

Effect of Training Program on Nurses' Performance and Health Outcomes for Patients with Diabetic Ketoacidosis

Manal Saad Shaker¹, Samar Faltas Marzouk Faltas², Monira Samir Abdelhady³

^{1,3} Medical-Surgical Nursing, Faculty of Nursing - Fayoum University, Egypt

² Critical Care Nursing, Faculty of Nursing - Ain Shams University, Egypt

Abstract

Background: Diabetic ketoacidosis is a life-threatening complication of diabetes, and is the most common cause of death. The effective management of patients with diabetic ketoacidosis depends on a knowledgeable and skillful nurse who play a central role in managing those patients. **Aim:** The aim of this study was to evaluate the effect of training program on nurses' performance and health outcomes for patients with diabetic ketoacidosis. **Study design:** a quasi-experimental study (pre-test-post-test design) was utilized to fulfill the aim of the study. Subject: A convenient sample consisted of 40 nurses worked at intensive care unit at El-Fayoum University Medicine Hospitals, and 25 adult patients with diabetic ketoacidosis. **Tools:** Three tools were used; self-administered questionnaire; an observational checklist and patients' health outcomes assessment tool. **Results:** This study found that, the mean level of nurses' total knowledge was (4.75±1.5) which statistically significant increase post implementing of the training program (34±1.5) and the mean nurses' total practice was (114.3±59.1) which statistically significant increase post implementing of the training program (823.04±2.6). Moreover, there was statistically significant improvement in health outcomes among patients with diabetic ketoacidosis post implementation of the program. **Conclusion:** This study concluded that the training program had positive effect on nurses' performance and health outcomes for patients with diabetic ketoacidosis. **Recommendations:** The study recommended conducting a standard educational programs in intensive care units for improving nurses staffing, enhancing the patient care level and the quality of care provided to this group of patients.

Key Words: Diabetic ketoacidosis, Golden hours, Nurses, Patients, Training, Program

Introduction

Diabetic ketoacidosis (DKA) is an acute, major, life-threatening complication of diabetes characterized by hyperglycemia, ketoacidosis, and ketonuria. It occurs when absolute or relative insulin deficiency inhibits the ability of glucose to enter cells for utilization as metabolic fuel, the result being that the liver rapidly breaks down fat into ketones to employ as a fuel source.

The over production of ketones ensues, causing them to accumulate in the blood and urine and turn the blood acidic. The DKA occurs mainly in patients with type 1 diabetes mellitus (T1DM), but it is not uncommon in some patients with type 2 diabetes mellitus (T2DM) (Hamdy,2017).

Many patients with DKA may require admission to intensive care units (ICUs) either because of disease severity or due to coexisting serious illness.

However, in certain institutions, patients are admitted in ICUs even if they have mild to moderate DKA for administration of intravenous insulin infusion either due to hospital regulations or because of unavailability of infusion pumps in the general medical wards. In this context the treatment of uncomplicated DKA with subcutaneous rapid acting insulin analog has shown promise as an effective alternative to the use of regular insulin **(Fernando et al., 2017)**.

Physical examination of patients with DKA is generally revealed signs of dehydration, including loss of skin turgor, dry mucous membranes, tachycardia, and hypotension. Mental status can vary from full alertness to profound lethargy; however, less than 20% of patients who are hospitalized have loss of consciousness. Body temperature is usually normal or even low, except in the case of concomitant infection. Consciousness can be affected in more severe cases of DKA. Acetone on breath and labored Kussmaul (deep) respiration may also be present on admission, particularly in patients with severe metabolic acidosis **(Umpierrez, 2018)**.

There are many factors affecting patients with DKA; multiple behavioral, socioeconomic, psychosocial, and educational factors interact to play a vital role in the development of DKA among patients with T1DM lead to poor compliance. The recognition of these factors and the institution of culturally appropriate interventions and education programs might reduce DKA recurrence **(Almalki et al., 2016)**.

Nursing care of the patients 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 **(Victoria Anastasiou et al., 2019)**. 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. Vital signs, arterial blood gases, and other clinical findings are recorded on a flow sheet. The nurse documents the patient's laboratory values and the frequent changes in fluids and medications that are prescribed and monitors the patient's responses. **(Brunner, Smeltzer, & Suddarth, 2016)**.

The most important complications of DKA and its treatment are: Cerebral Edema is the most dangerous complication, occurring sub-clinically both before and after treatment, its cause is unknown. **(Lindner et al., 2018)**. Hypokalemia and hyperkalemia are potentially life threatening conditions during the management of DKA; there is a risk of acute pre-renal kidney injury associated with severe dehydration; severe increases and decreases in the K^+ levels during DKA occurrence and treatment can be life-threatening, therefore, careful monitoring of K^+ is essential **(Mohammed, 2019)**.

Hypoglycemia; The blood glucose may fall very rapidly as ketoacidosis is corrected and a common mistake is to allow the blood glucose to drop to hypoglycemia levels. Severe hypoglycemia is also associated with cardiac arrhythmias, acute brain injury and death. Pulmonary edema; a rare complication associated with the treatment of DKA. Elderly patients with impaired cardiac function are at a greater risk **(Kohler & Levy 2014)**.

The DKA can lead to significant complications as cardiac arrest, kidney

failure, respiratory failure and death. Acute kidney failure due to severe dehydration which can cause the kidneys to stop working; Adult respiratory distress syndrome, the rapid and unpredictable changes in fluid levels that can occur in DKA can occasionally result in the lungs becoming filled with fluid and can cause serious breathing difficulties (**Hendrickx, & Winters, 2017**)

Significance of the study

Diabetes is a fast-growing health problem in Egypt with a significant impact on morbidity, mortality, and health care resources. Currently, the prevalence of diabetes in Egypt is around 15.6% of all adults aged 20 to 79 (**Hegazi et al., 2015**). Therefore, this study was conducted to study the effect of implementing training program on nurses' performance and health outcomes for patients with diabetic ketoacidosis to increase nurses' knowledge and skills regarding dealing with such group of patients.

Aim of the study

The aim of this study was to evaluate the effect of training program on nurses' performance and health outcomes for patients with diabetic ketoacidosis through the following:

- Assess nurses' level of knowledge and practice regarding diabetic ketoacidosis.
- Developing and implementing training program for nurses caring for patients with diabetic ketoacidosis.
- Evaluate the effect of training program on nurses' performance and health outcomes for patients with diabetic ketoacidosis post training program implementation.

Research hypotheses

- Nurses who exposed to the health education program regarding management of patient with DKA will exhibit improved performance compared to their pre intervention level.
- Patient with DKA who are cared for by the trained nurses will exhibit better outcomes

Subject and Methods

Research design: a quasi-experimental design (pre, immediate and post-test) was utilized to conduct this study. "It is an empirical interventional study used to estimate the causal impact of an intervention on target population without random assignment". (**Umpierrez, 2018**).

Setting: This study was conducted in intensive care unit at El-Fayoum University Medicine Hospitals.

- The unit was in 1st floor and consisted of 15 beds and divided to three main areas one for isolation (3 beds for patients with HCV & HBV, pneumonia, and infected wound) and the other two areas for immediate post-operative (3 beds) and critical condition patients (10 beds). The nurse patient ratio was nearly 1:2 or 1:3

Subjects: A convenient sample consisted of all the nurses who working in previous mentioned setting; the total number of nurses was (40) nurses. And total number of (25) adult patients from both gender who admitted to intensive care unit with DKA.

Tool for data collection: Three tools were used to collect data as follow:

Tool No. I: Nurses' Self-administered questionnaire:

This questionnaire was developed by the researchers after reviewing the related literatures (Ignatavicius & Workman, 2013; Joint British Diabetes Societies (JBDS), 2013; Pellico, 2013; & Burke et al., 2014). This tool was consisted of two parts as follow:

Part 1: It was concerned with demographic characteristics data of nurses including; age, gender, marital status, qualification, years of experience and attendance of previous training courses.

Part 2: is concerned with assessment of nurses' knowledge regarding DKA and its management e.g. definition, causes, types, precipitating factors, role of insulin, complications, diagnostic & Laboratory parameters, emergent care for DKA, prevention and health education. The questionnaire was tested for reliability using test-retest reliability; the correlation coefficient value was 0.94. This tool was applied three times; pre implementation of training program, immediately post the program implementation and post one month later (follow up) program implementation.

Scoring system: every correct answer was given one score and zero was given for every wrong answer. The total scores for all the questionnaire was 36 degrees. The total score of nurses' level of knowledge was presented in the form of mean \pm SD.

Tool No. II: Nurses' practice observational checklist: this tool developed by the researches after reviewing the related literatures (Hinkle & Cheever, 2014; & Urden et al., 2014;

and Alotaibi, 2019) to assess the level of nurses' practice regarding caring of patients with diabetic ketoacidosis. Overall test-retest reliability coefficients for these tool were Cronbach's alpha values of 0.92. This tool was applied three times; pre implementation of training program, immediately post the program implementation and post one month later (follow up) program implementation. The tool consists of five parts as follow:

Part 1: Primary assessment survey including: Airway (4 items), Breathing (4 items), circulation (3 items), and disability (4 items).

Part 2: Immediate intervention on admission including: vital signs (30 items), Head to toe survey (20 items), General survey, and DKA nursing interventions which involves; Insulin administration (10 items), KCL preparation and administration (12 items), ABG sampling (10 items), GCS (12 items), intake & output monitoring (10 items), O₂ therapy (10 items), parental nutrition (14 items), Na bicarb administration (10 items), urinary catheter insertion (15 items), ECG (16 items), blood glucose monitoring (10 items), measure ketone in urine (10 items), blood sampling (12 items), and SPO₂ monitoring (9 items).

Part 3: secondary assessment including (15 items)

Part 4: nursing intervention after patient stabilization (5 items)

Part 5: infection control measures including: hand washing (10 items), skin care (10 items), IV cannula care (10 items), center venous catheter care (10 items).

The scoring system: (1) mark was given for done and (zero) for not done. Total score of performance test was (270).

Tool No.3: Patients' health outcomes assessment tool: it was developed by the researchers after reviewing the related literatures (**Zaiton et al., 2019; and Gort, 2020**). This tool was applied three times; pre, immediately post and post one month later (follow up) program implementation. Overall test-retest reliability coefficients were Cronbach's alpha values of 0.89. The tool consisted of two main parts:

Part one: concerned with demographic characteristics of patients in ICU units which included: age, gender, types of DM, treatment, trigger or risk factors

Part two: concerned with patients' outcomes that includes:

1. DKA morbidity (complications) which including:

- DKA-related complications (hypovolemic shock 12 signs and symptoms, hyperkalemia 10 items, hypernatremia 13 items, HAG-Metabolic acidosis 12 items, and (DLOC) disturbed level of consciousness (8 items).

- DKA treatment therapy related complications (hypoglycemia 6 items, Volume overload 13 items, hypokalemia 8 items and hypochloremia 10 items).

- ICU related complication as nosocomial infection (9 items).

- Discharge, transfer to ward, and mortality (death)

Tools validity and reliability

Tool validity: The tools were tested for face and content validity through (9) experts ; (three experts from

medical surgical nursing department, Faculty of Nursing, Ain Shames University; five experts from critical care nursing department, Faculty of Nursing, Cairo University and in addition to three experts physicians in critical care department from Fayoum University) . They were requested to give their opinion regarding the tool's content, accuracy, relevancy and appropriateness to the research objective. Finally minimal modifications were done to meet the jury opinion.

Tool reliability: the developed tool was tested for the reliability by using test-retest reliability and correlation coefficient value was determined.

Pilot study: A pilot study was carried out on 10% the total number of the study sample to test the applicability, clarity, efficacy, and the feasibility of the research process. Accordingly minor modifications were made so those nurses were included in the study.

Ethical consideration: a primary permit was granted from the hospital director to apply this study and from the head nurse of ICU. Also at the initial interview, each legible nurse and patient was informed about the aim of the study and its importance. The researcher emphasized that participation in the study is entirely voluntary, and anonymity and confidentiality were assured through coding the data. Oral approval consent was taken from each nurse and patient who agreed to participate in the study. Approval was taken from family members for unconscious patients; also they were assured that they have the right to withdraw from the study at any time. As well as the obtained information will be used only for the purpose of the study.

DKA Training Program: An educational booklet in Arabic language was developed by the researchers based on recent medical and nursing literatures . (Alqahtani et al., 2019; Mittiga et al., 2019; Umpierrez ,2018; Fernando et al., 2017; Brunner, Smeltzer,& Suddarth, 2016; Almalki et al., 2016; Abdullah et al., 2017; and Hinkle & Cheever, 2014), it gives the nurse insight about DKA; causes, signs & symptoms, complications, guidelines regarding care of patient, medical management, and discharge instructions.

Field work: The current study was carried out in three phases; including implementation and evaluation phase.

Implementation phase: Once the approval was obtained to carry out the study, the researchers started to select the nurses and patients, collected data and implement the training program as follow:

- The data collection phase of the present study was carried out within three months period started from August to October 2019.

- Three tools were used three times *pre* to assess nurses' needs , *immediate* post to evaluate the understanding of knowledge and practical procedure for the nurses and post 3 months to evaluate the effect of training program on improving nurses' performance and health outcomes of patients with DKA.

- This phase started by interviewing 40 nurses in ICU in groups to explain the aim and nature of the study as well as taking their approval to participate in the study prior to data collection.

- The researchers were available in the morning and the afternoon shift four days per week by rotation.

- Patients who agreed to participate in the study; the researchers taking their approval to participate in the study prior to data collection after explaining the aim and nature of the study.

- Firstly the nurses who agreed to participate in the study were interviewed to fulfill the self-administered questionnaire (Tool 1) by the researchers to collect data about their knowledge regarding DKA management and to identify their needs to develop the training program. This interview done for nurses and allowed the researchers to offer a protection against ambiguous or confusing questions. It took for about 15-20 minutes, during which the researchers were clarifying any obscure questions. Applied pre and post implementation of training program.

- Then, every nurse was observed by the researches while practicing nursing activities to assess their level of practice regarding caring of patients with DKA hour by using the developed observational checklists. The observation took about 60 minutes for each nurse to be completed. Applied pre and post implementation of training program.

- Secondly, every patient in was interviewed by the researchers to collect their demographic data and Patients' health outcomes assessment (Tool 3) which were filed in by the researchers within 20 minutes for every patient in the study . Applied pre and post implementation of training program.

Training Program sessions

- Sessions for providing the training program were conducted for the study group; both theoretical and practical sessions starting with orientation about the training program purpose, time and content were done using simple words and a tone of voice that shows interest, concern and friendliness.

- The training sessions were carried out at the ICU over two to three days for. The training was provided through small group discussion, demonstration and the developed booklet, in addition to audiovisual materials. The researchers presented these sessions (2 session for knowledge and 2 session for practice) by rotation.

- The 1st session was directed toward knowledge about DKA; definition, causes, signs & symptoms, role of insulin, and complications. It was provided in about 20 minutes.

- The 2nd session was directed toward nurses' role in the hospital which including: primary survey, head to toe assessment, immediate management, discharge plans and expectations. It was provided in about 30 minutes.

- The 3rd session was directed toward practice of nursing activities. It was provided in about 60 minutes and including primary survey, immediate nursing interventions for DKA, infection control measures, secondary assessment, and nursing interventions after patients' stability.

- The 4th session was directed toward knowledge content about:

- Medical and nursing management for patient with DKA in golden hour. It was provided in about 20 minutes.

- Discharge Instructions for DKA. It was provided in about 20 minutes.

- Nurses were handled the developed educational booklet, with explanations from the researchers regarding its use.

Evaluation phase: three months later, the effectiveness of the training

program was evaluated using the same previously used assessment tools for assessment of knowledge, practice of nurses and health outcomes of the patients.

Statistical analysis: obtained data were tabulated, computed and analyzed using the statistical package for social sciences (SPSS) program version 21, Excel software used in: descriptive statistics including frequency and percentage distribution, mean, standard deviation. Qualitative variables compared using chi-square test to compare differences in distribution of frequencies among groups; T test applied to compare means values; and correlation coefficient were utilized. The level of significance was considered at the 5% level ($P = 0.05$).

Results

Table1: Shows the mean age of study group was (26.4 ± 3.8) years old, with mean duration of work experience of (3.1 ± 1.2) years, 55.8% of study group were females, versus 37.2% were males. 69.8% of them were single, and 23.3% were married. 81.4% of them educated to technical nursing level and no one of them receiving training.

Regarding demographic characteristics of the studied patients in the study and control groups, table 2 shows that, the mean age of the study group was 40 ± 13.4 , while the mean age of control group was 43.6 ± 12.9 with no statistically significant difference between them. Regarding patients' gender, it was found that, 80% of the study group were males compared to 60% of the controls with no statistically significant differences between the two groups regarding gender. As regards type of DM, 86% of the patients had type I DM. As regards treatment of DM, 64% of patients

in the study group and 48% of patients in the control group were taking insulin, with no statistically significant differences between both groups.

Table 3: Shows a statistically significant increase in nurses' knowledge level after training with p-value <0.05 , with significance decrease after one month follow up. On other hand, there is no statistically significant change in knowledge level after one month in each of definition and etiology of DKA with p-value >0.05 .

Table 4: There is a statistically significant increase in nurses' practice level after training with p-value <0.05 , with significance decrease after one month follow up except for the disability primary survey.

Figure 1: demonstrates that knowledge level among nurses increase from 13.19 % to 94.44% after training and then decrease to 80.28% on follow up assessment. For practice level it increased from 11.72% to 85.95% the decreased to 73.06% on follow up.

Table 5: Summarizes that there is statistically significant positive correlation between both total knowledge score and practice score before training with p-value <0.05 .

Table 6: Shows statistically significant decrease in all type of complications among patients with p-value <0.05 after training of nurses. But, there is no statistically significant difference with p-value >0.05 as regards DLOC complication.

Table 7: shows a statistically significant association between the nurses' age and their total knowledge immediately after and at follow up

measurements. No statistically significant association between nurses' gender and their total knowledge was revealed and a statistically significant association was reported through the three phased knowledge and the nurses' qualifications

Table 8: Shows that a statistically significant association between total practices pre implementation of program and demographic characters; but, there is no statistically significant post, and follow up of program.

Discussion

Training program today is very important for the nurses to increase knowledge and improve practice about diabetic Keto acidosis (Ali et al., 2019). Therefore, the aim of this study was to evaluate the effect of training program on nurses' performance and health outcomes for patients with diabetic ketoacidosis

Regarding the studied nurses: the present study revealed that the majority of studied nurses were under 30 years and their mean ages was (26.4 ± 3.8) years old, had experience less than 5 years with mean duration of work experience of (3.1 ± 1.2) years, more than half of them were females, and majority were married and educated to technical nursing level and most of them had no one of them receive training. From the researcher point of view; this might be due to elevated number of females working in the nursing field more than males and a reflection of preponderance of women in nursing. This not in the same line with the study of Abdullah et al., (2017) which entitled "Capacity building for Nurses' knowledge and practice regarding prevention of diabetic foot complications" who found that the

majority of nurses working in ICU were less than 30 years old.

As well, the study of **(Potdar et al., 2016; & Hussein et al., (2015)** which entitled "Effectiveness of Structured Teaching Program on Prevention of Nosocomial Infection among Nurses Working at Tertiary Hospital" whom revealed that the majority of nurses working in emergency places their ages ranged from 20-40 years, married, females, and have diploma of nursing, more than half of them their experience was more than 5 years. This could be explained as the nature of intensive care units, which necessitates nurses' experience for better quality of care.

In relation to attending any previous training program, results showed that all of nurses did not receive training programs. This might be due to lack of hospital staff development program. This result also, were disagreement with **Uğur, Demir& Akbal (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 studied sample had education course in DM after graduation.

Related to Nurses' knowledge about DKA: the data of the current study revealed that the mean level of nurses' total knowledge was (4.75 ± 1.5) which statistically significant increase post implementing of the training program (34 ± 1.5) . This results may be due to one or more of the following reasons, lack of orientation program prior to work as well lack care conferences during work in availability of procedure book specially prepared for the critical care areas and lack of direction and nurse's appraisal about patient's care.

These findings, were in conformity with the study done by **Mohamed, (2019)** which entitled " Effect of educational intervention and telephone follow-up program on knowledge, practice and quality of life among patients with DKA " who found that, there is a significant improving in nurses level of knowledge post implementing of educational program regarding DKA ($p < 0.05$) nurses was gained knowledge. While our study found decrease of the knowledge level after three month of the training program intervention which consider long time in this critical work load. As the researchers' point of view, the difference may be due to lack of updating information regarding DKA care, and this might be due to the fact that basic education was not incorporated into either diploma or degree curricula.

Supporting to these results study findings by **Mensah et al., (2019)** study which "entitled Nursing management of gestational diabetes mellitus in Ghana " who stated that, nurses' assessment prior to the program revealed that their knowledge are inadequate to work efficiently and safely with such group of patients which indicates poor quality of the care given to patients.

Nurses' practice regarding DKA: the findings of the present study revealed that the mean nurses' total practice was (114.3 ± 59.1) which statistically significant increase post implementing of the training program (823.04 ± 2.6) these results may be explained that preparation of a teaching program was successful in achieving better information and practice levels between nurses. The improvement in nursing performance which were found in present study results immediately post the training program this could be due to nurses were willing to gain knowledge and skills from the training program.

From the researchers' point of view the reasons for this result in the current study might be due to increased number of patients and work load, lack of in-service training programs, nurses' knowledge which reflects negatively on their practice. This result is in agreement with the study's findings were that of **Kassahun, & Mekonen, (2017)** study entitled "knowledge, attitude and practice related to diabetes among community members in four provinces" who reported poor practice of nurses towards diabetes. This is was in the same line with **Herath et al., (2017)** study entitled "Knowledge, attitude and practice related to diabetes mellitus among the general public in Galle district in Southern Sri Lanka: a pilot study" who mentioned that the level of practices significantly increase with the level of education. Moreover, (**Mostafa et al., 2019**) mentioned that in his study which entitled "Effect of Educational Program on Nurses' Knowledge and Practice about Oxygen Therapy" that, the nurses lack the efficiency of updating their practice after being and settled in the clinical environment for a longer time and this possible related to increase workload

Regarding the studied patients: the present study showed that large percentage of the studied DKA patients their mean age was (40±13.4) years old and majority of them were males, and more than half of them had type I diabetes, and treated with insulin with missed insulin dose trigger risks. This match with the study done by **Fernando et al., (2017)** which entitled "Comparison of outcomes and costs between adult diabetic ketoacidosis patients admitted to the ICU and step-down unit" who found that the main age who at risk of DKA was more than 40 years old. In the other hand This result is matched with the results of another study of **Bossman et al., (2020)** which entitled "Patients'

knowledge of diabetes complications and self-management practices in Ghana" who found that more than two third of patients were more than 40 years old.

While, the study done by **Urden et al., (2014)** which entitled "Postgraduate Education needs of Nurses' who are caregivers for Patients with Diabetes" in the other hand found that both IDDM and NIDDM have an equal chance to suffer from DKA which remains an important cause of morbidity and mortality, and further efforts to improve its management are warranted.

Regarding missing insulin dose about two third of our DKA studied patients mainly missed their insulin dose that considered the trigger risk for their emergency condition (DKA). This supported with the study done by, (**Gort, 2020**) which entitled" Effectiveness of Order Sets in the Management of Diabetic Ketoacidosis and Hyperosmolar Hyperglycemia who found that the missing insulin dose are common among patients. In addition to he stressed on controlling blood glucose through maintaining the insulin dose and time consider the first line of DKA prevention and treatment. In the opposite side the study done by **Azevedo et al., (2014)** which entitled "Incidence and long-term outcomes of critically ill adult patients with moderate-to-severe diabetic ketoacidosis" found that bad diet, and infection considered the main risk factors of DKA occurrence among type I DM.

This also, match with the study done by **Ali et al., (2019)** which entitled "Nurses' Performance Regarding Caring of Patient with Diabetic Ketoacidosis" who documented that efforts to improve insulin management need to be intensified either by highlighting insulin management when house officers and

nurses are instructed in the use of the nursing care program, or by using other methods to augment the critical care such as computer-based decision support systems to facilitate dosing of insulin or house staff and nurse training to increase familiarity and facility with insulin therapy.

Regarding relationship between the total nurses' knowledge scores and their demographic characteristics: the study result revealed that there was a , there is a statistically significant association between total knowledge score pre, post, and follow up as regards demographic characters (age of nurse) at p was 0.09 and 0.08 respectively. This result was agree with the study carried by **Ayed et al., (2015)** which entitled "The Nurses' Knowledge and Attitudes towards the Palliative Care" who found that the highest mean knowledge scores among younger nurses those who have the least experience.

On the other hand the present study found that there was a statistically significant between total knowledge score pre, post, and follow up as regards qualifications of nurse) with higher score among bachelor degree at p 0.03 and 0.04 respectively . This result agreed with **Abdullah et al., (2017)** study which entitled "Capacity building for Nurses' knowledge and practice regarding prevention of diabetic foot complications " who showed in his study that bachelor register nurse were significantly better practice. The educational level, and years of experience of studied nurses could be factors affecting on level of nurse's knowledge. Also, this study goes in in the opposite line with **Abdelrahman et al., (2020)** study which entitled " Assessment of Nurses' Knowledge and Practices Regarding Care Of Patients with Diabetic Coma " who were found that there was no

statistically significant relation between total nurses' knowledge and their demographic characteristics.

Regarding relationship between the total nurses' practice scores and their demographic characteristics: the study results revealed that there was a statistically significant high score of practice before training among females, aged above 30 years, and bachelor qualified nurses. This result agreed with **Kang, & Yang, (2016)** which entitled "Evidence-based nursing practice and its correlates among Korean nurses" that bachelor register nurse were significantly better practice, that was in it line with the present study results. The educational level, and years of experience of studied nurses could be factors affecting on level of nurse's performance.

On the other hand the present study found that there is no statistically significant difference in total practice score post, and follow up as regards demographic characters (gender, age, and qualifications of nurse). This match with the study done by **Ali et al., (2019)** which entitled "Nurses' Performance Regarding Caring of Patient with Diabetic Ketoacidosis" who found that the nurses' practice level not affected with their characteristics but affect with the work field and facilities or resources availability. In addition, study done by **Fernando et al., (2017)** entitled "Comparison of outcomes and costs between adult diabetic ketoacidosis patients admitted to the ICU and step-down unit" not agreed with our study and reported that the higher level of performance of the nurses the higher level of education and year of experience. And in accordance with the study done by **Kang, & Yang, (2016)** which entitled "Evidence-based nursing practice and its correlates among Korean nurses" who

found that there was no statistically significant relation between total nurses' practice and their demographic characteristics.

Regarding relationship between the total nurses' knowledge and their practice scores: the current study demonstrated that there was a statistically significant positive correlation between both total knowledge score and practice score only before training, which indicated pre training the increase knowledge score will associated with increase in practice score. On the other hand was no statistically significant correlation between both total knowledge score and practice score post and after

one month of training. This agreed with the study done by, (**Mostafa et al., 2019**) mentioned that in his study which entitled "Effect of Educational Program on Nurses' Knowledge and Practice about Oxygen Therapy" who stated that a highly statistical significant correlation between participants' scores of knowledge and practice in pre-program, but not in post program, 1 month and 2 months following the instructional program. And with the study done by **Ahmed et al., (2020)** which entitled "Assessment of Nurses' Knowledge and Practice for Patients Undergoing a Bronchoscopy" who reported the same results regarding correlation between knowledge and practice, there was no correlation between nurses' knowledge and practice.

Table (1): Frequency and percentage distribution of the demographic characteristics of studied nurses

Variables	Number (n=40)	
	No.	%
Age (years)		
- 20-25	17	42.5%
- 20-25	17	42.5%
- 25 – 30	16	40%
- 30+	7	17.5%
Mean Age:	26.4±3.8	(21-35)
Experience		
- <5 years	39	97.5%
- 5 – 10 years	1	2.5%
- Experience duration (years)	3.1±1.2	(1-6)
Gender		
- Male	16	37.2%
- Female	24	55.8%
Marital status		
- Single	30	69.8%
- Married	10	23.3%
Level of education		
- Technical nursing	35	81.4%
- Bachelor of nursing	5	11.6%
Have training		
- No	40	100%
- Yes	0	0%

Table (2): Frequency and percentage distribution of the demographic characteristics of the studied patients

Characteristics	Patient N=25		X ²	P Value
	N	%		
Age group (years):				
30 < 45	22	88	2.4	0.40
45 < 60	3	12		
Mean ±SD		40±13.4		
Gender:				
Male	20	80	1.3	0.12
Female	5	20		
Types of DM:				
Type I	17	86	0.12	0.21
Type II	8	32		
Treatment:				
Insulin	16	64	1.28	0.25
Oral treatment	5	20		
No treatment	4	16		
Trigger risk factors:				
Missed insulin	16	64	0.86	0.41
Imbalance diet	4	16		
Infection	5	20		

Table (3): Comparison of nurses' knowledge level before and after training program (N= 40)

Items	Knowledge Level			T- Test	P-value
	Pre Mean \pm SD	Post Mean \pm SD	Follow up Mean \pm SD		
A. Role of insulin	0.35 \pm 0.48	2 \pm 0	1.7 \pm 0.46	148.02	<0.001 ^{a,b}
B. Knowledge about DKA					
1. Definition	0.15 \pm 0.36	1 \pm 0	0.85 \pm 0.21	152.6	<0.001 ^{a,b}
2. Etiology	0.68 \pm 0.52	2.2 \pm 1.4	1.87 \pm 0.98	148.3	<0.001 ^{a,b}
3. Precipitating factors	0.3 \pm 0.6	3.9 \pm 0.16	3.3 \pm 0.11	175.9	<0.001 ^{a,b}
4. Diagnostic criteria	0.3 \pm 0.51	3.9 \pm 0.16	3.3 \pm 0.12	355.5	<0.001 ^{a,b}
5. Complications	0.25 \pm 0.9	3.95 \pm 0.22	3.31 \pm 0.19	355.6	<0.001 ^{a,b}
C. Emergent care for DKA	1.6 \pm 0.98	9.95 \pm 0.22	8.5 \pm 0.20	119.7	<0.001 ^{a,b}
D. Prevention	0.27 \pm 0.45	2.9 \pm 0.22	2.5 \pm 0.19	633.2	<0.001 ^{a,b}
E. Health education	0.85 \pm 0.77	3.98 \pm 0.15	3.4 \pm 0.13	466.2	<0.001 ^{a,b}
Total knowledge score (36)	4.75 \pm 1.5	34 \pm 1.5	28.9 \pm 1.4	164.6	<0.001 ^{a,b}

a:significance difference between pre and post training b: significance difference between post training, and follow up

Table (4): Comparison of Nurses' practices level before and after training program (N= 40)

Items	Practice score			T-Test	P-value
	Pre Mean \pm SD	Post Mean \pm SD	Follow up Mean \pm SD		
A. Primary survey score					
1. Air way	0.10 \pm 0.31	3 \pm 0	2.6 \pm 0.98	58.9	<0.001 ^a 0.01 ^b
2. Breathing	0.20 \pm 0.41	3.9 \pm 0.36	3.3 \pm 0.25	60.1	<0.001 ^{a,b}
3. Circulation	0.27 \pm 0.45	3.97 \pm 0.16	3.4 \pm 0.11	63.5	<0.001 ^{a,b}
4. Disability	0.30 \pm 0.46	2.95 \pm 0.22	13.1 \pm 0.18	57.6	<0.001 ^{a,b}
B. Immediate intervention on admission					
1. Vital signs	0.6 \pm 0.67	4 \pm 0	3.4 \pm 0.78	32.1	<0.001 ^{a,b}
2. General survey	0.3 \pm 0.46	4.9 \pm 0.22	3.9 \pm 0.20	63.7	<0.001 ^{a,b}
3. Head to toe assessment	0.37 \pm 0.58	5.98 \pm 0.16	5 \pm 0.11	58.9	<0.001 ^{a,b}
C. Secondary assessment					
	1.27 \pm 1.3	14.9 \pm 0.27	12.7 \pm 0.21	65	<0.001 ^{a,b}
D. Nursing intervention after stabilization					
	3.22 \pm 3.8	19.9 \pm 0.27	16.9 \pm 0.22	27.7	<0.001 ^{a,b}
E. Infection control					
1. Hand wash	2.2 \pm 3.4	15.9 \pm 0.22	13.5 \pm 0.18	27.8	<0.001 ^{a,b}
2. Skin care	2.1 \pm 2.8	14.9 \pm 0.27	12.7 \pm 0.22	65	<0.001 ^{a,b}
3. Iv cannula care	1.5 \pm 1.8	10 \pm 0	8.5 \pm 2.1	29.9	<0.001 ^{a,b}
4. Center venous care	1.8 \pm 2.9	13.9 \pm 0.3	11.7 \pm 2.5	26.2	<0.001 ^{a,b}
Total practice score (270)	114.3 \pm 59.1	823.04 \pm 2.6	712.3 \pm 2.2	75.8	<0.001 ^{a,b}

a:significance difference between pre and post training b: significance difference between post training, and follow up

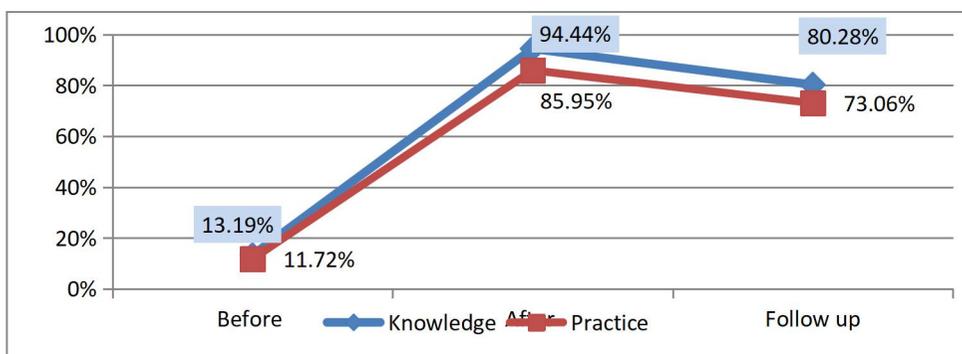
**Figure (1): Comparison between nurses' total knowledge and total practice level before and after training**

Table (5): Correlation between nurses' knowledge and their practice at pre, immediate post and follow up phases.

Total practice	Total nurses' knowledge		
	Pre r (p-value)	Post r (p-value)	Follow up r (p-value)
Pre	0.34 (0.03*)	-0.11 (0.5)	-0.10 (0.5)
Post	0.01(0.9)	0.18 (0.3)	0.19 (0.2)
Follow up	0.01(0.9)	0.18 (0.3)	0.19 (0.2)

Table (6): Comparison of patients' health outcomes before and after training.

Variables	Pre-implement program patient N=25		post implement program patient N=25		X ²	P-value
	No.	%	No.	%		
1. DKA morbidity (complications):						
A- DKA-related complication:						
1. Hypovolemic shock	14	56%	6	24%	4.2	0.02
2. Hyperkalemia	17	68%	3	12%	13.1	0.001
3. Hypernatremia	16	64%	4	16%	9.6	0.005
4. Metabolic acidosis	12	48%	2	8%	8.6	0.002
5. DLO	15	60%	1	4%	11.3	<0.001
B- DKA- treatment therapy related complication:						
1. Volume overload	20	80%	4	16%	15.2	<0.001
2. Hypokalemia	20	80%	7	28%	9.4	0.002
3. Hyperchloremia	21	84%	2	8%	22	<0.001
4. Hypoglycemia	21	84%	3	12%	19.2	<0.001
C- ICU - related complication:						
Nosocomial infection	17	68%	2	8%	15.5	<0.001
2. Discharge, Transferring and Death:						
1. Discharged	17	68%	22	88%	11.7	<0.001
2. Transferred to ward	6	24%	3	12%	14.2	<0.001
3. Death	2	8%	0	0	8.1	<0.001

Table (7): Relation between total nurses' level of knowledge and their demographic characteristics.

Items	Pre				Total knowledge (No=40) Post				Follow up			
	Mean	SD	T	P-value	Mean	SD	T	P-value	Mean	SD	T	P-value
Age (years)												
20 -25	4.5	1.8			33.7	0.47			28.7	0.7		
25 – 30	4.7	1.4	0.5	0.6	33.8	0.40	2.6	0.09	28.8	0.40	2.6	0.08
30+	5.3	1.3			35.1	3.5			30	3.1		
Sex												
Male	4.69	1.4	0.20	0.8	34.3	2.4	0.85	0.4	29.2	2.1	0.79	0.4
Female	4.8	1.7			33.8	0.38			28.8	0.38		
Qualification												
Technical	4.6	1.6	3.2	0.03	34.03	1.6	4.7	0.04	29	1.5	5.8	0.04
Bachelor	7.8	0.8			83.8	0.45			35	0.44		

Table (8): Relation between total nurses' level of practice and their demographic characteristics.

Items	Pre				Total practice (No=40) Post				Follow up			
	Mean	SD	T	P-value	Mean	SD	T	P-value	Mean	SD	T	P-value
Age (years)												
20 -25	91.9	15.3	27.3	* <0.001	837.6	2.3	0.33	0.7	712	1.9	0.33	0.7
25 – 30	95.4	12.9			838.2	2.9			712.4	2.5		
30+	212	90.1			838.6	2.6			712.8	2.2		
Sex												
Male	90.3	13.9	24.7	* 0.03	837.6	2.4	0.2	0.3	711.9	2.0	0.03	0.3
Female	130.3	71.6			838.4	2.7			712.6	2.3		
Qualification												
Technical	92.9	14.1	26.6	* <0.001	838.04	2.6	0	0.9	712.3	2.2	0.001	0.9
Bachelor	264.6	6.3			838.04	2.9			712.3	2.5		

Conclusion

From the study results, it can be concluded that, implementation of training program has a positive effect on improving the knowledge, and practice of nurses and health outcomes of patients with DKA during golden hour.

Recommendation

This study recommended providing training program for nurses in ICU to be followed in the routine nursing care for patients with DKA during golden hour. It is also important to be included in the curriculum of the faculty of nursing. This would decrease the incidence of complications, improve patients' outcomes, and reduce hospital length of stay. Also, more researches are needed to investigate the effectiveness of these program on other health outcomes and in the hospital stay.

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