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Evaluation of feeding interruption for enteral nutrition in intensive care unit patients

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ABSTRACT

Objective: Intensive care patients are at a high risk of malnutrition due to an oral intake failure. Enteral nutrition (EN) is considered to be the gold standard for such patients. However, even if everything is done properly, it is also known that there may be inconsistency between the calculated calorie requirements and the amount of calories given to the patient. There is no gold standard to minimize the EN interruption. The aim of this study was to determine the main factors involved in the EN cutting in an intensive care unit (ICU).

Methods: This study was done prospectively after an ethical approval and patient relatives' informed consent in 1489 study day of 80 ICU patients between September 2013 and September 2014 were obtained. The causes of the EN interruption were grouped under seven main categories (1. gastrointestinal dysfunction, 2. airway management, 3. tracheoesophageal fistula, 4. diagnostic and surgical reasons, 5. mechanical problems, 6. metabolic and hemodynamic instability, and 7. maintenance and position change). A total of 16 factors with subgroups were determined for analysis. Demographic data, the presence of dialysis, state of consciousness, comorbidities, and calculated calories and calorie intake were recorded. The patient's caloric needs were calculated on a daily basis using the Harris–Benedict formula.

Results: In our study, it was determined that 17.1% of the calories calculated as the EN support could not be applied to patients due to interruptions. The EN interruption factors were found to be the airway management (39.7%), mechanical problems (15.4%), metabolic and hemodynamic instability (14.1%), maintenance and position change (12.8%), and gastrointestinal dysfunction (12.8%).

Conclusion: The airway management and enteral feeding tube mechanical problems were the most frequently observed EN interruption factors. The awareness of EN interruption factors is important in preventing this problem.

Keywords: Enteral nutrition, intensive care, nutritional discontinuation

Introduction

A better understanding of the molecular and biological effects of nutrition over the last 30 years has contributed positively to the nutritional treatment of intensive care patients (1). In terms of nutrition, homeostasis refers to metabolic regulatory mechanisms that work to maintain the body's physiological function, energy, and other nutrient stores in a stable state (2). Therefore, nutritional support is considered as an important component of the management strategy of intensive care patients. However, although nutrition is very important, despite the current formulations used, most intensive care patients do not receive the targeted number of calories. Malnutrition causes an increase in nasocomial infections, prolonged hospitalization and intensive care hospitalization, and increased complications and increased rates of re-hospitalization in ICU (3-5).

In a recent review evaluating malnutrition rates in patients hospitalized in the ICU, they were ranging between 37.8% and 78.1% in heterogeneous intensive care patients (6). This ratio clearly shows that there are some uncontrolled factors related to the nutrition of the patients followed up in the ICU (7-9).

The difference between the calculated and given nutritional values has been described in different studies (7).

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Although various measures have been proposed to support the nutritional status of these patients, currently, a common guideline is not available. Updated guidelines provide some recommendations. However, the exact reasons for not reaching the desired calorie target cannot be clearly determined.

The aim of this study was to determine the causes of EN discontinuation in ICU patients, at what stage and with which factors the interruption occurred, and the difference between the calculated and given calorie amount.

Methods

This study was conducted prospectively between September 2013 and September 2014 at the Department of Anesthesiology and Reanimation, Pamukkale University, Medical Faculty Hospital, with the approval of the institutional ethics committee and consent of the patient's relatives. Eighty patients aged >18 years, with or without the mechanical ventilator support, were included into the study. Patients <18 years who were on the oral parenteral treatment, who were treated with total parenteral nutrition, and whose hospitalization was <3 days were excluded from the study.

To record the study data, a database form was created, and the forms of the discontinuation were grouped as the gastrointestinal dysfunction, airway management, tracheoesophageal fistula, diagnostic and surgical reasons, metabolic and hemodynamic disorders, and care and position changes (7, 10). Subgroups were added under these seven main headings to detail the reasons (Table 1). The patient ages, body mass index, gender, and diagnosis for hospitalization at the intensive care unit were recorded. The Acute Physiology and Chronic Health Assessment (APACHE) II score and Glasgow Coma Scale were used for the general status assessment, and the Nutritional Risk Assessment Scale (NRS) 2002 was used for the nutritional status assessment.

Nutrition was provided by the enteral route via the nasogastric tube or gastrostomy tube using readymade commercial products. During the study, products with immune nutrition such as fish oil, glutamine, arginine, etc. were not used. Caloric requirements of the patient were calculated daily using the Harris-Benedict formula.

Calculated and dispensed volumes of the nutrition products used during the study were recorded by calculating whether the nutrition was discontinued and the reason for discontinuation, duration, and rates of the discontinuation. The daily calories that could be applied were divided by the calculated calories, and the ratio was obtained. The non-given percentage was used. In addition, concomitant diseases, hemodialysis requirements, and consciousness status of the patients were also recorded. The patients were divided into three groups according to their discharge from the ICU, as those who were discharged, who returned to the service, and those who died.

Table 1. Factors leading to discontinuation of enteral nutrition

GIS dysfunction
Vomiting
Diarrhea
Abdominal distension
Excess residual amount
Airway Management
Intubation or extubation
Tracheal tube displacement
Opening of tracheostomy
TEF occurrence
Depending on Diagnostic and Surgical Procedures
Fiberoptic gastroscopy and gastrostomy opening
Transfer to the Radiology Department
Stopping pre-op feeding
Mechanical Problems
Feeding pump dysfunction/deficiency
Gastric tube occlusion and malposition
Catheter malposition/dysfunction
Metabolic and Hemodynamic Instability
MAP <40
Maintenance and change of position

GIS: gastrointestinal system; TEF: tracheoesophageal fistula; MAP: mean arterial pressure

Statistical analysis

The Statistical Program for Social Science version 11 (SPSS Inc.; Chicago, IL, USA) was used in the analysis of the data obtained. In the comparison of the averages, if there was no homogeneous distribution in the groups where the sample t-test was used, the Mann-Whitney U test was used. Sample t-test was used to evaluate the homogeneity of the groups. The one-way analysis of variance and Kruskall-Wallis test were used to compare more than two averages. The relation between two variables

Table 2. Descriptive characteristics of the patient population					
	Number	**Percentage (%)**	**Average**	**SD**	**Median**
Age			64.71	17.82	69
Gender					
Female	33	42.3			
Male	45	57.7			
Hospitalization diagnosis					
Shortness of breath	55	70.5			
Circulatory failure	12	15.4			
Neurological pneumonia	5	6.4			
Trauma	3	3.8			
Malignity	2	2.6			
	1	1.3			
Number of patient follow-up days			18.85	16.40	13
Body mass index			23.16	3.87	23
APACHE II Score			31.30	5.23	32
NRS 2002 Score			3.50	0.50	3.50
Dialysis					
Yes	16	20.5			
No	62	79.5			
Consciousness					
Closed	25	32.1			
Open	53	67.9			
Exit status					
Discharged	18	23.1			
Transfer to another service	18	23.1			
Exitus	42	53.8			

SD: standard deviation; APACHE: Acute Physiology and Chronic Health Evaluation; NRS: Nutrition Risk Assessment Scale

was examined using Pearson's and Spearman's correlation coefficients. Pearson's chi-squared test and Fisher's exact chi-squared test were used to analyze categorical data. The significance level was accepted as $p<0.05$.

Results

When the records of the 80 patients included in the study were examined, it was found that the calorie rates of 2 patients were very high. These 2 patients (a 77-year-old male, the non-given ratio: 100%; a 43-year-old male, the non-given ratio: 77%) were excluded from the study because of the possibility that the analyses would have affected the power and could be due to an error during registration. The data of the remaining 78 patients for 1471 days were used in the analyses. The average follow-up period was 18.85±16.40 days. There were 4 patients who were hospitalized for 60 days or more, which affected the distribution homogeneity. The median of the sequence was 13 days (Table 2).

The average age of patients was 64.71±17.82 (19-93); 25% were older than 78, and 25% were younger than 54. Of the patients followed, 33 were female, and 45 were

male. Descriptive characteristics of the patient population are presented in Table 2. It can be seen that the most common reason for hospitalization is respiratory failure. In our study, it was observed that only 82.9% of the calculated nutritional support could be given to patients. As a result, it was found that 17.1% of the targeted nutritional treatment could not be given to patients, and this rate ranged from 3% to 61%, varying from one patient to another.

One patient with tracheoesophageal fistula (TEF) and three patients who underwent diagnostic/surgical procedures were excluded from the study after being labeled as missing data (missing value) due to a low number. Reducing the number of groups in multiple group comparisons has a positive effect on statistical power. As a result, relational analyzes were performed in four groups of 74 patients due to interruption.

According to these variables, the most common cause of disruption in EN is airway management (39.7%) (Table 3). According to the results of the analysis, the factors causing interruption (gastrointestinal dysfunction, airway management, mechanical problems, metabolic and hemodynamic instability) differed in terms of inefficient calories and inefficient percentage, and thus were evaluated using the post-hoc Tukey and Mann-Whitney U tests. In conclusion, although the most common cause of the EN interruption was the airway management, it was observed that the highest amount of interruption was under the heading of "Metabolic and Hemodynamic Instability" (Table 4). In the subgroup of hemodynamic instability, the mean arterial pressure change (MAP<40) was the only variable constituting this subgroup (Tables 1 and 3).

Percentages of nutrition that could not be given were analyzed using the chi-squared test via the following percentage groups: <10%, 10%-19.9%, 20%-29.9%, and <30%. There was no significant difference in terms of age, gender, state of consciousness, and presence of hemodialysis in the groups with high percentage of nutrition could not be given. When the percentages that were not given were compared in terms of the ICU exit status, APACHE II, and NRS 2002 scores, there was no significant difference found between the groups ($p<0.05$). When the reasons for interruption and the percentages that could be given were compared, some significant differences were observed (Table 5). The reason for the interruption due to the maintenance and position change remained at 10% in most patients. Interestingly, 1 of the patients in this group was found to have a cut-off >30%. On the other hand, 45.5% of the patients in the metabolic and hemodynamic instability group had an interruption ≥30%. Among the reasons for the interruption were the gastrointestinal system dysfunction and within the mechanical problems groups, it was observed that the interruption was mostly <10%. The airway management was the most frequent cause of interruption, but in 54.8% of the patients in this group, the interruption was 10%-19.9%.

Table 3. Distribution of the factors that cause interruption of enteral nutrition in patients

	%	%
Gastrointestinal dysfunction		12.8
Vomiting	–	
Diarrhea	1.3	
Abdominal distension	2.6	
Excess residual amount	9	
Airline management		39.7
Intubation or extubation	28.2	
Tracheal tube displacement	–	
Opening of tracheostomy	11.5	
TEF occurance		1.3
Depending on diagnostic and surgical procedures		3.8
Fiberoptic gastroscopy and gastrostomy opening	–	
Transfer to the Radiology Department	1.3	
Stopping preoperative feeding	2.6	
Mechanical problems		15.4
Feeding pump dysfunction/deficiency	–	
Gastric tube occlusion and malposition	15.4	
Catheter malposition/dysfunction		14.1
Metabolic and hemodynamic instability		
Mean arterial pressure <40	14.1	
Maintenance and position change		12.8

TEF: tracheoesophageal fistula

Discussion

Critical patients are exposed to many adverse conditions in addition to their illness leading to intensive care. Malnutrition may rapidly develop in these patients, and it may adversely affect the healing of underlying diseases. Malnutrition has been reported to develop in up to 78% of ICU patients (6). Today, although various measures have

Table 4. Causes of interruption, calories cut, and non-given percent

	Patient (n)	Non-given calories Mean±SD	Non-given %	*Airway management (p) non-given %	*M/hemodynamic instability (p) non-given %
Gastrointestinal associated	10	3552±2436.45	16.8±12.38	0.560	0.051
Airwave management	31	3629.35±2777.51	17.29±8.19		0.013
Associated mechanical problems	12	3697.05±2647.93	19.33±12.8	0.841	0.118
Metabolic hemodynamic instability	11	4852.72±4200.75	28.45±15.41	0.013	

SD: standard deviation

Table 5. Correlation between interruption reasons and grouped interrupted amounts

	Grouped non-given percentages				
Reason for interruption	<10	10–19.99	20–29.99	30–100	Total
Maintenance and position change	9	0	0	1	10
	90.0%	0%	0%	10.0%	100.0%
Gastrointestinal dysfunction	4	3	1	2	10
	40.0%	30.0%	10.0%	20.0%	100.0%
Airwave management	6	17	4	4	31
	19.4%	54.8%	12.9%	12.9%	100.0%
Mechanical problems	5	3	1	3	12
	41.7%	25.0%	8.3%	25.0%	100.0%
Metabolic/hemodynamic	1	3	2	5	11
	9.1%	27.3%	18.2%	45.5%	100.0%
Total	25	26	8	15	74
	33.8%	35.1%	10.8%	20.3%	100.0%

been proposed to support the nutritional support of these patients, the reasons for not reaching the desired calorie target cannot be determined clearly. The variability of the difference between the calculated and given percentage is likely to be very causal, and ICU facilities, treatment options, and disease-related factors are effective (7-10).

In a study conducted by Heyland et al. (11), which was one of the first studies to determine the causes of the EN withdrawal in 1995 and examined 99 patients, it was found that 52% of patients could not tolerate enteral feeding, and the most common cause of interruption were gastrointestinal residual problems (11). In a study by Adam and Baston (12), 1929 daily data of 193 patients treated in five ICUs were examined, and it was found that only 76% of the targeted calorie amount could be given to patients. In a study by McClave et al. (13) evaluating 339 days of enteral nutrition in 44 patients, only 78.1% of the calories prescribed by the physician could be given to patients. In this study, the most common cause of interruption was also found to be a high gastric residual volume. In a more recent study from the Netherlands, the data of 55 hospitalized patients were evaluated, and it was observed that 87% (5-113) of the prescribed calories could be given (7). This study, different from ours, examines the methods of giving. While the amount that could be given by the pump was 85%, the amount given by gravity was 88%. In their study, Martin et al. shared the data of 152 patients and showed that 80% of the calorie value could be given. In this study, the most important cause of EN discontinuation was an inadequate hospital-based logistics (a delay between the EN prescribing and intake, including the preparation of enteral diets and delivery to the ICU ward) (14). As it can be seen, it is not possible to extract

data from the studies on this subject for definite reasons and their solutions. In addition to medical practices, many factors (logistics, personnel, etc.) that can sometimes be difficult to standardize, can also affect this process.

In our study, different from previous literature, we found that the airway management was the most common factor causing the discontinuation of EN in patients treated in the ICU (39.7%). As a subgroup, the intubation/extubation process was the factor that caused the highest amount of disruption. However, when we look at quality, we see that in 20% of our patients, the amount of interruption was less than 10%, and in 55%, it was between 10% and 20%. As a result, the airway management is a common cause of EN interruption, but when the interrupted amounts are evaluated, its negative impact on reaching the target calories is limited.

In our study, metabolic and hemodynamic causes led to a 14.1% nutrition interruption. Although it is in the third place, when we consider it as a quality, we see a different picture. Approximately, 45% of the metabolic and hemodynamic interruptions are in the group ≥30%. This ratio indicates the severity of the reason for interruption. In EN, non-obstructive mesenteric ischemia, which disrupts the function of the intestines, is a troublesome condition affecting the prognosis negatively, and its mortality is 80% (15). Elderly patients with cardiovascular disease, arrhythmia, and aortic insufficiency are at risk for mesenteric ischemia without bowel obstruction. Diabetes, smoking, and the presence of sepsis or a previous major infection increase the risk. Vasoconstriction-enhancing agents such as digoxin or alpha-adrenergic agonists applied in the ICU constitute a risk for ischemia (16). In general, all vasopressors may increase the risk of mesenteric ischemia without bowel obstruction, whether hemodynamically stable or unstable. Therefore, it is not easy to calculate the patient's risk for ischemia. Vasopressors applied to hypotensive patients carry more risk than normotensives (16). While some studies have stated that the presence of intestinal content is a predisposing factor for the development of mesenteric ischemia without intestinal obstruction (17, 18), there are studies that claim otherwise (19, 20). However, some authors recommend EN to be discontinued in the presence of a low mean arterial pressure (16, 17). The practical approach applied in our clinic is to stop EN when the mean arterial pressure falls below 40 mmHg.

In our study, the rate of interruption due to mechanical problems was 15.4%, and this was due to the occlusion and malposition of the gastric tube. When we look at the distribution within the group, the EN cut-off rate was 10% and below in 40% of the patients. This rate varies between 7.9% and 11% in the literature (12, 14). It is basically a factor that can be corrected by education and carries a moderate risk in terms of quality.

To mention some limitations regarding the method of the study, the study was planned to include patients receiving total parenteral nutrition therapy. However, since the number of patients fed with total parenteral nutrition was quite low (seven patients), it was not thought that it would be impossible to obtain a meaningful comparison, thus only data of the patients fed with EN were included into the study. In addition, the study was planned as a single-center study, reflecting the experience and data of our clinic. It is a small scale study. The small number of patients was one of the study limitations.

In our study, we found that 17.1% (3%-61%) of the calories calculated daily during the EN administration could not be applied to patients. While the most common reason for the EN interruption was the airway management, the amount of interruption was not very high. The patient care and position, which are relatively insignificant factors, become important risk factors when combined with other factors. In this regard, certain situations in which EN will not be interrupted can be determined, and the percentage lost at this stage can be reduced by education. However, necessary precautions should be taken with regard to the aspiration risk. The vasopressor use and mesenteric ischemia are both difficult to detect and take precaution. However, the most serious loss in our study is related to the application in this regard.

In our study, the airway management and enteral feeding tube mechanical problems were the most common EN cessation factors. It is expected that the findings of this study may contribute to the awareness of EN nutritional cessation factors and to prevent this problem in our practice.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Pamukkale University School of Medicine (04/2013).

Informed Consent: Written informed consent was obtained from patients' parents who participated in this study.

Peer-review: Externally peer-reviewed.

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