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Evaluation of Patient's Energy Intake between Different Types of Formulas in the First Week of Starting Enteral Feeding in Intensive Care Unit Patients

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Abstract

Background: Adequate energy intake is an important factor in intensive care unit (ICU) patients, and it can decrease the patients' complications, length of hospitalization, mortality and health care costs. Choosing an appropriate type of formula may be effective in providing the sufficient energy for these patients.

Objectives: This study aimed to assess the adequacy of energy intake, and to investigate the effect of different types of the formulas on the calorie intake and gastric residual volumes (GRV) in ICU patients in the first week of starting enteral feeding.

Methods: This prospective observational study was conducted on 128 ICU patients of two hospitals affiliated to Shiraz University of Medical Sciences, Shiraz, Iran. The patients were randomly assigned to one of the four groups of formulas including Ensure, Entrameal standard, Nutricomp standard and Enterameal high fiber formulas. Energy intake and GRV were recorded daily for 7 consecutive days from the beginning of enteral feeding.

Results: About 85% of the patients had traumatic brain injury. The average calculated energy requirement of the patients was 2293 kcal while the average energy intakes in seven days, and on the last day were 668 and 977 kcal, respectively. Only two patients (1.5%) received nearly all their energy requirement in the last day, however, only 5.5% and 35% of the subjects received ≥ 60% and ≥ 80% of their energy requirement, respectively. Enterameal high fiber formula was associated with a significant increase in GRV compared to Ensure formula ($p = 0.02$), but no significant relationship was found between calorie intake and gastrointestinal symptoms. No statistically significant difference was found in the energy intake between the four types of formulas.

Conclusion: It seems that enteral feeding in our ICUs is not successful in practice using the common available formulas. More attention should be paid to the incomplete delivery of the prescribed enteral nutrition in ICU patients.

Keywords: Energy intake, Enteral nutrition, Formula, Intensive care unit (ICU)

1. Background

Proper nutrition is an important component of treatment in hospitalized patients. Malnutrition leads to undesirable consequences including prolonged ventilation, increased length of hospitalization, increased risk of infections, increased health care costs and higher morbidity and mortality. Moreover, critically ill patients in ICU are more susceptible to these adverse consequences due to the hyper metabolic state of their bodies (1-5).

Enteral nutrition is commonly used for critically ill patients to meet the nutritional needs of them. But evidence has shown that only about half of these patients receive their estimated calorie requirement with the enteral feeding. Therefore, it is important to remove the barriers to enteral nutrition and increase calorie intake in the critically ill patients (6-9).

Receiving enteral nutrition has been recommended to be started as soon as possible due to reduced metabolic stress response, decreased bacterial infection and strengthening the intestinal mucosa. But in practice, not enough calories are delivered through enteral feeding and patients do not get the estimated calorie requirements (8,9). Underfeeding by the enteral nutrition seems to be a global common problem in critically ill patients. Failure to deliver adequate amounts of calories via enteral feeding may be caused by many factors including technical problems, slow advancement of infusion rate, gastrointestinal intolerance, intubation, clinical procedures and preparation for surgery (8,10,11).

Also several formulas are available today for enteral feeding, and it is difficult to choose the most appropriate one according to the specific diseases and conditions (12). For example, high-fiber formulas are useful to promote bowel movements, healthy gut microflora and to prevent constipation. In contrast, digestion and absorption of elemental and semi-elemental formulas are easier for the gastrointestinal tract of patients with malabsorptive complications. Standard formulas are made similar to a normal healthy diet to meet the general nutritional needs of the patients. So, choosing a more appropriate formula can be effective in improving dietary intake of patients (12,13).

Gastrointestinal intolerance can contribute to the failure of enteral feeding (9,14-16) and use of appropriate formula can affect the success of enteral feeding. So, in this study, we measured the caloric

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intake by four types of formulas, gastric residual volume, nausea, vomiting and bowel movement frequencies in ICU patients for a period of seven consecutive days after start of enteral feeding.

2. Methods

This prospective observational study was conducted from March to September 2012 in two hospitals affiliated to Shiraz University of Medical Sciences, Shiraz, Iran.

The main inclusion criteria were being older than 18 years, enteral feeding through nasogastric or orogastric tube by bolus method and patients who were more likely to be hospitalized for at least 7 days in ICU. Exclusion criteria included patients who required special formulas, such as diabetics, patients with liver or renal failures, those with immune suppression treatment, patients who have had surgery in the gastrointestinal tract, patients who have been transferred from the operating room to the ICU for further treatment, patients fed through a gastrostomy or jejunostomy, history of drug addicts and patients who their early death was likely due to the severity of their disease.

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Ethics Committee of Shiraz University of Medical Sciences. This study was registered in the Iranian Registry of Clinical Trial (registration ID: IRCT201112121566N4*)*. Written informed consent was obtained from each participant.

The participants through block randomization method, were placed into one of the following groups: Ensure formula (Ensure® Original Nutrition Powder, Abbott, Germany) (N=32), Entrameal standard formula, (Karen company, Iran) (N=32) Nutricomp standard formula (B. Braun Melsungen AG, Germany) (N=32) and Enterameal high fiber formula (Karen company, Iran) (N=32). Energy density of all the formulas was 1 kcal/ml (Figure 1).

Demographic data including age, sex, weight, age and also the patient's clinical information such as ICU diagnosis and underlying diseases were recorded. The energy requirement of the patients was calculated based on their ideal body weight by the Harris-Benedict equation and considering the stress factor (13). Registered dietitians planned the diet for all the participants in four groups to provide similar macronutrient distribution range (55% of calories from carbohydrate, 15% of calories from proteins and 30% of calories from fats); they also trained the nurses according to hospital guideline for enteral feeding and recorded the data.

According to hospital guideline for enteral feeding, Nasogastric feeding started at a rate of 50cc every 4 hours (all formulas) and if tolerated, the rate of feeding could be advanced by 50cc every 12 hours

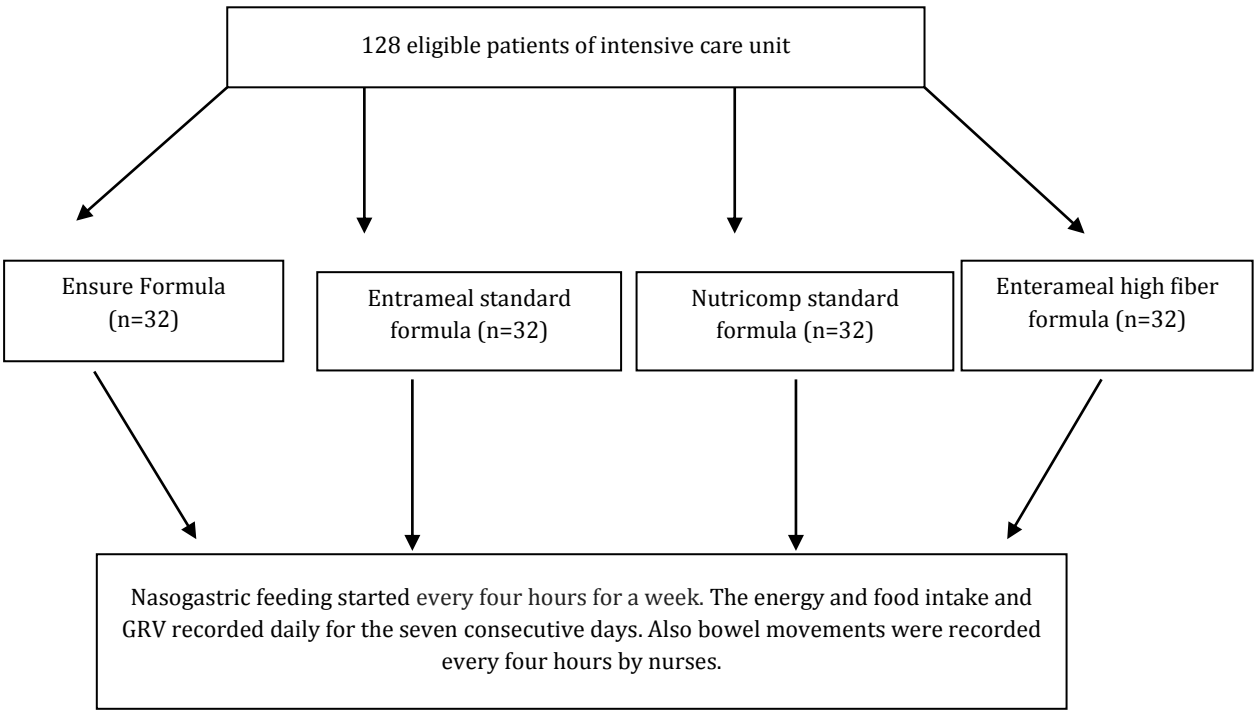

Figure 1. Study process flowchart

until the goal rate is met. GRV was checked every 4 hours and tube feeding was held for residuals greater than 250cc.

Patients were evaluated for a week from the beginning of nasogastric enteral feeding, and the energy and food intakes and GRV were recorded daily for 7 consecutive days; bowel movements were also recorded every 4 hours by nurse. At the end of the study, registered dietitians collected and analyzed the data (Figure 1).

Statistical Analysis

Statistical analyses were conducted using SPSS-16 software (version 16.0; SPSS, Inc., Chicago, IL). Continuous variables were expressed as means and standard deviations. The normal distribution of the variables was checked by Kolmogorov-Smirnov test. To compare continuous variables at the beginning of the study and mean changes of these variables during the intervention between the three groups, one-way analysis of variance (ANOVA) or its non-parametric equivalent Kruskal-Wallis was used. Bonferroni's multiple comparison was used to make comparison only if the intervention was significant. Paired t-test was used to compare the alterations in continuous variables within each group before and after the intervention. A level of $p<0.05$ was considered significant for all tests.

3. Results

Of the 128 patients entered to the study, one patient was excluded due to non-completion of the seven consecutive days and 21 women and 106 men were enrolled in this study (table 1).

Patients on average received about %42 of their estimated calorie requirements on the last day (table 2). The parenteral nutrition was not used to help get the nutritional needs of the patients, and just 1.5% of patients (n=2) reported receiving small amount of nutrients intravenously.

About 25% of the patients used Ensure formula (n=32), 25% used Entrameal standard (n=32), 26% used Entrameal high fiber formula (n=32) and 25 % used Nutricomp standard formula (n=32).

There was no statistically significant difference in calories between 4 types of formula.

No statistically significant difference was observed between different formulas in terms of nausea and vomiting, abdominal distension and bowel movements. The number of interruption days of enteral feeding was significantly higher in high fiber formula in compare to ensure formula (p = 0.0 20). Also GRV frequencies were significantly higher in high-fiber formula than ensure formula (p = 0.027) (table 3).

About 31% of men and 52% of women received sixty percent and more of their estimated calorie requirement on day 7, that the difference between them was not statistically significant (p=0.063).

About 92% of people had a bowel movement for 3 days or less. 45% of the patients had a bowel movement for 1 day or less. About 96% of the patients did not have symptoms of nausea and vomiting and 98.4% of them did not have abdominal distension. About 89% of the patients did not have

Table 1. General characteristics of the subjects

Variable	Amount
% Women (n)	16.4% (21)
% Men (n)	83.6 % (107)
Age (year)	30 (24 - 45)
Weight (kg)	75 (70 - 80)
Height (cm)	175 (170 -180)
% Brain trauma (n)	84% (108)
% Sepsis (n)	1.5% (2)
% Internal bleeding (n)	3.9% (5)
% Cancer (n)	1.5% (2)
% Cord injury (n)	3.9% (5)
% Respiratory arrest (n)	0.8% (1)
% Fracture (n)	3.1% (4)
% HTN (n)	1.5% (2)
% History of CVA	1.5% (2)

Values are expressed as median (Q1-Q3) and percentage (number).

Table 2. Calorie intake of the patients

Variable	Amount
Estimated calorie requirement (ECR)	2293 ± 361
Average calorie intake	668 ± 333
Final calorie intake (mean)	977 ± 606
Final calorie intake/ECR	42.3 % ± 28.4
Final calorie intake ≥ 80% ECR	7 (5.4%)
Final calorie intake ≥ 60% ECR	43(36%)

Values are expressed as mean ± SD and number (percentage).

Table 3. Interruption of feeding and GRV between the four types of formulas

Variable	Formula types	Four categories of days			
		1 (0-1 days)	2 (2-3 days)	3 (4-5 days)	4 (6-7 days)
% Interruption of feeding	Ensure	56.7%	13.3%	16.7%	3.3%
	Entera meal standard	40.6%	34.4%	18.8%	6.2%
	Entra meal high fiber	24.2%	36.4%	24.2%	15.2%
	Nutricomp standard	43.8%	34.4%	15.6%	6.2%
% GRV	Ensure	100%	-	-	-
	Entera meal standard	90.6%	6.2%	3.1%	-
	Entra meal high fiber	75.8%	15.2%	9.1%	-
	Nutricomp standard	90.6%	6.2%	3.1%	

significant GRV. There were no statistically significant differences for bowel movements, GRV and the gastrointestinal symptoms between the formulas ($p>0.05$).

4. Discussion

The results of this study showed that enteral feeding is not successful in practice with the common available formulas in ICU patients in two hospitals affiliated to Shiraz University of Medical Sciences, Shiraz, Iran. It seems that there is a need to find more executive solutions to improve the nutritional intake of critically ill patients in the intensive care units.

As far as we know no previous study investigated the success of enteral feeding in ICU patients of hospitals in Iran. Also no previous study compared the caloric intake between different available formulas.

Previous studies on critically ill patients have shown that delivery of administered enteral feeding to patients has been unsuccessful (9). O'Meara et al. in their study on 59 ICU patients reported that patients received only about 50 percent of prescribed calorie (an average of 1106 kcal) by enteral feeding. So, their results are similar to us, as the patients in our study received about 42% of their energy needs (an average 977 Kcal) in the 7th day of enteral feeding. The advantage of their study was more accurate assessment on interruptions of the enteral feeding, while our study was conducted on more patients and compared four common types of formulas (10).

Kim et al. in their study on 34 critically ill patients, reported that energy intake of the patients was significantly less than their requirement during the first 4 days of initiation of enteral nutrition (17). They reported that the most common reason for interruptions of enteral nutrition was gastrointestinal intolerance, whereas in our study there was no significant relationship between symptoms of gastrointestinal intolerance and interruptions.

Kim et al. in their study on 47 neurosurgical ICU patients, during 7 days, reported that about 76% of the patients were receiving their estimated energy requirement by enteral feeding (18). So, calorie intake in our study was worse than them (43% vs. 76%). In another study by Kim et al. on 34 ICU patients, it was reported that about 62% of Korean patients did not receive enough energy, that this result is very similar to the result of our study (62% vs. 57%) (19).

While enteral nutrition was not successful in delivering the calorie requirements of critically ill patients in our study, parenteral nutrition was not used by the medical team to help get the nutrients requirements of the patients. Heidegger et al. suggested that as long as the patients become able to get all the calories through enteral feeding, parenteral nutrition can be combined with the enteral nutrition. Some evidence indicates that enteral nutrition does not meet the needs of the patients alone and also the meta-analysis of studies showed that parenteral nutrition is not associated with increased mortality in ICU patients (20,21).

The results of our study showed that high-fiber formula is not a good choice for critically ill patients and increase the chances of gastrointestinal intolerance and interruptions of enteral feeding. Some previous studies have suggested that high-fiber formula is not an appropriate option for critically ill patients. Adequate fluid intake is required along with high-fiber formula, and in addition, some cases of bowel obstruction associated with high-fiber formula, are reported in patients with trauma or burn in previous studies (12,22). Therefore, high-fiber formula probably is not a good choice for critically ill patients.

The main limitation of this study was that we did not record all possible factors that could cause the failure of enteral nutrition. Moreover, due to the nature of powder formula and liquid formula, it was not possible to blind the study. We suggested further evaluation on the barriers of successful enteral feeding and ways to overcome them in future studies. It is also recommended to develop a practical protocol that can provide the nutritional needs of critically ill patients in practice.

5. Conclusion

The results showed that the enteral feeding in ICU was not successful in practice with the common available formulas. It seems that enteral tube feeding with the existing formulas could not

provide the nutritional requirements of ICU patients. Therefore, use of parenteral nutrition in addition to enteral feeding is recommended for these patients.

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Authors' contributions

All authors were involved in the concept and design of the study. The authors' responsibilities were as follows: F.Z. supervised the study and edited the final manuscript. F.E. contributed to conducting the study, collecting the data and writing the article. I.N. contributed to collecting the data and writing the article. G.S. contributed to conducting the study and providing advice. M.M contributed to conducting the study and providing advice. Z.M. contributed to collecting the data. LA and contributed to collecting the data. S.N contributed to collecting the data. On behalf of all authors, the corresponding author states that there is no conflict of interest. All the authors have approved the final article.

Conflicts of interest

The authors have no financial interests or potential conflicts of interest.

Footnote

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