ORIGINAL ARTICLE

Adequacy of Enteral Nutritional Therapy Offered to Patients in an Intensive Care Unit

Deborah Milani Pavão[1], Helena Dória Ribeiro de Andrade Previato[2], Diana Borges Dock Nascimento[3], Ana Carolina Pinheiro Volp[3], Sílvia Regina de Lima Reis[3]

[1]Nutritionist by Faculty of Nutrition, Federal University of Mato Grosso, Cuiabá, Mato Grosso, Brazil, [2]Department of Food and Nutrition, School of Food Engineering, University of Campinas, São Paulo, Brazil, [3]Department of Food and Nutrition, Faculty of Nutrition, Federal University of Mato Grosso, Cuiabá, Brazil

ABSTRACT

Introduction: Malnutrition is a common framework in hospitalized patients. Enteral nutritional therapy (ENT) is the most commonly used strategy to treat malnutrition. However, complications related to ENT can make it impossible to reach the nutritional requirements of the patient. **Objectives:** The objectives of the study are to evaluate the nutritional status of patients receiving exclusive ENT and to assess the adequacy of ENT in an intensive care unit (ICU). **Materials and Methods:** Retrospective study conducted in an ICU of a private hospital in Cuiabá/MT/Brazil between 2015 and 2016. The sample consisted of 115 patients >18 years of age in exclusive ENT. The nutritional status was evaluated using anthropometric, clinical, dietary, and biochemical measurements, and it was categorized by the subjective global assessment. The calorie and protein requirements were calculated according to the hospital protocol. **Results:** The most of the patients were elderly (86%) and were undernourished or at nutritional risk (99.1%) at the 1st day of hospitalization. The average nutritional requirements were 1765.31 ± 306.62 kcal and 91.96 ± 21.51 g of protein. However, the percentage of adequacy for calorie (40.31%) and protein (39.98%) were below nutritional requirements. The main complications regarding non-administration of enteral nutrition were awaiting the enteral feeding tube be placed and fasting period. In addition, there was a waste of 92.9 liters of diet due to non-infusion of prescribed enteral nutrition. **Conclusions:** Malnutrition, delay in enteral nutrition tube administration, and fasting for clinical procedures may have contributed to the low nutritional adequacy of the diet, which may increase the risk of mortality in critically ill patients admitted in ICU.

Key words: Adequacy, enteral nutritional therapy, intensive care unit, malnutrition

INTRODUCTION

Malnutrition is a very common condition in hospitalized patients. In Brazil, the Brazilian Survey on Hospital Nutritional Assessment detected 48.1% of malnutrition among hospitalized patients, and this percentage is still higher (60%) among critically ill patients in intensive care units (ICUs).[1]

A study conducted by the Brazilian Society of Parenteral and Enteral Nutrition showed that about 30% of the hospitalized patients became malnourished within the first 48 h of hospitalization. This percentage increased by 15% after 3–7 days of hospitalization, reaching 60% of malnutrition after 15 days.[2] In turn, malnutrition can lead to a series of other complications leading to an increased hospitalization time, costs, and mortality.[3]

Enteral nutritional therapy (ENT) is the most common strategy used to treat and/or prevent malnutrition. This route of nutritional support is used in patients, who present a functioning gastrointestinal tract and with total or partial impossibility of reaching energetic and protein requirements by oral route.[4] Although ENT is a strategy

Address for correspondence:
Silvia Regina de Lima Reis, Department of Food and Nutrition, Federal University of Mato Grosso, Cuiabá, Brazil.
E-mail: silviarlima@terra.com.br

to treat malnutrition, it can be used adequately to provide the nutritional requirements.[5] Incomplete diet infusion can lead to nutritional risk, worsening the patient's clinical condition and increasing costs, since the patient will need more medications, clinical procedures, and longer hospitalization.

Thus, it is necessary to know the adequacy of diet prescription/infusion to improve the patient's nutritional status and to properly use the financial resources to purchase enteral diets. Hence, the present study aimed to evaluate the nutritional status of patients receiving exclusive ENT and to verify the calorie-protein adequacy of the EN support offered in an ICU of a private hospital in Cuiabá/MT/Brazil.

MATERIALS AND METHODS

Retrospective study involves the medical records analysis of patients admitted in an ICU from 2015 to 2016. The sample consisted of 115 patients over 18 years of age, of both gender, with exclusive ENT for 4 consecutive days. Exclusion criteria were concomitant oral and/or parenteral nutrition associated with ENT.

Demographic, clinical, anthropometric, and biochemical variables

Data collection was started on the 1st EN day and lasted until the 4th day of nutritional therapy. The daily collected data included: Gender (male or female), age (years), weight (kilograms), origin, and clinical outcome. In addition, data from subjective global assessment (SGA) were classified as: A - well nourished, B1 - at nutritional risk, B2 - moderately malnourished, or C - severely malnourished.[6]

Biochemical data collected were concentrations of lactate, C-reactive protein (CRP), urea, creatinine, albumin, and blood glucose (all in milligrams per deciliter - mg/dL).

Dietary variables

Data collected from the charts: Calorie and protein need and prescribed, and volume prescribed and infused. First, the volume (mL) of the diet administered daily was collected from the chart, and afterward, the volume offered was converted into kilocalorie (kcal) according to the caloric density of each different formulas prescribed by the Hospital's Service of Clinical Nutrition.

After the data collection, the percentage of adequacy for calories and protein was calculated using: (1) The ratio of the total amount of calories and proteins administered and the respective amounts needs and (2) the total amount of calories and proteins administered and the respective amounts prescribed. The result was showed in percentage,[2,3] adopting 80% as a target of adequacy.[7-10]

Evaluation of enteral diet loss

Loss of enteral diet was measured considering the volume of enteral diets (mL) that were not administered in the ENT.

Statistical analyzes

Results were shown as mean and standard deviation. Levene test was used to verify the homogeneity of variances, and Shapiro–Wilk test was performed to verify the distribution of the variables. The paired Student's *t*-test was used to verify the difference between the amount of calories and proteins calculated and administered, and the amount of calories and proteins prescribed and administered. In addition, the data were submitted to analysis of variance (ANOVA) one-way and Tukey's *post hoc* test to evaluate differences between three or more variables. These tests were conducted using the Predictive Analytics SoftWare (PASW) version 15.0, considering the level of statistical significance of 5%.

RESULTS AND DISCUSSION

A total of 115 patients were evaluated. The demographic and clinical characteristics of the sample are shown in Table 1.

According to the age group, it was possible to observe the prevalence of elderly patients (approximately 75%). The large number of elderly hospitalized in the ICU is observed both in Brazil and in other countries as an effect of the growth of the elderly population in the world.[11] In addition to the common health complications in advancing age, the high prevalence of elderly patients in ICU can be explained by the fact that this group uses ENT more frequently, since they are hospitalized with more frequency and have prolonged hospitalization due the high risk of disability, illness, and malnutrition.[12]

Regarding the classification of nutritional status according to SGA, we observed that, at the beginning of the hospitalization, 47% of the patients presented malnutrition (23.5% - moderate malnutrition and 23.5% - severe malnutrition), while 52.1% of the patients were at nutritional risk and only 0.9% were eutrophic.

Similar results were observed in a study in which 54.8% of the patients presented malnutrition.[9] In the other hand, a study showed that 60% of the patients were eutrophic and only 29.4% malnourished.[13] Prada (2012) points out that the mean age of these patients was 48.27 years, so the study population was relatively young, which would possibly justify the lower incidences of malnutrition.[13] Schieferdecker analyzed Brazilian patients, attended at a public hospital, with indication of exclusive ENT, and he found that 78.1% of the patients presented moderate or severe malnutrition and 18.7% were eutrophic demonstrating a very similar prevalence with the present study.[8] Hospitalized patients in an ICU usually have acute-phase inflammatory response, which involves

Table 1: Demographic and clinical characteristics of patients with exclusive ENT Cuiabá-MT, Brazil, 2016

Characteristics	Values (%)
Gender (*n*, %)	
Female	57 (49.6)
Male	58 (50.4)
Life stage (*n*, %)	
Elderly	86 (74.8)
Adult	14 (25.2)
Age in years (mean±SD)	68.01±15.41
Weight in kg (mean±SD)	69.77±14.77
Origin (*n*, %)	
Residence	51 (44.3)
Infirmary	13 (11.3)
Surgery center	11 (9.6)
Others ICU	8 (6.9)
Others	32 (27.9)
Clinical outcome (*n*, %)	
Remained hospitalized	6 (5.2)
Transferred to infirmary	31 (27.0)
Transferred to semi-intensive	17 (14.7)
Death	56 (48.7)
Transferred	3 (2.6)
ENT end	2 (1.8)
Nutritional status (*n*, %)	
Eutrophic	1 (0.9)
Nutritional risk	60 (52.1)
Moderate malnourished	27 (23.5)
Severe malnourished	27 (23.5)

ENT: Enteral nutritional therapy, values presented in frequency absolute and mean±SD. SD: Standard deviation, ICU: Intensive care units

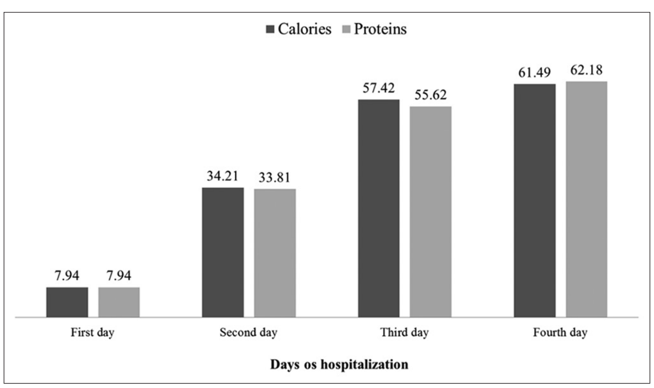

Figure 1: Percentage of adequacy for calorie and protein during 4 days of enteral nutrition therapy Cuiabá-MT, Brazil, 2016

intense catabolism, proteins mobilization for damaged tissues repair, high caloric requirement, fluid overload, and glucose intolerance among other health complications. Because of these, it is common to find a high percentage of malnourished patients.[14]

In relation to caloric and protein requirements, prescribed and administered, we overserved that the prescribed diet was significantly lower than nutritional requirements ($P < 0.05$; Table 2). The total volume administered was also significantly lower ($P < 0.05$; Table 2). This may be due to the low diet tolerance in terms of calories, proteins, and volume.

In addition, the percentage of adequacy in relation to nutritional requirements was 34.21 ± 35.24% for calories and 35.50 ± 35.42% for proteins. The percentage of adequacy was very low, with only 40.31 ± 37.40% of calories and 39.98 ± 37.43% of proteins actually administered. The minimum percentage of adequacy adopted for the present study was 80%. Thus, our results were below of the nutritional requirements proposed. This may be due the large number of patients (89.36%) that did not receive any nutritional volume infused on the 1st day of ENT, which 59.56% were waiting for the feeding tube introduction.

In another study, it was also observed that the calories prescribed and administered were lower than the calories required,[11] which could be explained by not usual pauses performed during the infusion of EN due the administration of medications and other routine procedures.[11] In this sense, it was demonstrated that patients, who had their enteral diet suspended for any cause, had a significantly lower mean caloric administered (61.4%) than those who received the infusion of EN continuous every day (71.7%).[15]

Several studies have shown a percentage of caloric adequacy between 70% and 80% in relation to calculated and prescribed values.[7-10] Researchers attribute this result to the use of enteral diet with higher caloric density in critically ill patients, since they often present some intolerance to large amount of volume infusion.[9]

In a survey conducted by Prada, the percentage of adequacy was categorized as "below caloric requirement" (<90%), "adequate caloric requirement" (between 90% and 110%), and "above caloric requirement" (>110%). Hence, 52.9% of the patients were classified as adequate or above caloric requirement.[13] However, it was disregarded the first 72 h of EN adaptation, starting to collect the data after that period. Hence, if it was not deducted these adaptation period, the percentage of adequacy for calorie would be higher (87.16%).[13] This high percentage of adequacy could be explained by the majority of the patients be younger (48.27 ± 17 years) and eutrophic, which present greater tolerance to enteral nutrition feeding.

In another study conducted in an ICU, 80% of the patients presented an adequacy of 82.2% for both calories and proteins in <36 h.[16] However, the patients' profile was different from our study, since the mean age was 55.7 ± 17.4 years, which may have contributed to this higher percentage of adequacy. The authors also pointed out that the patients received enteral diet exclusively by closed system administered continuously by infusion pump, which allows a more rigorous control of the administration speed and less gastrointestinal complications.[16]

More similarly to our results, some studies[17-20] showed 50% of adequacy for caloric and 60% for protein in relation to calculated and prescribed diet. One possible explanation could be the number of days (median = 4 days) evaluated, since the caloric and protein intake increase in the course of time.[18] The same result was observed in the present research, which showed an increase of the percentage of adequacy over the days, reaching approximately 60% of adequacy on the 4th day [Figure 1].

Regarding the biochemical data, it can be observed that a large part of the results were outside the reference values (Table 3). This is already expected in critical patients due to their severe clinical condition,[8] which difficult to reach the caloric-protein requirement, since the tolerance to EN is decreased.

Analyzing the characteristics of the patients by the SGA, we observed that malnutrition was associated with lower weight and caloric-protein requirement. There was no difference in terms of calories, proteins, and volume prescribed and administered. However, there was a worse adequacy of calorie and protein in patients with severe malnutrition, which also presented lower concentrations of albumin ($P < 0.05$; Table 4).

In relation to hyperglycemia, critically ill patients present resistance to insulin, characterized by increased hepatic gluconeogenesis and glycogenolysis although the concentration of insulin is increased. Even using enteral formulas that are free of sucrose and specific for glycemic control, hyperglycemia is still present in these patients, and there are few alternatives in how to manage it.[13]

High concentrations of urea may be due to muscle proteolysis, since patients were not receiving sufficient amount of protein in the ENT. In addition, the anabolism-catabolism disequilibrium increases urea concentrations.[21]

Some evidence suggests that in critically ill patients, especially with inflammation and/or immobility, there is a higher protein requirement to: Favor the synthesis of specific proteins, help maintain the concentrations of certain amino acids - such as glutamine or arginine, modulate the immune function, and reduce insulin resistance and oxidative stress.[22]

In our study, the prevalence of sepsis among the patients was 19.1%, and the hemodynamic stability was maintained with vasoactive drugs in 47.0% of the patients, demonstrating the severity of the clinical cases. Hence, this high percentage of individuals with hemodynamic stability may have possible

Table 2: Nutritional requirements calculated, prescribed, and administered to patients in an ICU Cuiabá-MT, Brazil, 2016

Variables	Mean±SD		
	Nutritional requirements	Total amount prescribed	Total amount administered
Calorie (kcal)	1765.31±306.62	1214.96±528.73	596.56±612.77*
Protein (g)	91.96±21.51	66.18±30.52	32.90±34.10*
Volume (mL)	-	786.53±445.45	411.93±423.18*

ICU: Intensive care unit. Values presented in mean±SD. Student's *t* test, *P<0.05. SD: Standard deviation

Table 3: Biochemical analysis of patients with exclusive ENT Cuiabá-MT, Brazil, 2016

Variables	Mean±SD	Minimum value	Maximum value
CRP (mg/L)	130.90±117.40	2.33	509.96
Albumin (g/dL)	2.71±0.57	1.70	4.00
Blood glucose (mg/L)	178.48±86.95	78.00	590.00
Lactate (mg/L)	22.10±15.13	6.00	153.00
Urea (mg/dL)	82.12±54.52	10.00	264.00
Creatinine (mg/dL)	2.37±4.34	0.29	59.00

Values presented in mean±SD, minimum and maximum value, ENT: Enteral nutritional therapy, CRP: C-reactive protein, SD: Standard deviation

Table 4: Characterization of the patients using the GSA Cuiabá/MT, Brazil, 2016

Characteristics	Nutritional risk (*n*=60)	Moderate malnutrition (*n*=27)	Severe malnutrition (*n*=27)
Age (years)	65.1±17.2	70.2±13.8	68.9±17.5
Weight (kg)	77.5±13.3[a]	67.6±8.1[b]	53.3±10.9[c]
Calorie requirement (kcal)	1920.7±293.4 [a]	1705.4±161.1[b]	1475.7±331.1[c]
Protein requirement (g)	100.5±20.2[a]	90.2±17.5[a]	73.4±19.2[b]
Calories prescribed (kcal)	1010.1±388.4	942.25±441.9	834.5±327.5
Protein prescribed (g)	54.5±19.9	49.9±24.9	45.4±15.4
Volume prescribed (mL)	879.0±263.6	671.1±305.9	594.1±216.4
Volume administered (mL)	773.4±273.8	666.6±87.8	493.3±353.5
Caloric-protein adequacy (%)	87.9±6.3[a]	82.4±8.9[a]	64.9±5.6[b]
CRP (mg/L)	136.8±125.6	101.6±100.8	147.4±103.1
Albumin (g/dL)	2.9±0.7[a]	2.7±0.5[a]	2.5±0.5[b]
Blood glucose (mg/L)	180±88.9	167.5±63.0	181±93.6
Lactate (mg/L)	21.5±14.6	20.7±18.3	25.6±19.5
Urea (mg/dL)	81.5±58.8	86.7±48.9	79.7±52.6
Creatinine (mg/dL)	2.5±1.8	2.3±1.9	2.4±2.0

ANOVA. Different letters indicate statistically significant differences between groups ($P<0.05$) in Tukey's *post hoc* test, GSA: Global subjective assessment, CRP: C-reactive protein

Table 5: Characteristics of enteral nutrition formulas and volume wasted in an ICU. Cuiabá-MT, Brazil, 2016

Formula classification	Volume wasted (L)
Standard formulas	
No fibers	38.66
With fibers	20.17
Modified formulas	
For diabetics	13.95
For diarrhea	1.82
For hepatic insufficiency	0.17
For respiratory insufficiency	18.16
Total result	92.9

ICU: Intensive care unit

contributed to the low adequacy of calories in ENT.[23]

The ENT is the most common method for patients in ICU. However, the total dietary administration is influenced by hemodynamic instability and fasting for procedures. In addition, mechanical problems with nasoenteric feeding tube are also common such as inadequate positioning and tube obstruction and gastrointestinal complications such as diarrhea and vomiting. In addition, the patients' clinical condition such as acidosis, hyperglycemia, hypernatremia, hemodynamic instability, and high use of vasoactive amines may reduce the efficiency and the quality of ENT for critically ill.[23]

We detected the main intercurrences that impaired the total infusion of the diet as delay at feeding tube placement (42.5%), fasting (20%), loss of the tube (9.5%), gastrointestinal complications (8.5%), operational problems (8.5%), delay in step (4%), diet not released by the medical plan (4%), and open tube (3.5%). In our study, 91.4% of the patients did not receive EN in the first 24 h of hospitalization, since 41% presented clinical symptoms and 50.4% due to other problems.

A study showed as complications: Pause for diagnostic, therapeutic examinations and surgical procedures (14.9%) and gastrointestinal intercurrences (13%).[11] Another study found that interruptions for administration of medication by catheter and pauses for bath were present in 40.6% of the patients.[10] Researches verified that the most frequent intercurrence was fasting due to problems related to EN administration as pause in the infusion to examinations and clinical procedures and does not start the infusion in a correct time, delay to exchange the enteral diet among other factors.[18,24] A study pointed out that the infusion of the diet was interrupted due to fasting (75%) and loss of the tube (25.2%).[25] In relation to the fasting time for examinations and procedures, it can be reduced by adequate planning for the interruption and reintroduction of the enteral diets, evidencing the importance of the multiprofessional nutrition support team, follow-up of protocol for diet administration, and constant training for a better patient care.[10]

Diet waste assessment

Table 5 shows the amount of enteral diet wasted. At the hospital where the present study was conducted, it is a routine to the nutrition service to divide EN into four stages, which means that each patient will use four bottles per day. There was a waste of 92.9 L of diet due to non-infusion of prescribed enteral nutrition.

CONCLUSION

According to results observed in the present study, we concluded that malnutrition, delay at the feeding tube placement and fasting for clinical procedures contributed to low percentage of adequacy of EN, which increase the hospitalization costs due to wasted diet as well as the mortality risk in critical patients in an ICU.

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