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Enteral Feeding of Critical Patients in Juan A Fernandez Hospital in Buenos Aires, Argentina. Does it Lead to Protein Deficit and Caloric Excess?

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ABSTRACT

Introduction: The critical patient is characterised by an alteration in the function of one or several organs or systems, a situation that may compromise his survival. The purpose of the present study was to deduce if patients who were fed by Enteral Nutrition (NE) in the Intensive Care Unit (ICU) had a protein deficit combined with caloric overfeeding. **Methods:** This cross-sectional study was undertaken between August 2013 and April 2014 in the ICU, Hospital General deAgudos "Juan A. Fernández", Buenos Aires, Argentina. The energy and protein prescriptions were obtained from medical indications. For the estimation of energy, the recommendations of the American Society of Parenteral and Enteral Nutrition (ASPEN) of less than 20-25 kcal/kg/day during the acute phase were taken into account. T-test and Mann-Whitney U test for comparison of groups was calculated with significance at p <0.05**. Results**: This study had a sample of 52 patients.The average daily energy requirements, calculated from the third day of ICU admission, was 1637 kcal (SD +/- 385, CI 95% 1529.8/1744.1), while the mean daily energy delivered was 1726 Kcal (DE +/- 365, IC95% 1624.4/1827.6). All patients had negative Accumulated Protein Balance (APB). **Conclusion**: The majority of the patients presented with energy over-prescription and protein deficit. Energy overfeeding could lead to an increase in hospital stay, which would further increase health costs

Key words: Critical care, enteral feeding, prescription

INTRODUCTION

The critical patient is characterised by an alteration in the function of one or more organs or systems, a situation that may compromise his survival (Domínguez Perera, 2003)

Nutritional support in the form of enteral nutrition (EN) should be indicated to a critically ill patient who is unable to sustain voluntary food intake but preserves acceptable digestive tract functions (McClave *et al.,* 2009b; Singer, 2013).

First, a caloric/protein target must be defined to determine the feeding method, the time for the start of the diet, and the most appropriate formula. The guidelines of the American Society for Parenteral and Enteral Nutrition (ASPEN) (McClave *et al.,* 2009a) recommend that enteral nutrition should be initiated within 24 – 48 h of admission and progress towards the nutritional goal in the subsequent 48 -72 h.

Malnutrition is a recognised problem in all hospitalised patients, due to alteration in

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the metabolism of the different substrates and nutrient deficit (Acuña *et al.,* 2003)

As there is a correlation between nutritional status and the severity of the disease, it makes the assessment of nutritional status at admission essential so as to implement the most appropriate nutritional support (Montejo González *et al.,* 2006).

As a first step, nutritional screening should be done, which will serve to identify malnourished patients or those at risk of malnutrition. ASPEN recommends Subjective Global Assessment (SGA) to perform the nutritional screening. For an objective evaluation of the nutritional status of the critical patient, unconventional methods are used with their implementation being very often complex (Detsky *et al*., 1987; Acosta Escribano *et al.,* 2005).

The critical patient is especially susceptible to malnutrition due to the hyper metabolic situation leading to a change in the nutritional requirements, which are often not covered by the enteral formulas. The study of nutritional intake is essential in this type of patients in order to know how their energy-nutritional needs are covered.

The purpose of the present study is to discover if patients who are fed by enteral nutrition in the Intensive Care Unit (ICU) have a protein deficit combined with caloric overfeeding due to a difference between prescription and estimated requirements. At the same time, the study also aimed to evaluate the financial impact of such analysis.

METHODS

Descriptive, observational, cross-sectional and a prospective study was performed between August 2013 and April 2014 at the ICU of the Hospital General de Agudos "Juan A. Fernandez", Buenos Aires, Argentina.

Inclusion criteria were: all admitted patients to the Intensive Care Unit with indication of exclusive enteral feeding that was initiated within the first two days and continued at least for eight days. Sample was obtained by convenience. The exclusion criteria were: patients under 18 years; pregnant; suspension of enteral feeding during the first 10 days of hospitalisation; implementation of other complementary feeding methods during the first 10 days of hospitalisation; ICU discharge and changes in respiratory condition (extubation or intubation) during the first 10 days of hospitalisation.

Each participant or relative was previously informed of the study and written consent was requested for inclusion. The study protocol was approved by the Hospital Ethics Committee.

Energy prescriptions were obtained from medical indications. For the estimation of energy, ASPEN 2009 recommendations were taken into account. (McClave *et al.,* 2009a). Protein prescription was obtained from medical indications as well, and for the protein estimation administration, the same recommendations were taken into account.

For obese patients, the caloric and protein requirements were obtained following ASPEN 2009 guidelines (McClave *et al.,* 2009a)

For the determination of nutritional status, the Subjective Global Assessment (SGA) was used. It classifies individuals into three categories: A - Well Nourished; B -Moderately malnourished or suspected of malnutrition; and C - Severely malnourished (Detsky *et al*., 1987).

The actual body weight referred by the patient or family member was used. In the absence of any body weight data, blinded measurements were estimated by the attendant physician, a nutritionist and a nurse. The average of these measurements was used (Actual Weight). The Ideal Weight was estimated according to the

Hamwi formula (1964), based on size and a reference weight for that size (Campbell, Zander & Thorland, 2010). In obese patients, ideal weight was used. Attending physicians were in charge of the nutrition care.

Body mass index (BMI) was obtained from the actual weight and height. It allowed for dividing the sample into obese patients (BMI>30) and non-obese patients (BMI<30). All variables were measured on the third day of hospitalisation. Ideal weight was used for the energy and protein requirements. Since ASPEN guidelines were followed, there was no range for energy and protein prescription.

A polymeric formula was used (Nutrison 1.0, NutriciaBagó, Buenos Aires, Argentina). It delivers 1 Kcal/ ml and 40g protein/1000ml (ARS$ 150 x 1000 c.c.; USD 22) When necessary, a protein supplementation was added. (Secalbum, NutriciaBagó, Buenos Aires, Argentina) (ARS$ 300 x 250g.; USD42 x 250g.). Administration was made through a small-bore nasogastric feeding tube in all samples.

Cumulative Energy Balance (CEB) was calculated from the difference between the energy prescription and the energy requirement of each patient, after 7 consecutive days with exclusive EN. This was divided into CEB positive when the energy prescription was higher than the estimate; CEB negative when it was lower ;and CEB neutral if energy prescription and the energy requirement were equal.

Accumulated Protein Balance (APB) was calculated from the difference between the protein prescription and the protein requirement of each patient after 7 consecutive days with exclusive NE. The same was divided into APB positive, negative and neutral.

For estimating the financial implications of the enteral feeding practice, the Effective Energy Cost (EEC) was obtained from the difference between the Real Energy Cost (REC) and the Theoretical Cost of Energy (TCE). The Real Energy Cost is the sum of the energy requirement prescription (Kcal) of 7 days x cost per kilocalorie (ARS$)(USD) and the Theoretical Energy Cost is the sum of the energy estimate (Kcal) of 7 days x cost per Kilocalorie (ARS$) (USD). The Effective Energy Cost was divided into EEC in excess, in default and neutral. The Effective Protein Cost (EPC) was obtained from the difference between the Real Protein Cost and the Theoretical Protein Cost. Real Protein Cost is the sum of the protein prescription (g) in 7 days x cost per gram of protein (ARS$) (USD) and the Theoretical Cost of protein is the sum of the protein estimate (g) in 7 days x cost per gram of Protein (ARS$)(USD).

The data were analyzed using the statistical package VCCstatVBeta 2.0.(ConSumaCiencia, Buenos Aires, Argentina). For different variables, SD, median, and t-test and Mann-Whitney U test for comparison of groups were calculated with significance at $p < 0.05$.

RESULTS

A total of 52 patients were included in the study. The average age was 59 years (+/-19-92), with 65.4% being men. Table 1 shows the distribution of the sample according to admission diagnosis, while Table 2 shows the nutritional status of the patients according to SGA and BMI.

The average daily energy requirement of the patients was 1637 kcal (SD +/- 385,CI 95% 1529.8/1744.1), while the average daily energy delivered was 1726 kcal (SD +/- 365, CI 95% 1624.4/1827.6)($p<0.05$). Out of the total patients, only 14 patients (10 non-obese and 4 obese patients) received protein supplementation The average daily protein requirement calculated was 113g (SD +/- 27, 95% CI 104.8/119.2), while the average daily protein amount delivered was 75g (SD + -21, CI95% 69.1 / 80.8) ($p< 0.05$).

Table 1. Distribution of patients according to admission diagnosis

Reason for admission	*N°*	*%*
Clinical	37	71,2%
Trauma	7	13,5%
Neurologyc	6	11,5%
Gastrointestinal Sugery	2	3,8%
Total	52	100%

Table 2. Nutritional status of patients according to Subjective Global Assessment (SGA) and Body Mass Index (BMI)

Nutritional status according SGA	*N°*	*%*
Well nourished	30	57.7
Moderate malnourished	15	28.8
Severe malnourished	7	13.5
BMI		%
BMI <30 Kg/m^2	35	67.3
BMI ≥30 Kg/m^2	17	32.7
Total	52	100

The average of Cumulative Energy Balance (CEB) of the total sample was +1225 Kcal (75/2064). The median CEB of obese patients was significantly higher than that found in non-obese patients (+2690 Kcal vs.+350 Kcal ($p < 0.05$)).

The average Accumulated Protein Balance (APB) of the entire sample under study was -254.8g (-307/-191). Obese patients maintained the same trend as the average CEB, surpassing that found in non-obese patients. All patients (n=52) presented negative APB, meaning the protein requirement in 100% of the sample was lower than the required. This was found for both obese and non-obese patients.

The average Effective Energy Cost (EEC) was ARS$ +36.2 (6.1USD) (95% CI 9.2/58.8). This is the economic cost "of more" energy in each critical patient in a week of hospitalisation in the ICU.

The average Effective Protein Cost (EPC) was ARS$ -160.3 (10.14USD)(95% CI -200.4/-116.9). This is the cost of "less" protein in each critical patient in one week of hospitalisation in the ICU.

DISCUSSION

The hospitalised patients' nutritional requirements must be adequate to the clinical condition, the evolution of the disease and the digestive tolerance (Singer *et al.,* 2014). The energy requirement can be calculated or measured by indirect calorimetry. Boullata *et al.*(2007) conclude that only indirect calorimetry can provide an accurate assessment of energy needs. However, the Canadian Guidelines for Clinical Practice report that there is insufficient data to make a recommendation on its use compared to predictive equations (Dhaliwal *et al.,* 2014) and although indirect calorimetry is considered the gold standard for evaluating the energy expenditure at rest in intensive care, many limitations hinder its use (Singer, 2013). Heyland, Cahill & Day (2011) showed that only 0.8% of ICUs used indirect calorimetry.

In terms of energy supply, the ESPEN guidelines suggest that during the acute phase of critical illness, a contribution greater than 20-25 Kcal/kg/day may be associated with poorer results. During the recovery phase, the goal is to provide 25-30 Kcal/kg/day. For its part, the Spanish Society of Parenteral and Enteral Nutrition (SENPE), recommends providing an amount of 25 Kcal/kg/day (Bonet Saris *et al.*, 2011)

The methods for accurately determining protein requirements are not currently available. ASPEN guidelines have suggested a protein intake in the range of 1.3 to 2g/kg/day. The SENPE guidelines indicate that protein supply in an amount of 1.5g/kg/day decreases protein catabolism by 70%. In this regard, ESPEN has defined an intake of 1.3-1.5g/kg/day as the ideal level in critically ill patients. Evidence suggests that meeting the protein requirement may be more transcendent than reaching the energy target to maintain nitrogen balance (Pitkänen *et al.*, 1991). However, most patients received no more than 0.8-1.0g/kg/day according to different studies (Singer & Cohen, 2013).

Standard enteral formulas provide an inadequately high caloric-protein ratio, leading to energy over-administration without meeting the protein requirement. Patients do not achieve their nutritional goal during hospital stay (Van den Broek *et al*., 2009). The majority of critically ill patients received less than half the recommended amount of protein during their stay at the ICU (Hoffer & Bistrian, 2012).

Conversely, several studies have shown that energy supply above the needs correlates with an increase in the rate of complications. Papirov *et al.* (2011) showed, in a prospective study, that 188 patients received energy amounting to 20% above their needs according to indirect calorimetry. McClave *et al.* (1998) reported that the majority of patients (58.2%) were overfed, receiving>110% of the required calories, and only 12.2% were malnourished, receiving more than 90% of the needs. This study showed that the reduction in excess volume of the administered enteral formula would have resulted in savings of up to USD1.3 million dollars per year.

On the other hand, it has been shown that nutritional support resulting in an energy deficit is also associated with an increase in morbidity and mortality. Singh *et al.* (2009) showed an increase in mortality in patients admitted to the ICU who received a daily calorie intake of less than 50% of the recommended value. Another study found 69% of hospitalised patients received deficient calories and that 90% of them had protein deficiency throughout the ICU stay (Dey, Bhattarcharyya & Todi, 2011). Allingstrup *et al.* (2012) reported that patients who received more protein had a lower mortality than those who received standard values. Another report observed that establishing and achieving energy and protein targets is associated with a 50% decrease in mortality at 28 days, compared to those patients who did not achieve that goal (Weijs *et al.*, 2012).

With regard to obese patients, the first objective of nutritional support should be to minimise the loss of lean mass since they present difficulties in mobilising or using fat as a source of energy during the critical period of the disease, resulting in increased protein oxidation and greater degradation of daily muscle mass, justifying the necessity of hyper-protein feeding (Mesejo *et al.*, 2011; Mesejo *et al.*, 2010; Dickerson *et al.*, 2002).

The present study showed that the highest percentage of these patients presented energy over-prescription and a protein sub-prescription compared to the requirements estimated by international societies. Although a wide variability was observed in the accumulated energy balances, more than 65% of the patients analysed had energy over-prescription during the first 7 days of hospitalisation in the ICU. This implies that a discrepancy between what was prescribed and what was required, showing that the weekly excess in the energy prescription was close to 1225 kcal. These results differ from two studies, which showed a combination of a lower energy requirement than required and an inadequate supply of what was prescribed (Yeh *et al*., 2016). There was also a deficit in the protein prescription in critical patients, with a weekly debt of 254.8g of protein/patient. This data correlates with the results in a review (Hoffer & Bistrian, 2013).

It should be noted that the comparison of the data obtained with other studies performed in this field is complex because of the different study design questions, since most of them focused on the required enteral feeding volumes administered instead of the prescribed values. Several observational studies have described an association between inadequate diet and poor clinical outcome in critically ill patients (Petros & Engelmann, 2006;Villet *et al.,* 2005).

Different studies have emphasised the importance of reaching the protein target in critically ill patients, since the protein deficit is directly correlated with the increased risk of mortality in the ICU (De Jonghe *et al*., 2001; Arabi *et al.,* 2015).

With respect to the financial impact analysis, this study showed that inadequate caloric intake due to overfeeding had an impact on costs, resulting in the actual energy cost being higher than the energy cost the patient requires, spending "more" per critical patient in a hospital stay of about $35. Although it does not seem excessive on a weekly basis, extrapolating it annually would yield a high economic impact. Energy overfeeding could lead to an increase in hospital stay, which would further increase health costs. The protein cost in enteral nutrition was lower than the protein cost the patient required, spending "less" per critical patient in a hospitalisation week, $160.3 (USD10.14). It is important to clarify that, for the calculation of the required costs, the prescribed formulas that were used, mostly standard, have lower amounts of protein according to the patient needs, leading to a high cost to cover the requirement.

It is of concern that few patients received protein supplementation. Standard formulas contain less than 18% of the Total Caloric Value (VCT) provided by protein. Protein supplementation through protein modules seems to be the best way not only to optimise the delivery but also as a strategy to rationalise available resources. This way, the excess energy cost would be reduced by reducing the volumes of standard formulas. Although the protein modules present a higher cost than these formulas, they would be more efficient, being able to obtain a better cost/benefit rate.

One of the limitations of this research was the estimation of the caloric requirements using predictive equations instead of indirect calorimetry. Likewise, the estimation of patient weight could not be properly evaluated because we do not have precise tools for anthropometric evaluation. At the same time, the causes of inadequate calorie/protein prescription may be due to the fact that standard formula was indicated, which would not achieve optimal nutrition in critically ill patients. Finally, it is worth noting the small sample size, which diminishes its representation.

There should be better consultation among the nutritionists in the ICU and the attending physicians on enteral feeding and compliance with guidelines.

CONCLUSION

The majority of patients analysed presented energetic over-prescription and protein under prescription. Although the causes were not analysed, this could be due to most medical prescriptions using indicated standard formulas, which would not lead to optimal nutrition for critically ill patients. An interdisciplinary team is necessary to achieve better enteral feeding results.

Conflict of interest

We declare that we do not have any conflict of interest.

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