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Original Article

Nutritional therapy and caloric achievement within the first week of PICU admission

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Abstract

Background Nutritional therapy is an important aspect in managing PICU patients. Careful decisions should be made regarding initiation, route of administration, and achievement based on caloric requirements. Many conditions could affect the application of nutritional therapy.

Objective To investigate the implementation of nutritional therapy during the 1st week after PICU admission.

Methods We conducted a retrospective study involving 156 children aged 1 month-18 years who were hospitalized for at least 4 days in the PICU during the period of January 1, 2015 to December 31, 2015. Subjects were divided into three groups according to initiation time of caloric administration, which were: category I (within the first 24 hours of PICU admission), category II (within the first 25-48 hours of PICU admission), and category III: (more than 48 hours after PICU admission). Caloric requirement was calculated using the Caldwell or Schofield formula, whilst caloric achievement was figured up from PICU daily monitoring sheets containing nutritional therapy given to the subjects.

Results Of 131 subjects, 72 (55%) had good nutritional status and 59 (45%) children had malnutrition. Caloric administration was initiated within 24 hours of admission in 101 (77.1%) patients, of whom 90 (89.1%) patients received enteral feeding. Nineteen (14.5%) patients received their initial calories within 25-48 hours of admission, with 16 (84.2%) using the enteral route. At the 4th and 7th days of hospitalization, 93 (71%) and 107 (81.7%) patients achieved >70% of their caloric requirements. Delays in feeding initiation were due to shock, gastrointestinal bleeding, inotropic support, and feeding intolerance, which reduced caloric achievement.

Conclusion Most patients receive nutritional therapy in the first 48 hours after PICU admission and achieve >70% of their caloric requirements at the 4th day of hospitalization. The enteral route is preferred. Delayed initiation of nutritional therapy reduces caloric achievement. **[Paediatr Indones. 2018;58:13-9; doi: http://dx.doi.org/10.14238/pi58.1.2018.13-9]**.

Keywords: *nutritional therapy; malnutrition; PICU; caloric achievement*

Critically ill conditions have been associated with catabolic stress that leads to increased morbidity and mortality if not managed properly. Nutritional support is an important aspect in management of patients in the PICU. Adequate nutritional therapy is needed to maintain the integrity of intestinal mucosa, improve the structure and function of the gastrointestinal system, hasten wound healing, decrease catabolic response to trauma, as well as reduce infection and early mortality.[1,2] The route selected for caloric administration, either oral, enteral, parenteral, or a combination, depends on the condition of the patient's gastrointestinal tract and its ability to absorb nutrients. Each of these routes has its own indications, benefits, durations of administration, and complications that may occur. The gastrointestinal tract in critically ill children often does not function optimally, so either the enteral or parenteral route is preferred. Many studies reported that enteral nutrition provides better outcomes than parenteral nutrition.[2–4]

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Enteral nutrition within the first 48 hours in adult patients with a mechanical ventilator was associated with a decrease in the mortality rate of up to 20%.3 Another study reported that adults with septic shock and mechanical ventilator who received enteral nutrition within the first 48 hours showed shorter durations of hospitalization and ventilator usage.[5]

The caloric achievement does not always meet the planned caloric requirement. Mehta et al. found that the achievement of caloric needs in PICU patients was only 51% of their caloric requirement on the 6th day of hospitalization.[4] Another study reported that on the 9th day of hospitalization, only 50% of patients reached their caloric needs.[6] These studies illustrate the constraints of achieving adequate nutrition children admitted to the PICU. Reasons that may be associated with these conditions were fluid restriction, enteral and parenteral route disruptions, feeding intolerance, and interruptions due to diagnostic procedures that require fasting, such as radiological examinations. Failure to achieve caloric need has been associated with longer length of stay and higher mortality rate.[4,7]

We aimed to describe the implementation of nutritional therapy in PICU patients including initiation time, route of administration, caloric achievement, as well as conditions that affected therapy. We found that the average length of stay in the PICU, Dr. Sardjito General Hospital in 2015 was 7 days, so we recorded nutritional therapy during this period of time.

Methods

We conducted a retrospective study in children aged 1 month to 18 years who were hospitalized in the PICU at Dr. Sardjito General Hospital, Yogyakarta, for at least 4 days from January 1, 2015 to the December 31, 2015. We chose a duration of at least 4 days based on the physiological phase of metabolic stress in critically ill patients. The ebb phase starts immediately and is followed by a flow phase after 48-72 hours. In the second phase, substrate mobilization to produce energy occurs in order to prevent the effect of auto-cannibalism, so the human body needs enough nutrition to provide the substrate. Data were collected from patients' medical records using a questionnaire covering demographic data (age and sex) and clinical data which included date of admission to and discharge from the hospital, date of admission to and discharge from the PICU, weight and height at admission, categories of primary disease (non-surgical, digestive surgical, or non-digestive surgical), course of the disease during hospitalization (fluid restriction, feeding intolerance, shock, gastrointestinal bleeding, availability of central access, absence of an intravenous line, and investigations/medical procedures that required fasting), as well as the patient's condition when discharged from the PICU (survived or died). Nutritional therapy data were obtained from medical records and daily monitoring sheets from the PICU. Caloric requirement was calculated using the *Caldwell* formula for patients with mechanical ventilator and the *Schofield* formula for patients without mechanical ventilator.[8–10] Patients with incomplete medical records were excluded from the study.

Subjects were divided into three groups based on initiation time of caloric administration, which were category I: patients who started nutritional therapy within the first 24 hours of PICU admission, category II: patients who started nutritional therapy within the first 25-48 hours of PICU admission, and category III: patients who started nutritional therapy at more than 48 hours after PICU admission. Route of administration was classified into 2 groups according to the route selected to initiate caloric administration, either enteral or parenteral route. Meanwhile, we set a caloric achievement cut-off value of 70% of the caloric requirement. This cut-off was derived from a previous study that stated that energy intake >66.7% resulted in significantly lower mortality.[4]

The sample size was calculated using the simplified *Lameshow* binomial formula for survey study based on an estimation that 50%[6] of patients could achieve the caloric requirement, with precision of 10%. This calculation resulted in a minimum required sample size of 100.

Data were analyzed using a *SPSS version 20* software. Univariate analysis was conducted to describe the characteristics and distribution of research data. The variables were compiled in the form of descriptive narrative and tables. This study received approval from the Medical and Health Research Ethics Committee of the Universitas Gadjah Mada Medical School/Dr. Sardjito General Hospital.

Results

There were 156 children aged 1 month to 18 years who were treated in the PICU at Dr. Sardjito General Hospital for at least 4 days during the one-year study period. Twenty-five patients were excluded because of incomplete medical records, leaving a total of 131 subjects. Characteristics of the study subjects are shown in **Table 1**. Of our subjects, 55% had good nutritional status and 45% had malnutrition. In the group of patients who died, as many as 59.6% were malnourished, with undernourished as the highest proportion (32.7%).

Our subjects were distributed into the following categories of nutritional therapy initiation: 101 (77.1%) patients in category I, 19 (14.5%) patients in category II, and the remaining 11 (8.4%) patients in category III. The enteral route was used more frequently than the parenteral route in patients from category I [90 patients (89.1%) *vs.* 11 patients (10.9%), respectively] and category II [16 patients (84.2%) vs. 3 patients (15.8%), respectively]. Patients from category III differed, in that the parenteral route was used more frequently than the enteral route [7 patients (63.6%) vs. 4 patients (36.4%), respectively].

Thirty patients who received caloric administration after the first 24 hours (categories II and III) consisted of 28 (93.4%) non-surgical patients, 1 (3.3%) digestive surgical patient, and 1 (3.3%) non-digestive surgical patient. The 11 patients who started caloric administration after 48 hours (category III) of PICU admission were all non-surgical patients. The reasons for delays in feeding initiation in both groups are shown in **Figure 1**.

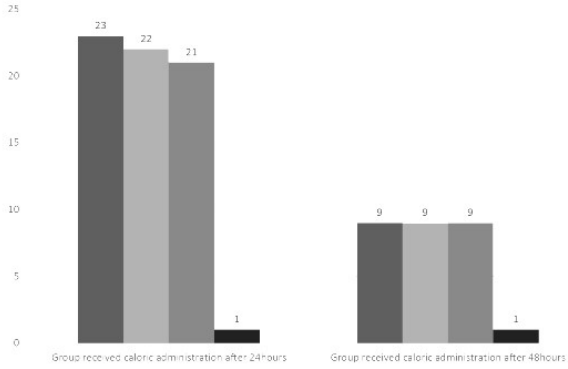

Figure 1. Reasons for withholding caloric administration

Table 1. Basic characteristics of study subjects

Characteristics	Total N=131	Category I n=101	Category II n=19	Category III n=11
Sex, n(%)		56 (55.4)	12 (63.2)	4 (36.4)
Male	72 (55)			
Median age (range), month	36 (1-197)	14 (1-197)	82 (11-182)	101 (360173)
Nutritional status, n(%)				
Good	72 (55)	54 (53.5)	12 (62.3)	6 (54.5)
Undernourished	26 (19.8)	24 (23.8)	1 (5.3)	1 (9.1)
Severe malnutrition	23 (17.6)	18 (17.8)	1 (5.3)	4 (36.4)
Overweight	4 (3)	1 (1)	3 (15.8)	-
Obese	6 (4.6)	4 (4)	2 (10.5)	-
Primary disease, n(%)				
Non surgical	113 (86.3)	85 (84.2)	17 (89.5)	11 (100)
Digestive surgical	10 (7.6)	9 (8.9)	1 (5.3)	-
Non-digestive surgical	8 (6.1)	7 (6.9)	1 (5.3)	-
Mechanical ventilator, n(%)				
No	47 (35.9)	33 (32.7)	9 (47.4)	5 (45.5)
Yes	84 (64.1)	68 (67.3)	10 (52.6)	6 (54.5)
Outcome, n(%)				
Survived	79 (60.3)	54 (53.5)	16 (84.2)	9 (81.8)

Classification of nutritional status was based on 2006 WHO Z-score weight per height criteria for children aged < 5 years old, body mass index (BMI) per age criteria for children > 5 years old.
Good nutritional status: weight per height or BMI per age Z-score of -2 SD < Z score < 2 SD;
Undernourished: weight per height or BMI per age Z-score of -2 SD < Z score < -3 SD;
Severe malnutrition: weight per height or BMI per age Z-score of < -3 SD;
Overweight: weight per height or BMI per age Z-score of 2 SD < Z score < 3 SD;
Obese: weight per height or BMI per age Z-score > 3 SD.

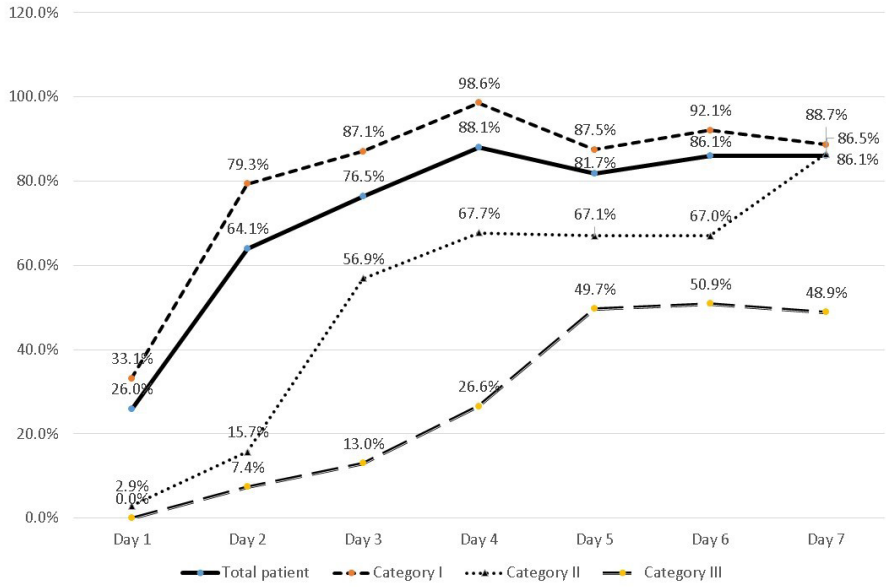

Figure 2. Daily mean percentage of caloric achievement
Total patients: days 1-4: 131 patients, day 5: 109 patients, day 6: 95 patients, day 7: 84 patients.
Category I: day 1-4: 101 patients, day 5: 86 patients, day 6: 76 patients, day 7: 69 patients.
Category II : day 1-4: 19 patients, day 5: 14 patients, day 6: 13 patients, day 7: 10 patients.
Category III: day 1-4: 11 patients, day 5: 9 patients, day 6: 6 patients, day 7: 5 patients.

On the 4th day of hospitalization, 82 (62.6%) patients achieved more than 70% of their caloric requirements through the enteral route, and 93 (71%) patients achieved such through enteral and/or parenteral routes. On the 7th day of hospitalization, 99 (75.6%) patients reached 70% of their caloric target through the enteral route and 107 (81.7%) patients through enteral and/or parenteral routes. The daily mean percentage of caloric achievement is shown in **Figure 2** and the proportion of patients who achieved more than 70% of the caloric requirement on the 7th day of hospitalization based on time of initial feeding is shown in **Figure 3**.

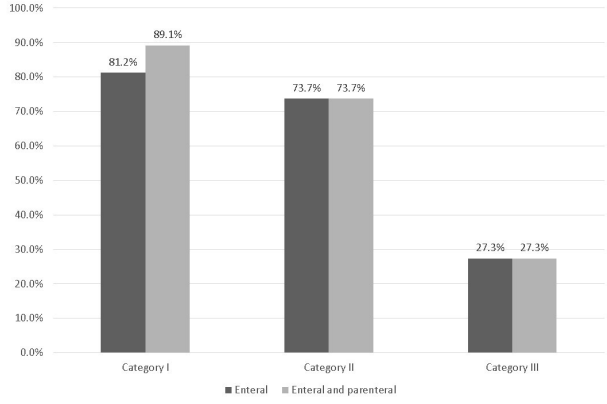

Figure 3. Proportion of patients who achieved >70% of caloric requirements on the 7th day of hospitalization, based on time of initial feeding

Discussion

The proportion of malnourished patients in our study was 45%, higher than in several previous studies which reported 15-30%.[7-9] This discrepancy could be due to our setting, since most previous studies were conducted in developed countries. Most children treated in the PICU become malnourished during hospitalization because of their hypercatabolic condition caused by sepsis, shock, and inflammation. This condition may rapidly decrease body mass, weaken the function of vital organs, and destroy the immune system, all of which absorb 30-50% of their energy.[8-10]

Enteral nutrition is the first choice in patients without gastrointestinal disorders because using the enteral route can prevent atrophy of intestinal mucosa and reduce intestinal permeability to prevent bacterial

translocation and sepsis.[11] A previous study noted that the administration of enteral nutrition in the first 12-24 hours of hospitalization may effectively increase cumulative energy, as well as reduce the incidence of infection and length of hospitalization.[7] Of the subjects receiving initial nutrition within 24 and 24-48 hours, 89.1% and 84.2% of patients received first caloric intake through the enteral route, respectively. Previous studies have provided evidence that early enteral nutrition is an effective way to prevent the occurrence of stress-related mucosal damage (SRMD), an effect of metabolic stress that occurs in critically ill children. Enteral nutrition may increase blood flow to the intestine, increase perfusion, increase gastric pH, and prevent ischemia that can cause SRMD and, consequently, trigger gastrointestinal bleeding.[11-13] Parenteral nutrition has a higher risk of becoming a source of infection than the enteral route. However, in patients who cannot tolerate the enteral route, the parenteral route should be the choice of administration.[12] In our study, the initial feeding by parenteral route was given in less than 16% of patients.

We found the common reasons for withholding caloric administration to be shock, gastrointestinal bleeding, and use of inotropes. This finding was consistent with a previous study which reported such conditions to be the reasons for delaying enteral nutrition, in order to reduce the risk of intestinal necrosis.[17] The latest consensus of the *American Society for Parenteral and Enteral Nutrition* (ASPEN) 2016 was in agreement, while the consensus for pediatric patients in 2009 had not mentioned about this yet.[18,19] However Panchal *et al.* did a retrospective multicenter study with children treated in the PICU for 4 days or more, who received at least one type of vasoactive drug. They showed that enteral nutrition was well tolerated in 78% of patients and there was no significant difference in gastrointestinal side effects between the group of patients who received enteral nutrition within 48 hours and the group of patients who did not. Nevertheless, the limitations of their study were the selective samples, differences in patients' basic characteristics, and differences in the vasoactive inotropic score (VIS) between the two patient groups.[20] Further prospective study will be needed to determine the effect of enteral nutrition in patients with hemodynamic instability and those who use of vasopressors. A Korean study reported 59 cases of delayed enteral nutrition due to gastrointestinal bleeding, which later revealed that only 7 (11.9%) of these cases had active gastrointestinal bleeding. Most of the cases (52 cases or 79.7%) were actually a blood clot.[21] A specific definition of gastrointestinal bleeding is needed because it affects patient management. The SRMD was a common cause of upper gastrointestinal bleeding within the first 24 hours of hospitalization in 75-100% of patients admitted to the PICU. Enteral nutrition was reported safe in patients with SRMD, and even reduced the likelihood of further bleeding; while in patients with massive upper gastrointestinal bleeding, enteral nutrition was contraindicated until the patient was stable and had low risk of recurrent bleeding.[14] The limitation of our study was its retrospective design. Diagnosis of gastrointestinal bleeding was solely based on the information available in the medical records with limited detail on severity.

We observed that delayed feeding initiation reduced caloric achievement, especially when started at more than 48 hours after admission. These results were consistent with those of Martinez *et al.* who found that one-day delay of initiating caloric intake decreased caloric achievement by 16.66%.[22]

In conclusion, during the first week of treatment, most patients in the PICU at Dr. Sardjito General Hospital, Yogyakarta receive caloric administration within the first 48 hours of hospitalization and achieve more than 70% of the caloric requirement on the 4th day of admission. The enteral route is the preferred route to initiate caloric intake. Delays in feeding initiation reduce the percentage of caloric achievement.

Conflict of Interest

None declared.

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