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Nutritional Care Process in Pediatric Patients with Severe Diabetic Ketoacidosis, Type 1 Diabetes Mellitus, Septic Shock, and Obesity

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ABSTRACT

The primary risk factors increasing the prevalence of diabetes mellitus are obesity, lack of physical activity, and unhealthy eating patterns. Objective: To determine the effect of nutritional management on improving the condition of patients with DKA, Type 1 Diabetes Mellitus, Sepsis Shock, and Obesity. This study used a case study design. The data used in this study included primary data from patient medical records. Results. Here's the revised paragraph without mentioning "table" or "graph" explicitly. Laboratory results showed a progressive decline in random blood glucose levels from 341 mg/dL to 229 mg/dL over five days, accompanied by improvements in hemoglobin and white blood cell counts. Physical observations indicated clinical recovery through stabilized vital signs, improved consciousness and respiratory function, and a nutritional transition from nasogastric feeding to soft oral intake. Nutrient intake steadily increased, with carbohydrate consumption exceeding 80% of daily requirements starting on the third day, while energy, protein, and fat intake continued to rise though remained below optimal levels.

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Key Messages:

- This study highlights the importance of nutritional care in the treatment of patients with Diabetic Ketoacidosis (DKA), Type 1 Diabetes Mellitus with Obesity, especially those hospitalized, which includes nutritional assessment, nutritional diagnosis, intervention, monitoring, and evaluation.
- Case studies on standardized nutritional care essential to evaluate the effectiveness of dietary interventions in managing Type 1 Diabetes Mellitus.

INTRODUCTION

Diabetic ketoacidosis (DKA) is one of the serious complications of type I diabetes mellitus (DM) and causes high mortality and morbidity in children. This occurs due to absolute insulin deficiency caused by damage to the beta cells of the pancreas. DKA can also occur in type 2 DM, but the incidence rate is lower than in type 1 DM (1). The incidence rate of type 1 DM varies greatly around the world. In some Western countries, it accounts for 5–10% of all diabetes cases, and over 90% of diabetes cases in children and adolescents are type 1 DM. The highest incidence of type 1 DM worldwide is in Finland at 43/100,000, while the lowest incidence is in Japan at 1.5–2/100,000 among those under 15 years of age. It is estimated that 80,000 children under the age of 15 worldwide will develop Type 1 diabetes (2).

The prevalence of diabetes mellitus in children in Indonesia is also quite high. According to data from the Indonesian Pediatric Association (PP IDAI), there were 1,021 cases of Type 1 diabetes in children up to 2014. The prevalence of children with type 1 diabetes increased in 2018, with 1,220 children diagnosed with type 1 diabetes. The peak incidence of type 1 diabetes in children occurs at ages 5–6 and 11 years. In the 10–14 age group, the proportion of girls with type 1 diabetes (60%) is higher than that of boys (28.6%). Seventy-one percent of children were first diagnosed with type 1 diabetes mellitus with diabetic ketoacidosis (DKA) (2).

Sepsis is life-threatening organ dysfunction caused by dysregulation of the body's response to infection (3). Sepsis and septic shock are global issues because one in four people with sepsis dies. The underlying infection causing sepsis can trigger DKA in patients with diabetes mellitus (DM) (4). The main risk factors for the increased prevalence of diabetes mellitus are obesity, sedentary lifestyle, and unhealthy eating patterns (5). Dietary management in children with DM

involves efforts to reduce weight through calorie restriction. Weight loss is necessary for patients with type 2 DM, who often experience obesity, while in children with type 1 DM, dietary management aims to optimize growth and development and achieve good metabolic control by regulating the calories needed for basal metabolism, growth, puberty, and daily activities (2). Medical nutritional therapy (MNT) is one of the four pillars of DM management. In DM, emphasis is placed on regulating the quantity, schedule, and type of food (6). Based on the above description, nutritional management was conducted for patients diagnosed with Severe KAD, Type 1 Diabetes Mellitus, Sepsis Shock, and Obesity in the Pediatric Intensive Care Unit (PICU) of Prof. Ngoerah General Hospital. This study aimed to assess the effectiveness of the Nutritional Care Process in managing pediatric patients with severe diabetic ketoacidosis, type 1 diabetes mellitus, septic shock, and obesity.

CASE DESCRIPTION

The type of research used was observational research using a case study design. The research was conducted in June 2025, from 25 to 30 June 2025, in the Pediatric Intensive Care Unit (PICU) of Prof. Ngoerah Denpasar General Hospital. The sample size for this case study was one patient diagnosed with severe KAD, Type 1 Diabetes Mellitus, Sepsis Shock, and Obesity. The data used in this study were primary and secondary. Primary data were obtained through direct interviews with the patient's family using the Food Frequency Questionnaire (FFQ) method and a 24-hour recall. Additionally, anthropometric measurements were taken using a weighing scale to assess the patient's nutritional status. Secondary data were obtained from the patient's medical records held by the hospital.

Assessment: A Child (An. AACM), aged 16 years and 5 months, is a female child diagnosed with severe KAD, type 1 diabetes mellitus, septic shock, and obesity in the PICU of Prof. Ngoerah Denpasar Hospital. The patient is a second-year high school student. She is Hindu and of Balinese ethnicity. The patient has a prior medical history of being hospitalized at age 4 for typhoid fever at a private hospital. Before admission, the patient experienced weakness at a campsite, shortness of breath, and abdominal pain. She was then picked up by her parents and brought to the nearest hospital. Upon arrival at the hospital, the patient remained weak, short of breath, and experienced abdominal pain. A blood sugar test was conducted, yielding a result of 341 mg/dL. The patient was immediately referred to Prof. Ngoerah General Hospital and admitted to the intensive care unit (ICU). While in the ICU, a nasogastric tube (NGT) was inserted, and the patient's stool was found to be brownish in color, leading to fasting.

Anthropometric data: body weight 83 kg, height 165 cm, body mass index 30.48 kg/m^2. Based on nutritional status assessment using the Body Mass Index z-score according to age, the result was BMI/U >3 SD (obesity), with an ideal body weight of 56.9 kg. Laboratory test results showed elevated blood glucose levels (GDS) at 341 mg/dL, HbA1c at 14%, and white blood cell count (WBC) at 31.21 × 10^3/µL, all above normal ranges. However, the hemoglobin (Hb) level was 6.9 g/dL, below the normal range. The patient's clinical physical condition before intervention was inadequate, with somnolent consciousness, experiencing shortness of breath, and having a nasogastric tube (NGT) for decompression. The patient's blood pressure was normal at 110/60 mmHg, temperature increased to 39°C, respiration rate was 30 breaths per minute, heart rate increased to 110 beats per minute, and SpO2 was 99%.

The patient's dietary history before admission to the hospital, based on interviews with the patient and the patient's mother, showed that the patient ate three main meals a day in sufficient quantities and enjoyed snacking up to 3-4 times a day, often consuming snacks such as light foods and sweet drinks. The patient also mentioned enjoying instant noodles up to 2-3 times a week, with each meal consuming 1-2 packets of instant noodles. At school, the patient often buys snacks like spicy Indonesian wet cracker dish and other trendy snacks that are high in sugar and saturated fat.

Nutritional diagnosis: NI-2.1 Inadequate oral food intake related to the patient's pathological condition (fasting due to black NGT production) and the patient's history of weakness and abdominal pain, as indicated by the 24-hour recall results: Energy deficit (23%), protein deficit (32%), fat deficit (39%), and carbohydrate deficit (44%). NC-3.3 Obesity related to poor dietary habits, as indicated by a BMI/U >3 SD. NB-1.1 Lack of knowledge about food and nutrients is associated with insufficient nutrition education, as indicated by the patient's history of frequently consuming sweet drinks almost daily and laboratory results showing a GDS level of 341 mg/dl and an HbA1c level of 14%.

RESULT

Biochemical Data

Tabel 1. The Results Of Laboratory Tests

Type of Examination	Before Intervention	Results					Reference
		Day I	Day II	Day III	Day IV	Day V	
RBG	341 mg/dL	329 mg/dL	234 mg/dL	253 mg/dL	241 mg/dL	229 mg/dL	60-200 mg/dL
WBC	31,21 10^3/µL	-	-	-	-	19,35 10^3/µL	4,1–11 10^3/µL
HGB	6,9 g/dL	-	8,9 g/dL	-	-	9,3 g/dL	12 – 16 g/dL
HbA1c	14%	-	-	-	-	-	>6,5%

Based on Table 1, the laboratory test results showed an increase in random blood glucose (RBG), HbA1c, and white blood cell (WBC) counts above normal values. Meanwhile, the laboratory test results for hemoglobin (Hb) levels were below normal values.

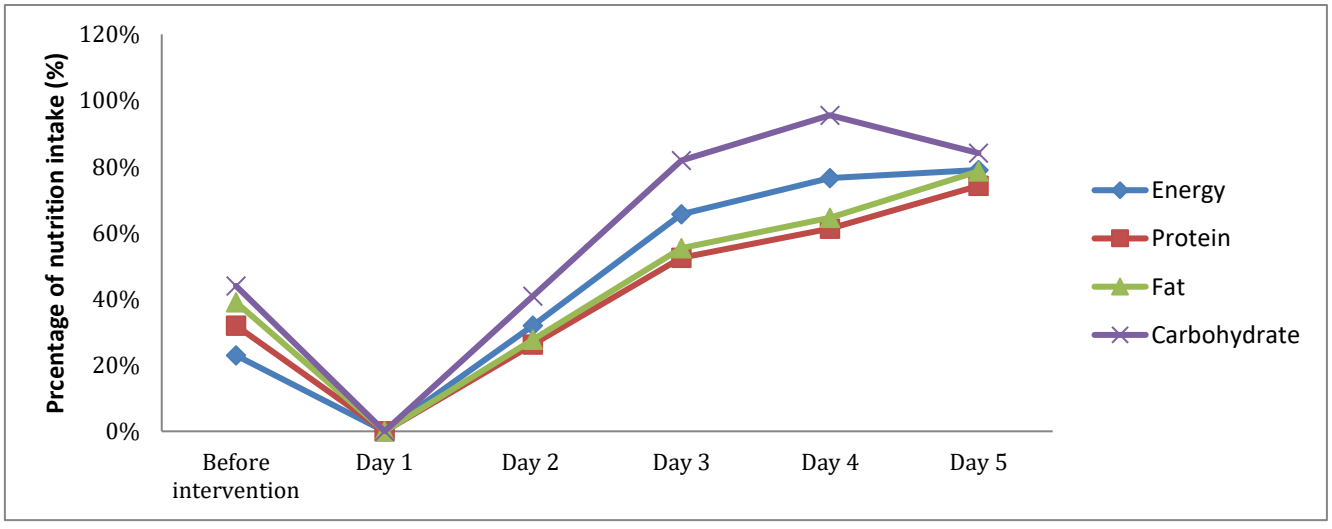
Clinical Physical Data

Tabel 2. Clinical Physical Condition

Parameter	Results						Normal Value
	Before Intervention	Day 1	Day 2	Day 3	Day 4	Day 5	
Blood Pressure	110/60 mmHg	120/70 mmHg	125/80 mmHg	120/75 mmHg	115/71 mmHg	118/78 mmHg	120/80 mmHg
Temperature	39 ^{0}C	37,1 ^{0}C	36,7 ^{0}C	36.8 ^{0}C	36.9 ^{0}C	36.7 ^{0}C	35.5 – 37,5°C
Respiration	30x/min	30x/ min	30x/ min	25x/ min	20x/ min	20x/ min	12–20 x/min
Heart rate	110x/ min	108x/ min	111x/ min	95x/ min	100x/ min	98x/ min	60–100 x/min
SpO2	99%	99%	99%	97%	98%	98%	≥95%
Physical Examination	Hasil						
	Before Intervention	Day 1	Day 2	Day 3	Day 4	Day 5	
Awareness	Inadequate	Inadequate	Composmentis	Composmentis	Composmentis	Composmentis	
Breath	Shortness of breath	Shortness of breath	Shortness of breath improves	Shortness of breath reduced	Shortness of breath improved	Shortness of breath still exists	
Physical Appearance of The Body	Weak, NGT Installed	Weak, NGT Installed	Weak, NGT Installed, able to communicate	Weak and Improving, NGT in place, able to communicate	Weak and improving, aff NGT, drinking milk orally	Weak and improving, started soft diet	
Digestive system	NGT decompression, fasting	*Tropic Feeding* (TF) via NGT was started	Good tolerance, drinking via NGT increased	Good tolerance, drinking via NGT increased	Drinking orally, good tolerance.	Started soft food, food intake	

Based on Table 2, it can be seen that the monitoring results over 5 days showed that the patient's physical condition on the first to second day was still inadequate, with vital signs including normal blood pressure of 120/70 mmHg, respiratory rate (RR) of 30 breaths per minute (increased), pulse rate 110 beats per minute (increased), the patient was experiencing shortness of breath and was administered oxygen, and an NGT was inserted with brownish discharge. On the first day of intervention, the patient was still fasting due to the brownish NGT discharge, and on the second day, the NGT discharge began to clear. From the third to the fifth day, the patient's condition improved further, with adequate consciousness and vital signs such as blood pressure still within normal limits at 110/70 mmHg, pulse rate 90 beats per minute, respiratory rate 36 breaths per minute, and the patient still on oxygen. On the fourth day of intervention, the patient's condition was good, still on oxygen, able to communicate bidirectionally, and had already been removed from the NGT. The patient was also started on an oral diet with a liquid consistency. On the fifth day of intervention, the oxygen tube was removed, and the patient requested solid food.

Nutrient Intake Data



Graph 1. Percentage of Nutrient Intake from Total Patient Requirements

Monitoring and evaluation. Food assessment intake is carried out for 5 days, namely on June 25 to 30, 2025, in the inpatient Pediatric Intensive Care Unit (PICU) of Prof. Ngoerah General Hospital. The food served to patients is hospital food. The food served is adjusted according to the patient's condition and nutritional needs.

The type of diet given during the patient's intervention period was a DM diet with gradual food consistency, starting with liquid meals. Enteral formula was administered to the patient according to a predetermined schedule, namely at

09:00, 12:00, 15:00, 18:00, 21:00, 00:00, 03:00, and 06:00. The consistency is then increased to solid food with three main meals and three snacks by the management of the Diabetes Mellitus diet. The daily nutritional requirements for the patient are as follows: Energy = 2560 kcal; Protein = 128 grams; Fat = 85 grams; Carbohydrates = 320 grams. The carbohydrate distribution is as follows: breakfast 25%, morning snack 10%, lunch 25%, afternoon snack 10%, dinner 20%, and evening snack 10%.

Anthropometric Data

Anthropometric measurements were taken during the initial assessment, before the intervention, by measuring weight and height. For anthropometric results, on the last day of the intervention, weight measurement was not performed because the patient was still on bed rest and therefore unable to be weighed. However, weight measurement was performed on the last day of hospitalization, i.e., after the patient had been hospitalized for 11 days. Before the patient was discharged, a weight measurement was taken, resulting in a weight of 80.07 kg. Based on the determination of nutritional status using the Body Mass Index (BMI) z-score according to age, the result was found to be between +2 SD and +3 SD, indicating that the patient's nutritional status was in the overweight category. Based on these results, the diagnosis of NC-3.3 Overweight related to improper eating patterns, as indicated by the BMI/age calculation falling between (+2 SD to +3 SD), can be established.

DISCUSSION

Biochemical

Hemoglobin A1c assessment in DM patients to detect complications early and assess compliance with DM control. HbA1c is the non-enzymatic binding of glucose molecules to hemoglobin through post-translational glycation (7). Normal HbA1c levels can be maintained by always maintaining normal blood sugar levels. Since red blood cells have a lifespan of 8–12 weeks before regeneration occurs, measuring glycated hemoglobin (HbA1c) can reflect average blood glucose levels over that period (8).

One way to control diabetes mellitus is to consume foods that can control blood sugar and actively consult with a nutritionist to plan a good diet. Blood sugar levels essentially indicate the amount of glucose present in the blood (9). The number of leukocytes (WBC) is significantly higher in the KAD group compared to the non-KAD group. White blood cell counts reflect acute infections and hyperglycemic crises, with a significant increase in white blood cell counts in patients with KAD and infections. KAD occurs as an acute complication of poor metabolic control or as an early manifestation of Type 1 diabetes mellitus. Hyperketonemia increases systemic inflammatory processes and oxidative stress (10). Low hemoglobin levels indicate the presence of anemia. The side effect of decreased Hb levels, which function as a means of transporting oxygen throughout the body, will cause DM patients to experience anemia or a deficiency of red blood cells, which can be used as a parameter for decreased nutritional status that will affect blood sugar levels (11).

Nutrient Intake

The patient's nutritional intake showed a significant improvement, reflecting the success of the intervention based on the Standardized Nutritional Care Process (NCP). Before the intervention, the patient's energy intake was very low, indicating a risk of serious metabolic disorders and digestive problems with NGT decompression. Through the administration of special diabetic formula milk, energy intake increased on the second to fourth days of the intervention. This increase in energy intake was also accompanied by an increase in other nutrient intakes, namely: protein, fat, and carbohydrates.

On the fifth day of the intervention, the patient was started on a soft food diet with three main meals and three snacks, and carbohydrate distribution by the management of Diabetes Mellitus. The dietary regimen was gradually introduced, starting at 80% of total requirements. The patient's tolerance to food was good, although they were unable to finish their meals, they were willing and compliant in following the prescribed diet during their hospital stay. The patient's oral intake showed good progress. The patient and their family were also committed to continuing the Diabetes Mellitus diet at home, following the dietary education provided.

Dietary therapy is the primary therapy in the management of Diabetes Mellitus; a healthy diet can reduce the progression of Diabetes Mellitus. The diet is primarily aimed at controlling the patient's weight, especially for patients with Diabetes Mellitus and obesity, as weight loss is key in the management of Diabetes Mellitus. It is important to note that the focus of the diet is on the number of calories required by everyone, not the quantity of food consumed. This is aimed at achieving metabolic, lipid, and blood pressure control (12).

Aim to eat at regular intervals. If meals are delayed, hypoglycemia (low blood sugar levels) may occur. Symptoms of hypoglycemia include dizziness, nausea, and fainting. If this occurs, drink sugar water immediately. The recommended food intake for diabetes patients is small portions but frequent meals. Patients should eat small amounts but frequently, divided into a meal plan of six meals. The type of food determines the speed at which blood sugar levels rise or fall. The speed at which a food raises blood sugar levels is called the glycemic index. Avoid foods with a high glycemic index, such as simple carbohydrates, sugar, honey, syrup, bread, noodles, and others. Foods with a lower glycemic index are those rich in fiber, such as vegetables and fruits (12).

Dietary management for type 1 diabetes aims to achieve good metabolic control without neglecting the calories

needed for basal metabolism, growth, puberty, and daily activities (13). Adolescents tend to be consumptive and have irregular eating patterns because they are in a growth phase, so they often consume foods that are appealing and high in glucose. Frequent consumption of high-glucose and high-fat foods can lead to overweight conditions and may trigger the onset of diabetes mellitus (14). In addition to genetic factors, environmental factors, medications, and hormones also play a significant role in the development of obesity. Therefore, providing appropriate nutrition education, promoting a healthy lifestyle, and increasing physical activity are important steps to reduce the risk of diabetes mellitus (15).

Factors influencing patient adherence to therapy: self-motivation, perception, family support, self-confidence, and support from healthcare professionals. According to research conducted by Susanti, one of the factor's influencing adherence is family support. With family support, patients are expected to feel happy and at ease, as this support fosters their self-confidence to better manage or cope with their condition. Additionally, it becomes easier to accept information about the concept of diet, guidance on the importance of adherence in following the diet, and guidance on examples of how to modify the diet menu, thereby increasing respondents' adherence to the diet (16).

CONCLUSION

Patients diagnosed with severe KAD, type 1 diabetes mellitus, septic shock, and obesity during the 5-day intervention period showed a gradual increase in energy and nutrient intake over the 5-day intervention period but did not yet reach the target levels required. The failure to meet the target for energy and nutrient intake is attributed to the patient's prior placement of a nasogastric tube (NGT), resulting in a liquid diet (commercial diabetes formula) administered gradually, starting with Tropic Feeding (TF), and on the final day of the intervention, the patient was provided with a diabetes diet (DM) with soft food consistency. For carbohydrate nutrients, the target was achieved according to the patient's needs from the third day until the last day of the intervention. Additionally, the patient did not experience weight loss during the intervention period, so the patient's nutritional status was classified as overweight. Based on these results, it can be concluded that the provision of standardized nutritional care to the patient was able to maintain and improve the patient's quality of life, particularly during the recovery process, and help reduce the patient's GDS.

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