

Patient with diabetic ketoacidosis

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Summary

Ketoacidosis is a life threatening condition caused by hyperglycemia. It affects approximately 15-70% of patients with diabetes. A patient with ketoacidosis requires intensive treatment, monitoring and constant nursing care. The aim of the study was to present the most important patient care issues associated with ketoacidosis based on the International Classification for Nursing Practice ICNP®.

Keywords: diabetes, diabetic ketoacidosis, nursing care, the International Classification for Nursing Practice ICNP®.

Introduction

Ketoacidosis is an acute complication of diabetes caused by hyperglycemia. It is often the first symptom of diabetes type 1. Ketoacidosis occurs in approximately 15-70% of patients in North America and Europe. The risk of DKA (ang. Diabetic Ketoacidosis) in a patient previously diagnosed with type 1 diabetes is 1-10% per year [1].

DKA occurs as persistent hyperglycemia with insulin deficiency. The guidelines of PDA (Polish Diabetes Association) mention the following reasons: interruption or errors in insulin intake, too late diagnosis of type 1 diabetes mellitus, alcohol abuse, acute inflammation, pregnancy and other [2]. Impatient drain and improper placement of a subcutaneous drain may lead to a lack of insulin in the body and thus the persistent hyperglycemia and DKA. Figure 1. presents the pathomechanism of DKA. The causative

agents are insulin deficiency, the insulin omission of a patient diagnosed with diabetes, the relative ineffectiveness when insulin action is antagonized by the physiological stress (sepsis) and redundancy of counterregulatory hormones. Occurring in the body hormonal changes enhance the production of glucose from glycogenolysis and gluconeogenesis, while reducing glucose utilization, resulting in hyperglycemia, osmotic diuresis, loss of electrolyte, dehydration, decreased glomerular filtration (further increase hyperglycemia) and hyperosmolarity. Simultaneously with the process of lipolysis is an increased amount of free fatty acids, which facilitates oxidation and gluconeogenesis produces acetoacetic acid and NL-hydroxybutyric acid (ketones). Mentioned acids reduce the performance of the metabolism leading to metabolic acidosis ($\text{pH} < 7.3$), accompanied by lactic acidosis due to poor tissue perfusion. Progressive dehydration, hyperosmolarity, acidosis and electrolyte imbalance increases cortisol secretion. This leads to the creation of self-perpetuating cycle of progressive metabolic decompensation [3].

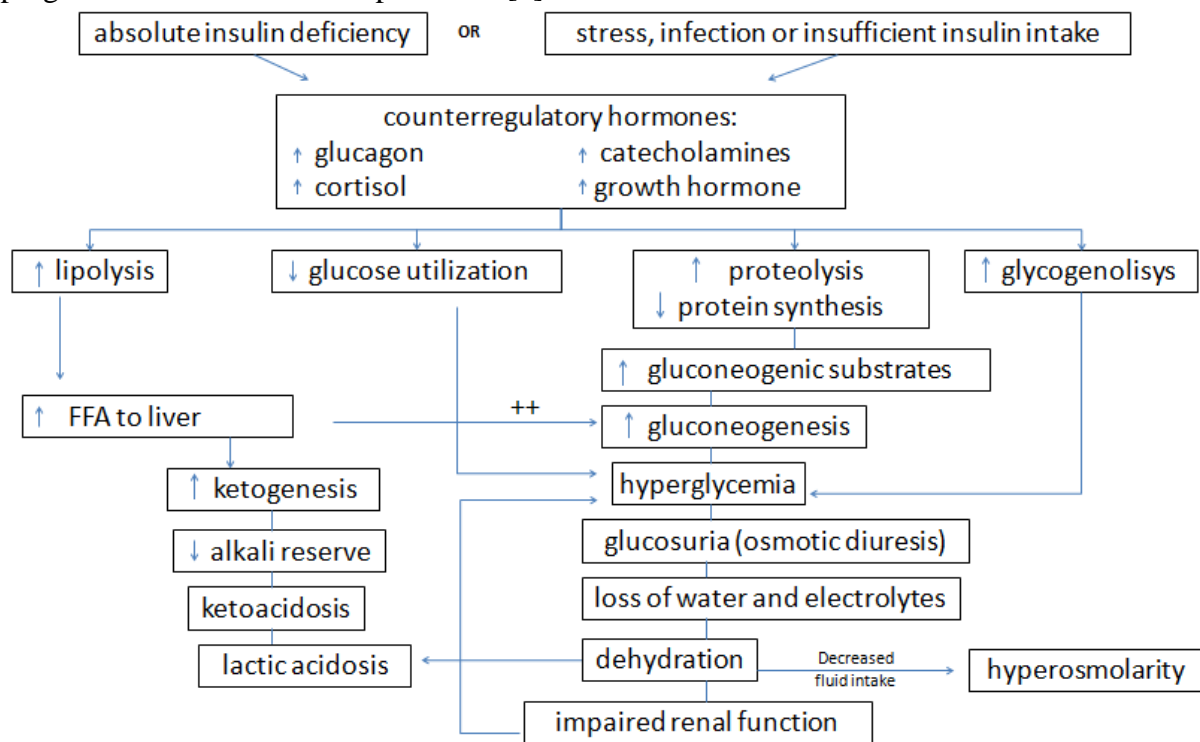


Figure 1. Pathogenesis of DKA [3].

FFA - free fatty acids

The first DKA symptoms are usually hyperglycemic symptoms i.e. weight loss, polydipsia, polyuria. The more characteristic symptoms are: abdominal pain, vomiting and/or nausea, dry mouth, blurred vision, spasms of different parts of muscles, deepening fatigue and sleepiness. As a result of these symptoms may come to dehydration occurs and all its features - a faster breathing in order to reduce pCO_2 and acidosis (Kussmaul breathing), acetone concomitant odor, abdominal pain and progressive stenosis of respiratory tract leading to coma. Concomitant hyperglycemia promotes fungal infections occur in the oral cavity or genitourinary organs. The state of consciousness of the patient can be distorted to varying degrees, or even coma may be present. The patient may also have a neurological symptoms suggestive of cerebral edema (the most dangerous complication of diabetic ketoacidosis). In addition, patients may experience the atony of intestines and/or bladder [4,5].

Table 1 shows the criteria for diagnosis of DKA. Ketoacidosis should be distinguished from starvation ketosis, alcohol ketoacidosis, metabolic acidosis with the anion gap > 20 mEq/l or lactic acidosis and other conditions leading to hyperglycemia and ketosis. DKA should be differentiated from stroke and uremic coma. For this purpose, the blood glucose

level, blood pH, serum bicarbonate, ketone bodies in urine and blood, electrolyte levels (anion gap) should be determined [2].

Table 1. Criteria for diagnosis of DKA [6].

Criterion	Type of DKA		
	Light	Moderate	Severe
Glucose in mmol/l (mg/dl)	> 13.9 (> 250)	> 13.9 (> 250)	≥22,2 (≥400)
Arterial pH	7.25-7.30	7,00-7,24	<7.0
Serum bicarbonate (mmol/l)	15-18	10-15	<10
Ketone bodies in urine and /or serum	present	present	present
Anion gap (mmol/l)*	> 10	> 12	> 12
Disturbances of consciousness	conscious	conscious/may be confused	coma

*Calculated according to the formula in which the measured value is used, but not the corrected sodium concentration: serum concentration of Na^+ (mmol/l) - [Cl^- (mmol/l) + HCO_3^- (mmol/l)].

A patient with ketoacidosis requires careful monitoring of vital signs:

- blood pressure, pulse rate and its other characteristics (rhythm, force, tension) number of breaths and their character, the degree of consciousness (every 1-2 hours)
- liquid balance (every 1-2 hours)
- body temperature (every 8 hours)
- glucose level (every 1 hour)
- electrolyte level: Na^+ and K^+ in serum (every 4 hours, in the case of hyperkalemia above 5.5 mmol/l potassium control after 2 hours and after normalization every 4 hours)
- blood gas analysis (every 4 hours)
- the output indication of ketones in the blood and /or urine

Therapeutic procedure in case of DKA includes a preliminary assessment - an interview with the patient and/or his family (the duration of disease, medications intake, comorbidities, possible complications), urine and blood specimen collection to determine the cause of DKA, physical examinations with assessment of consciousness (GCS scale), a preliminary evaluation of dehydration and weight measurement. The next step is to start watering the patient. The guidelines of PTD suggest start refilling the supply of water deficit intravenous for 24-48 hours, at an average rate of 100 ml/kg, 1000 ml of 0.9% NaCl in the first hour, followed by 500 ml/hour 0.9% NaCl for 4 hours, and then 250 ml/hour 0.9% NaCl until the acid-base balance will be restored. After lowering glucose levels <250 mg/dl (13.9 mmol/l), it should be accompanied by intravenous infusion of 5% glucose at a rate of 100 ml/hour. If you include glucose after 24 hours of fluid therapy, reduce the amount of administered of 0.9% NaCl to 150 ml/hour. In the states of increased energy requirements (e.g. infection, hyperthyroidism, pregnancy), it is recommended to administer 10% instead of 5% glucose infusion at a rate of 70 ml/hour. The irrigation process must be under the control of the state of the circulatory system. The next step is to reduce hyperglycemia through the introduction of intravenous insulin therapy. Initially adjust the dose of insulin in the form of initiating bolus of 0.1 j./kg b.w., and then continues with insulin infusion at a rate of 0.1 j./kg/hour, under the control of blood glucose levels. The rate of infusion should be adjusted depending on the blood glucose levels. Recommend glucose lowering should not be greater than 100 mg/dl/hour (5.6 mmol/l/hour). After analyzing the deficiency of electrolytes

in the body need to be addressed and their complementary alignment of acid-base balance. According to the guidelines deficit potassium a person with DKA is 3-5mmol/kg. Proceeding in this situation is supplementation potassium rates depending on its concentration in the blood of the patient. The use of bicarbonate should only be considered in case of arterial pH <6.9, not exceeding the dose of 1 mmol/kg b.w. The finding of elevated levels of lactate is not an indication for the administration of bicarbonate DKA [7]. Moreover, in case of infection in the body need to take antibiotics.

Action to be taken at every stage of the treatment is to monitor vital signs. During therapy keep the continuous monitoring of the biochemical parameters and the observation of symptoms. Pay attention to the possible side effects of therapy - hypokalemia, hypernatremia, hyperchloremia, hyperglycemia caused by interruption of intravenous insulin intake after improvement, without the administration of insulin subcutaneously and hypoglycaemia due to too intensive insulin treatment. DKA may give complications in the form of hypovolemic shock, acute renal failure and cerebral edema [2].

Care of a patient with ketoacidosis is based primarily on observing the patient towards deepening DKA and the occurrence of serious complications. Activities performed by a nurse include participation in diagnostics, pharmacotherapy and fluid therapy, monitoring vital signs and assisting in satisfying basic life needs. One of the elements of treatment is also diabetic education run by a nurse. Education aims to identify the patient's needs and deficiencies and to supplement them. This is a preventive measure taken to prevent another DKA episode.

The aim of the study was to present the most important patient care issues associated with ketoacidosis.

Material and methods

The individual care was a method used in the study. The study used the technique of observation and analysis of the available patient medical records. Nursing process has been developed based on the International Classification for Nursing Practice ICNP® [8].

A case report

18-year-old man was admitted to the internal as a matter of urgency due to ketoacidosis in the course of type 1 diabetes. In an interview diabetes from the age of 3, in the past one episode of diabetic ketoacidosis in 2016. Before the hospitalization gradual deterioration of the general condition of the increasing of general weakness and fatigue. The SOR found severe ketoacidosis (glucose level: 1159 mg/dl, pH=7.03). The patient was conscious, in logical contact, efficient cardio-respiratory and acidic breathing. Intravenous fluid administration and intensive insulin intake were used. It resulted in gradual lowering glucose levels and alleviation of acidosis. On the 3rd day of hospitalization, an intravenous infusion with insulin was completed, and intensive insulin therapy model with the use of prandial bolus and basal insulin was included in the treatment. The patient had the dawn phenomenon, therefore glycemic measurements were also taken at 3:30. During his stay, the patient presented a negative attitude in relation to people. In an interview with a psychologist, he admitted that the deterioration of diabetic alignment took place after using a high-carbohydrate diet, which he used for sports activities. He was at odds with his parents because they "watched" to lead a life according to therapeutic recommendations. From conversations with parents it is known that for years of suffering glycated hemoglobin was within the normal range (currently 11.6%). The diagnostic tests carried out confirmed anemia and diabetic nephropathy. On the 7th day of hospitalization, the patient in good condition discharged from the department at his own request before determining the final insulin dose.

Nursing process**Client:** Patient [10014132]**Diagnosis 1:** Hyperglycaemia [10027550]; Localization (L): Endocrine System Component [10025060]; Time (T): Present [10015581]

Action	Means
Monitoring Blood Glucose [10032034]	Monitoring Device [10012177]
Administering Insulin [10030417]	Nurse [10013333]
Collaborating In Fluid Therapy [10030948]	Nurse [10013333]
Documenting [10006173]	Nurse [10013333]
Monitoring Response To Treatment [10032109]	Nurse [10013333] Physician [10014522] Assessment Tool [10002832]
Monitoring Laboratory Result [10032099]	Nurse [10013333] Physician [10014522]
Relating [10016678]	Talking [10019436]
Score: Blood Glucose Within Normal Limits [10033685]	

Diagnosis 2: Somnolence [10018512]; T: Present [10015581]

Action	Means
Relating [10016678]	Talking [10019436]
Monitoring Blood Pressure [10032052]	Monitoring Device [10012177] Nurse [10013333]
Monitoring Vital Signs [10032113]	Monitoring Device [10012177] Nurse [10013333]
Monitoring Respiratory Status [10012196]	Nurse [10013333]
Score: Able To Communicate [10025025] / Consciousness [10004975]	

Diagnosis 3: Acid Base Imbalance [10033539], or Electrolyte Imbalance [10033541] or Dehydration [10041882]; T: Past [10014113], Present [10015581]

Action	Means
Collaborating In Fluid Therapy [10030948]	Nurse [10013333] Physician [10014522]
Collaborating In Electrolyte Therapy [10030930]	Nurse [10013333] Physician [10014522]
Measuring Blood Pressure [10031996]	Monitoring Device [10012177] Nurse [10013333]
Evaluation Response To Fluid Therapy [10007176]	Physician [10014522]
Collecting Specimen [10004588]	Blood [10003319] Nurse [10013333]
Monitoring Response To Treatment [10032109]	Nurse [10013333] Physician [10014522] Assessment Tool [10002832]
Score: Improved Acid Base Balance [10033502], or Improved Electrolyte Balance [10033518]	

Diagnosis 4: Weakness [10022880]; T: Past [10014113], Present [10015581]

Action	Means
Encouraging Rest [10041415]	Nurse [10013333] Physician [10014522] Talking [10019436] Pillow [10014607] Blanket [10003293] Bed Linen [10003175]
Administering Medication And Solution [10001804]	Nurse [10013333] Venous Cannula [10020677] Fluid Therapy [10031321] Aseptic Technique [10002639]
Assisting With Toileting [10023531]	Nurse [10013333] Sanitary Towel [10017487] Soap [10018358] Comb [10004638] Toothbrush [10019853]
Monitoring Physiological Status [10012183]	Nurse [10013333] Monitoring Device [10012177] Talking [10019436] Observing [10013474]
Documenting [10006173]	Nurse [10013333] Computer [10004906]
Score: Ability To Perform Self Care [10023729]	

Diagnosis 5: Lack Of Knowledge Of Disease [10021994]; T: Present [10015581], or Impaired Ability To Monitor Disease [10029613]; T: Past [10014113], Present [10015581]

Action	Means
Assessing Knowledge Of Disease [10030639]	Nurse [10013333] Assessment Tool [10002832] Talking [10019436] Listening [10011383]
Teaching About Disease [10024116]	Nurse [10013333]
Promoting Health Seeking Behaviour [10032465]	Talking [10019436]
Teaching About Health Seeking Behaviour [10032956]	Educating [10006564]
Teaching About Treatment Regimen [10024625]	Nurse [10013333]
Assessing Symptom Control [10026161]	Nurse [10013333]
Evaluation Treatment Regimen [10031268]	Nurse [10013333] Assessment Tool [10002832]
Managing Disease [10031912]	Nurse [10013333] Reading Material [10016433]
Managing Symptom [10031965]	Nurse [10013333] Reading Material [10016433] Patient [10014132]
Monitoring Laboratory Result [10032099]	Nurse [10013333] Physician [10014522]
Score: Knowledge Of Dietary Regime [10023772], Adequate Knowledge [10027112] or Able To Perform Health Maintenance [10023452]	

Diagnosis 6: Risk For Impaired Peripheral Neurovascular Function [10015228]; T: Future [10008299]

Action	Means
Assessing Knowledge [10033882]	Nurse [10013333] Assessment Tool [10002832]
Contracting for Adherence [10024349]	Nurse [10013333]
Assessing Symptom Control [10026161]	Nurse [10013333] Assessment Tool [10002832]
Counseling Patient [10031062], Diabetes [10005876]	Nurse [10013333] Reading Material [10016433]
Educating [10006564], Diabetes [10005876]	Nurse [10013333] Reading Material [10016433]
Promoting Adherence To Regime [10032449]	Nurse [10013333]
Supporting Ability To Manage Regime [10032800]	Nurse [10013333]
Score: Effective Peripheral Neurovascular Function [10028125]	

Diagnosis 7: Emotional Problem [10029839]; T: Past [10014113], Present [10015581]

Action	Means
Assessing Emotional Support [10030589]	Nurse [10013333] Assessment Tool [10002832]
Providing Emotional Support [10027051]	Nurse [10013333] Family [10007554]
Promoting Positive Psychological Status [10032505]	Nurse [10013333]
Managing Negative Emotion [10031851]	Patient [10014132]
Managing Negative Response To Situation [10031867]	Nurse [10013333] Patient [10014132]
Managing Anxiety [10031711]	Nurse [10013333]
Score: Effective Coping [10022378]	

Diagnosis 8: Risk For Depressed Mood [10032329] or Depressed Mood [10022402]; T:Past [10014113], Present [10015581]

Action	Means
Assessing Depressed Mood [10026055]	Nurse [10013333] Physician [10014522] Assessment Tool [10002832] Talking [10019436] Observing [10013474]
Assessing Emotional Support [10030589]	Nurse [10013333] Talking [10019436] Observing [10013474]
Assessing Self Esteem [10027079]	Nurse [10013333] Talking [10019436] Observing [10013474]
Identifying Psychological Status [10044241]	Nurse [10013333] Occupational Therapist [10026628] Assessment Tool [10002832] Talking [10019436] Observing [10013474]
Supporting Psychological Status [10019161]	Occupational Therapist [10026628] Family Therapy [10007667] Talking [10019436]
Demonstrating Relaxation Technique [10024365]	Nurse [10013333] Physiotherapist [10024003] Patient [10014132] Hydrotherapy [10039266] Music Therapy [10012371] Relaxation Technique [10016700]
Managing Negative Emotion [10031851]	Nurse [10013333] Occupational Therapist [10026628] Patient [10014132] Calming Technique [10003839] Stress Management [10038675]
Score: Effective Response To Therapy [10036423]	

Diagnosis 9: Non Adherence To Therapeutic Regime [10022155]; T: Past [10014113], Present [10015581]

Action	Means
Assessing Barriers To Adherence [10024214]	Nurse [10013333] Assessment Tool [10002832] Talking [10019436] Observing [10013474]
Educating [10006564]	Nurse [10013333] Reading Material [10016433] Instruction Material [10010395] Talking [10019436]
Supporting Psychological Status [10019161]	Nurse [10013333] Establishing Trust [10024396] Talking [10019436] Family Therapy [10007667] Occupational Therapist [10026628]
Score: Ready To Learn [10042498]	

Résumé

A patient diagnosed with ketoacidosis require intensive care staff. Placing the patient in nursing care is required not only during hospitalization, but also after discharge from the hospital. First of all, the patient should be diagnosed with non-adherence causes and use some of the available methods to improve adherence. First of all, the nurse should pay attention to the causes of decompensation and introduction of preventive measures. For this purpose, it is necessary to conduct diabetes education, which along with diet, physical activity, pharmacotherapy and insulin therapy is an indispensable element in the treatment of diabetes. The guidelines of the Polish Diabetes Association emphasize that education is the basis for effective effective prevention of diabetes and care for a diabetic [2]. Through the implementation of specific activities, the educator is able to help the diabetic patient overcome environmental factors, prevent the disease process from deepening and enable the patient to return to society. The goals that should be achieved after diabetes education are in addition to transferring knowledge and skills to change patient behavior, strengthen the motivation to comply with therapeutic recommendations, help improve the quality of life, create a partner relationship in the therapeutic process, prepare for self-care, increase the awareness of the patient about risk factors cardiovascular diseases and increasing the patient's mental immunity [9].

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