	12 40.0	18 60.0	19 63.3	11 36.7	14 46.7	16 53.3	26 86.7	4 13.3	0.271 0.602 n.s	4.356 0.037 *	11.579 0.001**
Potassium Level (3.5-5.5 mEq/L)	19 63.3	11 36.7	19 63.3	11 36.7	15 50.0	15 50.0	27 90.0	3 10.0	1.086 0.297 n.s	5.963 0.015 *	10.055 0.001**
Blood Glucose Level (110-140 mg/dl).	0 0.0	30 100.0	22 73.3	8 26.7	0 0.0	30 100.0	28 93.3	2 6.7	N.A	4.320 0.038 *	N.A
Urine ketones level (negative).	0 0.0	30 100.0	22 73.3	8 26.7	0 0.0	30 100.0	28 93.3	2 6.7	N.A	4.320 0.038 *	N.A
Central Venous Pressure (3-15 mmhg)	5 16.7	25 83.3	16 53.3	14 46.7	11 36.7	19 63.3	24 80.0	6 20.0	3.068 0.080 n.s	4.800 0.028 *	5.250 0.022*
Bicarbonate sodium level (22-26 mEq/L)	0 0.0	30 100.0	14 46.7	16 53.3	0 0.0	30 100.0	24 80.0	6 20.0	N.A	7.177 0.007 *	N.A
PH of blood level (7.35-7.45)	0 0.0	30 100.0	14 46.7	16 53.3	0 0.0	30 100.0	24 80.0	6 20.0	N.A	7.177 0.007 *	N.A

Table (6): Correlation between total knowledge and total practices among nurses regarding DKA patient post the educational program (n=70)

r-\ p values variable	Total knowledge	
	R	P
Total practice	0.740	<0.001**

Discussion

Diabetic ketoacidosis (DKA) is one of the most serious complications after diabetes poor control, which seriously threatens human life, health, and safety. DKA can rapidly develop within hours or days leading to death. Early evaluation of the prognosis of DKA patients and timely and effective intervention are very important to improve the prognosis of patients **Mahmoud, (2021).**

The current study revealed that two fifth of the studied nurses their age were < 25 years old with mean age of 25.89 ± 0.89 years and had 1-<5 years of experience, this explains that most of those nurses were newly graduated and reflect the demanding nature of intensive care units for more experienced nurses.

This result was in the same line with **Shaker et al., (2020)** who studied "effect of training program on nurses' performance and health outcomes of patients with diabetic ketoacidosis" and stated that the majority of studied nurses were under 30 years and their mean ages were (26.4± 3.8) years old and **Mccary, (2018)** who stated that the studied nurses had 1-5 years of experience.

The results of the present study also revealed that more than half of the studied nurses were females and had technical nursing institute. This may be due to the nursing profession in Egypt was exclusive for females only until few years ago. These finding were in the consistent with, **Mccary, (2018**) who studied "a quality improvement project: increasing early diagnosis and management of DKA by registered nurses" and reported that nearly three quarters of the participants were females and agreed with **Abdelrahman et al., (2020)** about "assessment of nurses' knowledge and practices regarding care of patients with diabetic coma" who reported that more than half of the studied nurses had technical institute of nursing.

This result also agreed with the study conducted by **Kulkarni et al., (2019)** who studied the knowledge regarding diabetes management amongst medical intern and nursing staff in tertiary care teaching hospital in Marathwada region of Maharashtra, India and reported that most of nurses were females.

Regarding to marital status, the results revealed that half of the studied nurses were singles. This finding was agreed with **Mehany, (2015)** who studied "effect of an educational program on nurses ' knowledge and practice regarding management of diabetic crisis in the emergency medical unit at Assiut University Hospital" and stated that two thirds of studied nurses were single. From the researcher point of view this may be due to the studied nurses were at the age group less than 25years old and newly graduated. But these results disagreed with **Mohammed et al., (2019)** who studied "effect of educational program on nurses' performance regarding patients with acute pancreatitis" and stated that more than half of the studied nurses were married.

The results of current study revealed that majority of the studied nurses had not attended any training courses related to DKA in ICU. This finding may be because lack of hospital financial resources for training or shortage of nursing staff and work overload which considered as barrier for nurses to leave the work and attend training course, This result agreed with study by **Zaiton et al., (2019)** about "barriers and strategies of implementing DKA care set in the emergency department as perceived by nurses" and reported that the majority of participants not attending any courses related to DKA.

But, this finding disagreed with **Uğur et al., (2015)** who carried out a study about "postgraduate education needs of nurses who are caregivers for patients with diabetes" and found that more than two thirds of the studied sample had education course in DM after graduation.

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Regarding the total nurses' knowledge pre and immediate post the educational program, the current study demonstrated that, there was significant improvement regarding total level of studied nurses' knowledge about DKA and its management post the educational program where more than three quarters of them had satisfactory knowledge post program compared to 18.6% pre the program. From the researcher point of view, the results may be due to the refreshment of essential knowledge for nurses during the educational program and giving them updated information about DKA and its management.

These findings were in the conformity with **Shaker et al., (2020)** who reported that the mean scores of nurses' total knowledge about diabetic ketoacidosis and its management were statistically significant increased post implementing of the training program than pre training program, the results also agreed with **Pontejos, (2022)** who studied " diabetes education for nursing staff in primary health care" and reported that there is an overall significant improvement of knowledge gained. In addition, the study was in agreement with **Huley, (2019)** who reported that the total scores of corrected answers were increased posttest than pretests.

The results revealed that, the mean score of the total knowledge of nurses improved post program implementation than pre-program, there were highly statistically significant differences in all items of knowledge pre and post program at P≤ 0.001 regarding general knowledge about DKA, nursing care and pre discharge nursing instructions for patients with DKA.

This study in the accordance with **Alishaq, (2018)** who studied "The impact of diabetes educational interventions on nurses' knowledge of in-patient diabetes management in hospitals in Abu Dhabi & Dubai" and reported that the

results showed that total knowledge and information level of nurses improved after training sessions than pre training sessions.

The current study revealed that the mean score of total practice was increased post educational program implementation than pre implementation. There were highly statistically significant differences among all items of practices pre and post educational program implementation at (p≤0.001) including; emergency care on admission, blood glucose test, urine ketone test, intravenous fluid infusion, insulin infusion, arterial blood gases sampling, and routine care.

Regarding difference between nurses' total practice level about caring for patient with diabetic ketoacidosis pre and immediately post implementing the program, the current study demonstrates that, less than three quarters of the studied nurses had competent level of practice regarding caring of patient with DKA immediately post implementation, compared to minority of them had competent level of total practice pre -program implementation.

From the researcher point of view, the reasons for low practice level pre- program implementation in the current study might be due to increased number of patients and work load, lack of in-service training programs for nurses which affect negatively on their practice. While post program implementation the majority of the studied nurses had competent level of practice. This improvement in their performance may be due to their willing to gain knowledge and skills regarding caring of patients with DKA and the preparation of a teaching program was successful in achieving better information and practice levels between nurses.

The current study results was consistent with **Mehany, (2015)** study which reported that the total scores of the nurses' practice were improved from less than one quarter pre-

program to more than two quarters immediately post program implementation. Also agreed with **Shaker et al., (2020)** who stated that the mean nurses′ total practice was statistically significant increase post implementing of the training program.

Regarding correlation between total knowledge and total practices among nurses regarding patient with DKA patient post the educational program, the current study revealed that there was a highly significant positive correlation between total nurses' knowledge and their practices regarding DKA patients after implementing the program where p < 0.001. This might be due to the educational program improved level of nurses' knowledge which affects positively on their practice regarding diabetic ketoacidosis ' patients.

This study was disagreement with **Ali et al., (2017)** and reported that there was no significant relation between nurses' knowledge and practice; this might be due to lack of supervision, equipment and practice training.

Regarding demographic characteristics of studied patients, the current study reveals that nearly two fifths of both controls & study group at age group from 45-<60 years old with no statistically significance difference between control and study group.

This result was agreed with **Thakare& Ankar, (2021)** who studied the knowledge regarding signs and symptoms of diabetic ketoacidosis and its prevention among diabetes patients in India" and reported that more than two fifth of the studied patients were in the age group of 51 - 60.

Also, the current results were supported by the study done by **Farah et al., (2021)** who studied "knowledge, attitude and practice on common diabetic patients among diabetic complications at Egyptian hospital in Mogadishu, Somalia" and reported that the majority of studied patients were between 40 and 60 years of age.

But, the current study was disagreed with **Plianpan et al.,(2019)** who studied " Clinical characteristics and outcomes of care in adult patients with diabetic ketoacidosis: A retrospective study from a tertiary diabetes center in Thailand" and reported that the mean age of studied patients were 47.4 ± 20.4 years old.

Concerning gender, more than two third of studied patients were males. This result was in the consistent with **Tefera et al., (2021)** who studied "diabetic ketoacidosis management and treatment outcome at medical ward of Shashemene Referral Hospital, Ethiopia" and stated that more than half of the studied subjects were males. But, this result disagreed with **Davidson et al., (2022)** who studied "the effects of diabetes self-management education on quality of life for persons with type 1 diabetes: a systematic review of randomized controlled trials" and reported that more than half of the studied participants were females.

Regarding type of diabetes mellitus, the majority of control & intervention group had type I diabetes mellitus, this might be due to that DKA commonly occur in T1DM. This result was in the same line with **Tefera et al., (2021)** and stated that more than two third of the studied subjects had known T1DM with DKA. But, this result was disagreed with **Banerjee et al., (2020)** who studied about "clinical profile and outcomes in COVID-19 patients with diabetic ketoacidosis" stated that three quarters of the studied patients had T2DM.

The current study also revealed that three quarters of control group and study group were on insulin treatment, this might be due to the majority of them had T1DM which commonly managed with insulin and named as insulin dependent diabetes mellitus (IDDM). This result was in the same line with **Balmier et al., (2019)** who studied "Initial management of diabetic ketoacidosis and prognosis according

to diabetes type: a French multicenter observational retrospective study" and reported that more than half of studied patients had T1DM.

In contrast with **Mohammed et al., (2020)** who studied "effectiveness of structured teaching program on improvement of diabetic patient's health information, treatment adherence and glycemic control" and reported that more than two third of the studied patients were on oral treatment for DM.

Concerning trigger risk factors, two fifth of control and intervention group had infection and missed insulin dose. This result was agreement with **George et al., (2018)** study entitled "correlation between the outcomes and severity of diabetic ketoacidosis: a retrospective pilot study" and reported that more than half of the studied patients had infection.

Also, the current result was consistent with **Plianpan et al., (2019)** who studied "Clinical characteristics and outcomes of care in adult patients with diabetic ketoacidosis: A retrospective study from a tertiary diabetes center in Thailand" and reported that more than half of studied patients had infection.

Also, the current result was consistent with **Plianpan et al., (2019)** who reported that more than half of studied patients had infection.

Regarding conscious level, the current study revealed that more than two fifth of control and study group were semiconscious or confused. This study agreed with **Qari, (2015)** who studied "clinical characteristics of patients with diabetic ketoacidosis at the intensive care unit of a university hospital" and stated that more than one third of studied patients had altered consciousness.

Concerning lengths of ICU stay, the study revealed that majority of the studied group stayed from 1 week to < 2 weeks. This might be related to severity of DKA. This result was

disagreed with **Plianpan et al., (2019)** who reported that median length of stay was 3 days and more than three quarters of patients were discharge within 5 days after admission.

Concerning comparison between control and intervention group according to their health outcomes on admission and post one week of program implementation, the current study clarified that there was no statistically significant difference between both groups on admission at p>0.05 in physiological parameters; temperature, heart rate, respiratory rate, blood pressure, oxygen saturation, central venous pressure, and potassium level. But showed significant difference post one week in the intervention group compared to control group regarding respiratory rate, blood glucose level and urine ketone level p value < 0.05.

Related to difference between health outcomes on admission and post one week in the intervention group, there was highly statistically significant differences in temperature rate, heart rate, oxygen saturation, and potassium level, and statistically significant differences in respiratory rate, blood pressure, and central venous pressure at (p ≤ 0.05 and p≤0.001). These results indicated that the educational program positively had an effect on patients ' health outcomes.

This result similar to the study conducted by **Shaker et al., (2020)** who reported that there was no significant difference between both study and control group in physiological parameters measurement in day of admission. But showed highly significance difference in study group after one week compared with control group was (P<0.05). Also, the current results were in the same line with **Mahmoud et al., (2022)** who studied about "effect of implementing nursing care protocol on critical patients' safety outcomes" and reported that there was no statistically significant difference between both groups on admission p>0.05 to

become highly significant difference after one week p ≤ 0.001.

Conclusion

There were highly statistically significant improvement of nurses' knowledge and practice regarding care of patients with diabetic ketoacidosis post implementation of educational program than pre- program implementation. Also, there was statistically significant positive correlation between total nurses' knowledge and total practice post educational program implementation. In addition, there were statistical significant improvements in patient' health outcomes for study group than control group after one week with statistically significance differences at p≤ 0.001

Recommendations

In the light of the findings of the present study, the following are recommended:

☐ In service education should be provided in hospital to improve nurses' performance regarding diabetic ketoacidosis through acquiring knowledge and through implementing the established protocol of care which must be updated periodically.

☐ Standard nursing procedures booklets should be available and developed in areas of diabetic ketoacidosis in both Arabic and English language.

☐ Posters and simple illustrations about caring of diabetic ketoacidosis' patients should be available in every intensive care unit.

☐ Close supervision and teaching on spot is needed to ensure that quality of care is provided by nurses.

Further research:

A similar study should be replicated on a large sample and other places to generalize the findings.

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تأثير برنامج تعليمي على الاداء التمريضي والنتائج الصحية للمرضى فيما يتعلق بالحموضة الكيتونية السكرية

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تعد الحموضة الكيتونية السكرية من المضاعفات التي تهدد الحياة لمرضى السكري ، وهي السبب الأكثر شيوعًا للوفاة بين مرضى السكري. يعتمد العلاج الفعال لمرضى الحموضة الكيتونية السكرية على تمريض ذات معلومات ومهارات جيدة. يلعب التمريض دورًا مركزيًا في علاج هؤلاء المرضى. لذا هدفت هذه الدراسة الى تقييم تأثير برنامج تعليمي على أداء التمريض والنتائج الصحية للمرضى فيما يتعلق بالحموضة الكيتونية السكرية. تم استخدام تصميم شبه تجريبي. أجريت هذه الدراسة في وحدة العناية المركزة العامة بمستشفى جامعة بنها على جميع افراد التمريض المتاحين (70 ممرضًا) والذين يعملون في وحدة العناية المركزة وعينة ملائمة من 60 مريضًا حضروا إلى وحدة العناية المركزة في غضون 6 أشهر وتم تقديم الرعاية التمريضية لهم بواسطة التمريض المشارك في الدراسة . أوضحت الدراسة أن هناك تحسن ذو دلالة إحصائية عالية في مجموع درجات المعرفة والممارسة للتمريض المشارك بالدراسة مباشرة بعد تنفيذ البرنامج التعليمي وكذلك تحسين النتائج الصحية للمرضى. وقد اوصت الدراسة بوجوب تكرار دراسة مماثلة على عينة كبيرة وأماكن أخرى لتعميم النتائج .