Original Article

Studying the role of nurses in the diabetic ketoacidosis management

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ABSTRACT

DKA (Diabetic ketoacidosis) as an acute condition is a complication of the life-threatening of diabetic patients. Efficient management of diabetic ketoacidosis affects the condition of the disease. The purpose of this study is to highlight and identify the role of the nurse in the management of diabetic ketoacidosis. This research was a review study and related papers were chosen during a comprehensive study in electronic databases with keywords, and after the study, it is important and widely utilized points were presented. Nurses have a role in the diagnosis, assessment, and management of diabetic ketoacidosis. Effective roles include maintaining fluid and electrolyte balance, setting the patient's insulin dose, and sketching a discharge plan to exclude DKA recurrence. Management of ketoacidosis is an interdisciplinary team effort in which nurses play a key role in controlling, identifying, and prohibiting the progression and symptoms recurrence. For the effective management of ketoacidosis, the use of skilled and knowledgeable nurses is essential.

Keywords: Diabetic ketoacidosis, Management, Nurses, Diabetic patients.

Introduction

Diabetic ketoacidosis (DKA) is a usual acute complication at the time of diabetes assessment and happens in approximately one-third of new cases of type 1 diabetes. DKA can happen in any type of diabetes mellitus and is a serious complication of hyperglycemia that should be considered [1, 2].

Although several epidemiological research have stated that in recent years, the number of hospitalizations due to DKA worldwide has increased in both type 1 and 2 diabetes [3, 4]. According to the UK National DKA Survey, adult patients with type 1 diabetes had a higher readmission rate than adults with type 2 diabetes but were more likely to be discharged within 2 days. So out of every three young people with type 1 diabetes, one person is diagnosed with DKA [5, 6].

The patient's number presenting to the hospital with DKA is steadily increasing in the United States and many other countries [7]. The presence of DKA at the onset of type 1 diabetes is related to serious and devastating consequences such as increased hospitalization time, increased insulin requirements, shorter recovery period, and finally, increased mortality risk [8, 9], which is the rate in developing countries. Development is higher than in developed countries due to mismanagement or unknown aggravating factors [10].

DKA occurs when the level of serum insulin is insufficient, leading to the triad of acidemia (venous pH is less than 7.3 or serum bicarbonate level is less than 15 mmol/liter), ketonemia (serum b-hydroxybutyrate ≥ 3 mmol/L), or ketonuria (+2 ≤), and hyperglycemia (blood glucose >200 mg/dL). DKA Complications include osmotic diuresis, which causes dehydration and loss of electrolytes (especially potassium ions), cerebral edema, metabolic and lactic acidosis, and potential death. In addition to co-morbidities that can increase DKA mortality, the difficulty in properly implementing DKA management protocols may also be involved in increasing this trend [11, 12].

Previous studies revealed that the correct use of standard DKA protocols led to a decrease in mortality to less than 2% [13]. Considering that nurses and doctors have a fundamental role in

the correct implementation of DKA management protocols, by using the protocols correctly and familiarizing themselves with the job description, each plays a vital role in the management and treatment of DKA [14, 15]. Especially since the first encounter of a DKA patient in the emergency room is with the nurse. In addition, nurses play a vital role in controlling the critical conditions of diabetes [16, 17]. Therefore, one of the important elements in the effective and successful management of sick patients is knowledgeable and expert nurses who play the main role in the management of these patients [18]. Considering the importance of the nurse's role, the concern of this review article is to highlight and identify the different roles of nurses in the management of DKA and symptom control.

Materials and Methods

To provide comprehensive insight into the nurse's role in DKA management, we reviewed DKA control and management protocols and relevant studies published between 2018 and 2024. ProQuest, PubMed, Scopus, Web of Science, and Google Scholar were searched using the following keywords: DKA protocol, Diabetes, Nurse, and Ketoacidosis. We also manually searched the relevant CDC (Centers for Disease Control and Prevention), and WHO (World Health Organization) protocols and guidelines. Non-English language articles, commentaries, letters to the editor, and case reports were excluded.

Results and Discussion

The role of nurses in the management of diabetes

Type 2 diabetes includes approximately 90% of all diabetes cases. Complications of type 2 diabetes affect all body systems and can have fatal consequences. Nurses play an essential role in the care of diabetic patients and should be sensitive to the warning signs of diabetic patients [19, 20]. One of the emergency conditions of diabetes is DKA, which nurses play an important role in its prevention and treatment. The main principles of its management include treating hyperglycemia, correcting electrolyte abnormalities, restoring circulating blood volume, and diagnosing and then treating the aggravating cause, which nurses working in the diabetes department must have sufficient knowledge of how to manage each one [21, 22].

The role of nurses in the diagnosis, assessment, and management of DKA

People who are diagnosed with type 1 diabetes for the first time (unaware of their disease), poor compliance with insulin therapy, inadequate insulin therapy, and infections such as chest infections, urinary tract infections, skin infections, and events Acute coronary/vascular are concomitant diseases that can cause or exacerbate DKA in a diabetic individual [23]. Therefore, the awareness of nurses in identifying these cases and the accurate assessment of the patient for the timely diagnosis of concomitant diseases can be very important to prevent the occurrence of DKA. Based on the review of DKA nurse-oriented management protocols, the main diagnosis and intervention of nurses in DKA management are presented in **Table 1** [22, 24, 25].

Table 1. List of nursing diagnoses and interventions in DKA.

Nursing interventions	Nursing diagnoses
Monitor electrolytes as potassium levels decrease when insulin therapy is initiated	Nausea and vomiting
Look for infection signs (a common cause of DKA) Check urine and blood cultures	Abdominal pains
Start fluid therapy as recommended	Excessive thirst
Lung auscultation to check for rales or crackles Encourage the patient to quit smoking and avoid alcohol	Shortness of breath
Assessment of the patient's mental status Ask the patient to wear an identification bracelet that indicates she or he has had an episode of DKA	Lethargy
Start fluid therapy as recommended Educate the patient about the importance of monitoring and checking urine output	Polyurea
Assessment of the patient's mental status Ask the patient to wear an identification bracelet that indicates he or she has had an episode of DKA	Confusion
Monitor vital signs Check blood sugar - Treat with insulin as prescribed - Encourage a healthy diet Give the necessary training to the patient about the compliance importance with diabetes medications	Blood sugar is higher than normal
Lung auscultation to check for rales or crackles Monitor vital signs	The smell of rotten fruit on the breath
Assessment of kidney function Monitor vital signs Insert two large IV lines	Increased amount of ketones in the urine

The DKA diagnosis is based on the triad of hyperglycemia, acidemia, and ketonemia. The required biochemical monitoring is glucose, ketones, venous pH, and serum potassium [21]. Therefore, to care for patients with DKA, the nurse must monitor these parameters. Patients with DKA may have a large number of symptoms at presentation, usually occurring within hours of the inciting event. The symptoms that the nurse should be aware of when evaluating the patient include symptoms of hyperglycemia (which is common), including frequent urination, excessive drinking, and sometimes more severe manifestations such as unwanted weight loss, weakness, vomiting, and psychological changes [22, 26]. Metabolic imbalance worsens and

dehydration with progressive uncontrolled osmotic pressure, which can cause lethargy, respiratory obstruction or failure, coma, and even death. The pain of Abdomen is also a usual complaint in DKA. Patients generally present with vomiting and abdominal pain [22].

On physical examination, most patients with ketoacidosis present with hypovolemia features due to loss of fluids and electrolytes from the gastrointestinal tract or kidneys. In more severe cases, patients may experience hypotension and shock. Sufferers may have deep, rapid breathing efforts as a compensatory mechanism known as cosmic breathing. They may also have a distinct fruity odor on their breath, which is mainly due to the production of acetone [22, 26].

The primary laboratory evaluation of a patient doubtful of DKA includes things such as the evaluation of blood levels of electrolytes, creatinine, BUN, ketones, calculated anion gap, glucose, arterial blood gases, blood culture, osmolality and CBC diff, and urine ketones, urine test. Urine culture, chest X-ray, and ECG should also be performed [27, 28].

Airway and breathing management followed by initial circulatory stabilization is the priority in all patients. Specific treatment of DKA needs hyperglycemia correction with intravenous insulin, frequentative monitoring and electrolytes replacement, mainly potassium, hypovolemia correction with intravenous fluids, and acidosis correction [29, 30].

Due to the severity of the disease and the requisition for reiterated monitoring for treatment with intravenous insulin and conceivable arrhythmias, patients may be accepted to the intensive care unit. Blood glucose and electrolyte levels should be monitored every hour in the initial phase of management [31].

Fluid therapy and correction of electrolytes

The most critical and first therapeutic intervention in DKA is appropriate fluid therapy followed by insulin administration. Correcting and balancing electrolytes, clearing ketones, and restoring blood circulation volume are the goals of intravenous (IV) fluid therapy [21]. In addition, fluid replacement and increased circulating volume not only correct hemodynamic instability but also improve renal perfusion and reduce insulin resistance by decreasing the level of counter-regulatory hormones [32, 33].

The recommended injection solution for starting fluid therapy in patients with DKA is sodium chloride 0.9% (normal saline) in an amount of 15-20 ml/kg (about 1 up to 1.5 liters) starting in the first hour [34]. Then, by re-evaluating the patient's clinical condition, the amount and type of fluids can be changed, but if the patient is in hypovolemic shock, normal saline should be continued at a rate of 1 to 2 liters per hour until the patient is stabilized [35]. When patients with hypovolemic shock are stabilized, intravenous fluid management is altered to the same protocols as for moderate hypovolemia. If the patient is still in shock, the type of intravenous fluids is specified by the serum sodium level. If the sodium level is low (<135mmol/L), normal saline is continued, and if the level is high or normal (≥135mmol/L), the injection solution should be altered to half-saline (0.45% sodium chloride) [34, 35]. In addition, if the blood glucose level drops to 200 mg/dL, 5% dextrose should be added along with half saline at a rate of 150 to 250 cc/h to maintain the blood glucose at 150 to 200 mg/dL [34].

DKA is associated with significant depletion of total serum electrolytes, particularly potassium, sodium, and chloride [36]. It should be noted that the use of arterial blood is not necessary to assess acid-base or electrolyte status. A venous blood sample is also sufficient because the difference between venous and arterial pH/HCO3 is not significant and is sufficient for the diagnosis and management of DKA [21].

Although sodium and chlorine deficiency can be compensated by the guidelines mentioned above, an overdose of 0.9% sodium chloride solution causes hyperchloremic metabolic acidosis, and an increase in serum chlorine can give the impression to the inexperienced that the creation of a high anion gap can be because of the continuous presence of ketones and not because of the fluid resuscitation with normal saline [34, 36].

According to the patient's serum potassium concentration, we perform potassium replacement. If the potassium concentration level is more than 5.2 mEq/L, we do not need to use solutions containing potassium for the patient, however, the potassium level should be carefully monitored by the nurse because with the increase in intravascular volume, insulin therapy and reduction of acidosis It facilitates the entry of potassium into the cell and ultimately reduces the level of potassium in the serum. When the level of serum potassium is less than 3 mEq/L, insulin should be stopped and potassium displacement should be started at 20 to 30 mEq/h until the level of serum potassium rises to more than 3.3 mEq/L. The goal is to maintain it in the range of 4-5 mEq/L. For levels 3.3-5.2 mEq/L, displacement should be started slowly using 20 to 30 mEq of potassium per liter of intravenous fluids [34, 36].

The studies that were reviewed showed that phosphate replacement was not needed, as it did not make a difference in recovery outcomes. The use of sodium bicarbonate to treat acidosis in DKA has not shown any effect on the clinical results of patients. Indeed, treatment with bicarbonate increases the risk of cerebral edema and hypokalemia and demonstrates the recovery process of ketosis [37, 38]. Acidosis is generally corrected by DKA treatment, as IV fluid therapy improves renal function and tissue perfusion, thereby increasing organic acid excretion, and insulin therapy prevents further ketone synthesis, allowing excess Keto acids to be metabolized. In addition, since bicarbonate is produced again with this process, there is no need to administer sodium bicarbonate [29]. However, in cases of severe acidosis, it may be necessary to use sodium bicarbonate [37]. If the doctor prescribes sodium bicarbonate, the nurse should monitor the potassium serum level because treatment with bicarbonate can reduce its level [32].

Insulin is the main line of treatment for DKA

Insulin plays a vital role in the treatment of DKA due to the reduction of hepatic glucose production. By inhibiting ketogenesis, lipolysis, and glucagon secretion, insulin increases peripheral glucose use and thereby the production of ketoacidosis is reduced and the blood glucose level is reduced [39, 40].

Insulin as an intravenous bolus using a weight formula is started with a dose of 0.1 units per kilogram of regular insulin, and then continuous infusion is performed with the same dose every hour [21]. Empires et al. revealed that repeated subcutaneous insulin injections were as effective as intravenous insulin for mild treatment to moderate DKA in these people. Subcutaneous insulin therapy should begin with a primary bolus of 0.2 to 0.3 units/kg followed by 0.2 to 0.1 units/kg every 1-2 hours [41]. Nurses should estimate the patient's weight; treatment should not wait for the exact weight [21]. In children, intravenous injection of insulin in the form of a bolus is not recommended, because it may cause cerebral edema [42].

Aggressive management of insulin can lead to hyperkalemia and reduce the gap before increasing bicarbonate. As a result, bicarbonate in the serum should be noted. ADA guidelines recommend using arterial pH, but the pH of venous can also be utilized [43, 44].

When the blood sugar level reaches 200 mg/dL, the insulin infusion is decreased to 0.02 to 0.05 units/kg/h and 5% dextrose should be added to the IV solution to prevent hypoglycemia. Continue insulin administration until ketoacidosis is controlled [32, 34]. In this part of the treatment, the nurse should check the speed of insulin injection and blood glucose level to prevent hypoglycemia.

Designing a program for discharge

The best way to manage and prevent diabetes crises such as ketoacidosis is to teach the patient how to control glucose through a professional team including a pharmacist, nurse, and endocrinologist [22]. The nurse should follow up with all patients to adopt a positive lifestyle, follow up with doctors, and ensure adherence to medication orders [45]. In addition, the nurse should teach all patients how to manage blood glucose at home and the significance of careful blood glucose monitoring during trauma, stress, and infection. All patients should be educated about exercise and the significance of maintaining a healthy weight [22, 45]. Finally, the nurse should teach the patient to identify the risk factors and recurrence of DKA and emphasize adherence to insulin therapy, which is the most important risk factor for DKA recurrence [46].

Conclusion

Our findings show that although the management of DKA is a team effort, the role of nurses is central. Nurses are the first level of contact between patients and healthcare providers and spend the most time with them. Evidence-based nursing care affects DKA patient outcomes. Considering that DKA is a critical condition and is related to high mortality and morbidity in diabetic patients, the performance of nurses in the DKA management team should be defined in an integrated manner. It is recommended that all treatment systems follow a single protocol designed in collaboration with nurses and other professionals in related fields for the management of DKA. Nurses working especially in the emergency triage and intensive care units should be trained on their role in implementing the protocol. Implementation of educational programs targeting nurses' knowledge and skills in DKA management is essential for nurses caring for diabetic patients.

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