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Relation of micronutrients with antioxidant properties in patients with chronic diseases and exclusive enteral nutrition

Relación de micronutrientes con propiedades antioxidantes en pacientes con enfermedades crónicas y con nutrición enteral exclusiva

Danielly O. Stefenon¹. <https://orcid.org/0000-0002-7231-2949>

Anieli Golin². <https://orcid.org/0000-0003-4144-9659>

Mairin Schott². <https://orcid.org/0000-0002-4248-5240>

Bruna P. Alves². <https://orcid.org/0000-0002-0249-4919>

Cristina Dalmolin². <https://orcid.org/0000-0002-9639-6331>

Juliana E. Brondani³. <https://orcid.org/0000-0001-5478-6633>

Milena C. Cassol³. <https://orcid.org/0000-0001-9854-7415>

Andréa R. Marques³. <https://orcid.org/0000-0003-0626-9732>

Elisângela Colpo^{2*}. <https://orcid.org/0000-0002-3886-0765>

1. Graduate program in nutrition, Federal University of Santa Catarina (UFSC), Florianópolis, Santa Catarina, Brazil;

2. Nutrition department, Franciscan University (UFN), Santa Maria, Rio Grande do Sul, Brazil;

3. University Hospital of Santa Maria (HUSM), Santa Maria, Rio Grande do Sul, Brazil.

*Corresponding author: Elisângela Colpo,

Universidade Franciscana (UFN), Santa Maria (RS), Rua Silva Jardim, 1175.

Código postal: 97010-491, Brazil.

Email: elicolpo@yahoo.com.br

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ABSTRACT

Objective: To evaluate the intake of micronutrients with antioxidant properties through exclusive enteral nutrition therapy (ENT) in hospitalized patients with chronic diseases compared to the estimated average requirement (EAR). **Methods:** This prospective, longitudinal, descriptive, observational study was performed in a public hospital, with adult and elderly patients. The adequacy of the volume of ENT prescribed and offered was considered satisfactory when >80%. The adequacy of micronutrients with antioxidant properties was performed according to the estimated average need (EAR). Data were considered statistically significant when $p < 0.05$. **Results:** Of the 53 included patients, 58.5% were male. Most of patients (45.3%) were in the neurology clinic, and the main cause was cerebral vascular accident (18.9%). The volume administered was less than the prescribed volume of ENT in both male and female patients. However, recommendations for micronutrients with antioxidant properties, such as vitamin A, vitamin C, vitamin E, zinc, selenium, copper and iron, are according to EAR and did not exceed the tolerable intake limit (upper limit, UL), ($p < 0.05$). The present study shows a very large variability in the concentration of micronutrients in each enteral diet. It is necessary to consider the pathologies that affect the patient, as some health conditions may be able to require specific amounts of micronutrients. **Conclusions:** Patients received a lower volume of enteral nutrition therapy compared to the prescribed volume. The micronutrient concentrations were consistent with daily EAR recommendations and did not exceed the tolerable intake limit (UL) for healthy individuals.

Keywords: Antioxidants; Enteral nutrition; Humans; Minerals; Vitamins.

RESUMEN

Objetivo: Evaluar la ingesta de micronutrientes con propiedades antioxidantes a través de la terapia de nutrición enteral exclusiva (ENT) en pacientes hospitalizados con enfermedades crónicas en comparación con el requerimiento promedio estimado (RPE). **Métodos:** Prospectivo, longitudinal, descriptivo y de observación, se realizó en un hospital público con pacientes adultos y ancianos. La adecuación del volumen de ENT prescrito y ofrecido se consideró satisfactoria cuando fue >80%. La adecuación de micronutrientes con propiedades antioxidantes se realizó de acuerdo con la RPE. Se consideraron estadísticamente significativos $p < 0,05$. **Resultados:** De los 53 pacientes incluidos, 58,5% eran hombres. La mayoría de los pacientes (45,3%) se encontraban en la consulta de neurología y la principal causa fue el accidente vascular cerebral (18,9%). El volumen administrado fue menor que el volumen prescrito de ENT tanto en pacientes masculinos como femeninos. Sin embargo, las recomendaciones de micronutrientes con propiedades antioxidantes, como vitamina A, vitamina C, vitamina E, zinc, selenio, cobre y hierro, están de acuerdo con la RPE y no superan el límite de ingesta tolerable (UL), ($p < 0,05$). El presente estudio muestra una variabilidad muy grande en la concentración de micronutrientes en cada dieta enteral. Es necesario considerar las patologías que afectan al paciente, ya que algunas condiciones de salud pueden requerir cantidades específicas de micronutrientes. **Conclusiones:** Los pacientes recibieron un volumen menor de ENT en comparación con el volumen prescrito. Las concentraciones de micronutrientes fueron consistentes con las recomendaciones diarias de la RPE y no excedieron el límite de ingesta tolerable (UL) para individuos sanos.

Palabras clave: Antioxidantes; Humanos; Minerales; Terapia de nutrición enteral; Vitaminas.

INTRODUCTION

Hospitalized patients may develop, from the general clinical perspective, metabolic stress, triggered by an inflammatory cascade that involves neuro-immuno-endocrine changes. These changes can intensify the inflammatory process, causing the development of unfavorable consequences including the exacerbation of pre-existing chronic diseases. Among chronic diseases, those that most commonly appear in hospital admissions are stroke, diabetes mellitus, systemic arterial hypertension and chronic obstructive pulmonary disease. Among the unfavorable consequences of the exacerbation of chronic diseases, we can mention changes in the nutritional status of hospitalized patients^{1,2}. This is because diseases generate a catabolic state, whereby body expenditure is higher than intake, which induces changes in the patient's body composition (decrease in fat-free mass) and cell mass, leading to decreased physical and mental function^{3,4}. With the aim to reduce hypercatabolism, the use of enteral nutrition therapy (ENT) is recommended⁵.

ENT occurs through the administration of enteral formulas via an enteral catheter in patients with a functioning gastrointestinal tract with different levels of tolerance (none, half or complete) to oral feeding as the only route of consumption, with the aim to meet the nutritional requirements of the patient. Thus, ENT has a strong and economically viable physiological foundation⁶. It is a therapeutic alternative that enables the maintenance of nutritional status⁵. Enteral feeding has been used in patients with partial or total inability to maintain the oral route for feeding and should be used whenever the gastrointestinal tract is functioning⁷, as well as being the preferred method to improve the nutritional status of critically ill patients⁸. The advantages of ENT include enhancement of intestinal mucosal integrity, absorption of nutrients, enhancement of metabolism and immune response, and reduction of hospital costs and possible complications.

ENT formulas are composed of macro- and micronutrients,

the quantities of which are dependent on the type of diet and their indication. These nutrients, when in adequate quantity and quality, can significantly contribute to the maintenance and/or rehabilitation of the patient's global state. Micronutrients are organic compounds that are essential for cell replication, growth and the development of physiological systems. Deficiencies can occur due to inadequate intake or can be associated with specific diseases. Some micronutrients act as antioxidants. According to Halliwell et al⁹, antioxidants are defined as any substance which, when present in low concentrations as an oxidizable substrate, slows or significantly inhibits oxidation of the substrate, thereby preventing the formation of reactive oxygen species (ROS). Elevated production of ROS contributes to the development of oxidative stress, responsible for cell damage, and ROS are associated with the occurrence of comorbidities and related complications during hospitalization¹⁰.

Some examples of antioxidants that have been associated with increased cellular immunity due to their anti-inflammatory and antioxidant activities include zinc (Zn), copper (Cu) and selenium (Se), among others^{11,12,13}. Iron (Fe) is not considered a mineral with antioxidant activity; however, when consumed in adequate quantities, the combination of iron with other antioxidant compounds may facilitate chemical reactions in the individual^{14,15}. Nevertheless, the concentration of this micronutrient must comply with the recommended dose as a high concentration of iron in the body can lead to elevated oxidative stress^{16,17}.

Furthermore, some vitamins have similar characteristics to the previously mentioned minerals, such as vitamins A, C and E, which act to increase lymphocyte activity, cellular immunity and antibody production^{18,19,20}, as well as limit ROS production. It is well established in the literature that micronutrients with antioxidant properties are fundamental for the maintenance of physiological processes in the body; however, there are no specific recommendations for hospitalized patients or those with diseases²¹. Thus, the

use of dietary reference intakes (DRI) values is accepted for these patients.

According to McClave et al²², the guidelines of American Society of Parenteral and Enteral Nutrition (ASPEN) and Singer et al²³, through the recently published European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines, there are currently no safe dose recommendations for the supplementation of selenium, zinc and other micronutrients with antioxidant properties in critical patients due to conflicting studies. The present study arose from the need to investigate how hospitalized patients receive micronutrients with antioxidant properties through exclusive enteral nutrition from enteral diets. Thus, this study aimed to evaluate the intake of micronutrients with antioxidant properties through exclusive enteral nutrition therapy in hospitalized patients with chronic diseases compared to the estimated average recommendations.

MATERIALS AND METHODS

Type of study and ethical aspects

This prospective, longitudinal, descriptive, observational study included a randomly selected convenience sample composed of hospitalized adult and elderly patients, with chronic diseases, of both sexes with exclusive enteral nutrition. The study was carried out at a public hospital in the central region of Rio Grande do Sul from August 2017 to October 2018 and included hospitalized patients who were admitted in Adult Emergency Service and in the medical clinic unit.

The research project and free and informed consent of participants were in accordance with Resolution no. 466 and were approved by the Ethics Committee from Universidade Franciscana (UFN).

Criteria for inclusion and exclusion

The study included hospitalized patients with chronic diseases and exclusive ENT, aged 18 years or older, who were lucid and/or accompanied by a caregiver. Patients receiving ENT associated with another feeding route, such as oral or parenteral, were not included in the study. In addition, patients in anasarca, those receiving comfort measures or palliative care, and patients and/or caregivers who were unable to sign the informed consent term were excluded.

Data collection

Data collection for each patient started the day the individual was admitted to the hospital or within 72 hours of hospitalization in the Adult Emergency Service or the medical clinic unit. A form for each patient was filled in manually with the following data: name; date of birth; age; sex; reason for hospitalization; associated diseases; medical clinic in which patient was hospitalized; type of diet route; prescribed and administered micronutrients; and intercurrents that interfered with the administration of the enteral diet, such as mechanical, gastrointestinal pauses and pauses for the performance of examinations and other procedures.

To perform ENT monitoring during the hospitalization period, in addition to assessment of the patient and associated complications, the electronic medical record was used. Patient monitoring was performed for at least 5 days during the 30-day period, or until the patient was excluded due to the initiation of another feeding route such as oral or parenteral, hospital discharge or death, in order to monitor the nutritional status of patient, as well as to observe whether nutritional therapy was being effective.

The nutritional needs of the patients were estimated and prescribed by the nutritionist according to established hospital protocols. To evaluate nutritional status, formulas were used according to nutritional diagnosis, from 30 to 35 kcal/kg of current weight for malnourished patients, and up to 50 kcal/kg of current weight, depending on the medical diagnosis; from 25 to 30 kcal/kg of current weight for eutrophic patients; 25 kcal/kg of current weight for overweight patients; and 20 to 25 kcal/kg adjusted weight for obese patients.

The adequacy of the administered volume was assessed by the prescribed volume and administered using the following formula: volume adequacy administered (%) = volume administered/prescribed volume x 100, based on Teixeira et al²⁴. Therefore, the adequacy of the volume was considered satisfactory when the percentage was above 80%, according to Assis et al²⁵.

To analyze the composition of micronutrients with antioxidant properties of enteral diets available at the hospital, the nutritional information of the diets was assessed in detail. The adequacy of micronutrients with antioxidant properties, such as vitamin A, vitamin C, vitamin E, zinc, selenium, copper and iron, was performed according to the estimated average need (EAR)^{26,27}. The data regarding the adequacy of the amount of ENT prescribed and administered were defined based on the recommendation of Assis et al²⁵. The needs of these individuals were met according to the estimated average requirement (EAR)^{26,27}. The latter is the average daily intake estimated to meet the needs of 50% healthy individuals in a group at a given stage of life and sex²⁸.

Statistical analysis

The results for micronutrient prescription and administration were presented every 5 days during 30 days of follow-up. These data were presented in figures, separated by sex, in which the prescription and administration of micronutrients with antioxidant properties had the adequacy percentage analyzed according to as the recommendations of the EAR by sex and age of the patients.

Data were analyzed using the Statistical version 10 program. Statistical analyses were performed using repeated-measures analysis of variance (ANOVA) and the non-parametric Wilcoxon test. Descriptive analysis of the data was performed to demonstrate the baseline characteristics of the patients. Data were considered statistically significant when $p < 0.05$, and results were presented as mean $\pm$ standard deviation (SD).

RESULTS

The study was performed over 14 months, during which 92 patients with ENT were initially followed. In the first step, 46 patients were excluded because they did not meet the inclusion criteria. The main reason was that the subjects started oral feeding, associated with ENT or not, before 5 days of follow-up. Thus, 53 patients were included in the study.

Regarding demographic data, the mean age of the patients was 63 ± 15 years (range: 22 to 89 years). According to their stage of life classification, 37.7% (n= 20) were adults and 62.3% (n= 33) were elderly patients. Regarding sex, 58.5% (n= 31) were male and 41.5% (n= 22) female.

Most of the patients (n= 24, 45.3%) were in the neurology clinic, and the main cause of hospitalization was a cerebral vascular accident, either ischemic (AVCi, n= 10) or hemorrhagic (AVCh, n= 3). The second most prevalent clinic was internal medicine, with patients having diseases such as systemic arterial hypertension, alone or in association with diabetes mellitus, with 15 and 6 patients, respectively. The third clinic was pneumology, in which the main reason for hospitalization was chronic obstructive pulmonary disease (COPD, n= 5). The diseases described above may have occurred individually or associated with each other, as the same patient may have a basic pathology and several other associated comorbidities.

In relation to the micronutrient content of the enteral diets, we observed a significant variation in their concentration. In the hospital, there were 11 types of enteral diets, aimed at the research public, with a caloric density between 1 and 2 kcal/ml (normal to hypercaloric) and protein concentration between 38 and 100 g/L (normal to hyperproteic). We observed that enteral diets containing higher amounts of micronutrients with antioxidant properties were hypercaloric and hyperproteic; however, diets with a higher concentration of micronutrients were not identified on the label or characterized as immunomodulatory.

In addition, the indication of use of the formulas, from the label, varies greatly. The hospital obtained formulas aimed at patients with an increased need for protein and calories, patients in high metabolic stress, patients requiring normalization of the gastrointestinal tract, preferably using fiber formulas, patients with restriction of large dietary volumes, patients with water restriction, with chronic obstructive pulmonary disease, for example, patients with moderate to severe malnutrition, patients with diabetes mellitus, and patients who needed glycemic control.

The prescribed and administered amount of enteral diet volume of the individuals during the time of hospitalization was analyzed, as well as the percentage of adequacy relating the prescription and what was actually infused. Observing table 1, it was possible to notice that initially the patients had an adequacy percentage of 75%, which was not considered satisfactory, but rather was below expectations. This parameter remained stable up to 20 days of follow-up, when the amount administered came close to the prescribed one, with 90% adequacy, becoming satisfactory, since it was above 80%.

Figure 1 shows the difference between the prescribed and administered concentrations of vitamin A ($\mu\text{g/day}$), C (mg/day) and E (mg/day) for patients during hospitalization, stratified by sex.

The antioxidant vitamins A, C and E were administered at a lower level than that prescribed for patients of both sexes during all periods, being statistically significant for vitamin A in the periods of 5 days ($p < 0.001$), 10 days ($p < 0.001$), 15 days ($p < 0.01$) and 20 days ($p < 0.01$) in males and 5 days ($p < 0.001$), 10 days ($p < 0.001$), 15 days ($p < 0.01$), 20 days ($p = 0.02$), 25 days ($p = 0.02$) and 30 days ($p = 0.02$) in females (Figure 1 A and B).

Vitamin C had significant values in the periods of 5 days ($p < 0.002$), 10 days ($p < 0.003$), 15 days ($p < 0.02$) and 25 days ($p < 0.04$) in males and 5 days ($p < 0.009$), 10 days ($p < 0.003$), 15 days ($p < 0.03$), 20 days ($p < 0.01$), 25 days ($p < 0.04$) and 30 days ($p < 0.02$) in females (Figure 1 C and D). Finally, vitamin E had significant values in the periods of 5 days ($p < 0.004$), 10 days ($p < 0.009$), 15 days ($p < 0.02$), 20 days ($p < 0.01$) and 30 days ($p < 0.04$) in males and 5 days ($p < 0.001$), 10 days ($p < 0.007$), 15 days ($p < 0.03$), 20 days ($p < 0.04$), 25 days ($p < 0.04$) and 30 days ($p < 0.02$) in females (Figure 1 D and E). However, it can be seen that patients received concentrations of micronutrients with antioxidant properties according to the EAR (see the dotted line in Figure 1).

At the beginning of the enteral diet, the vitamins were administered at a concentration closer to the EAR, then increased during subsequent periods and decreased or stabilized from the 20th day of follow-up. Regarding vitamin E, we observed greater linearity between the prescribed and administered concentrations in females, and the concentrations administered seemed to be closer to the reference values of the EAR.

Figure 2 shows the difference between the prescribed and administered concentrations of zinc (mg/day) and selenium ($\mu\text{g/day}$) that hospitalized patients received during the hospitalization period. As with vitamins A, C and E, the administered concentrations of zinc and selenium were statistically lower in relation to the prescribed concentration in both sexes in almost all of the analyzed periods, with significant values of zinc in the periods of 5 days ($p < 0.004$), 10 days ($p < 0.002$), 15 days ($p < 0.002$), 20 days ($p < 0.01$), 25 days ($p < 0.04$) and 30 days ($p < 0.04$) in males and 5 days ($p < 0.001$), 10 days ($p < 0.003$), 15 days ($p < 0.03$), 20 days ($p < 0.01$), 25 days ($p < 0.04$) and 30 days ($p < 0.07$) in females (Figure 2A and B). On the other hand, selenium had significant values in the periods of 5 days ($p < 0.001$), 10 days ($p < 0.004$), 15 days ($p < 0.02$), 20 days ($p < 0.01$) and

Table 1. Percentage of adequacy of volume of the enteral diet, comparing prescription and administration during the hospitalization period.

Hospitalization period	% Adequacy
5 days	75
10 days	74
15 days	73
20 days	83
25 days	90
30 days	75

Figure 1: Prescribed and administered amount of vitamin A (µg/day), vitamin C (mg/day) and vitamin E (mg/day) in hospitalized patients of both sexes with exclusive enteral nutrition over 30 days. Dashed line indicates the values predicted by the estimated average requirement (EAR). * P<0.05 (non-parametric analysis, Wilcoxon test).

30 days ($p<0.04$) in males and 5 days ($p<0.001$), 10 days ($p<0.002$), 15 days ($p<0.003$), 20 days ($p<0.01$), 25 days ($p<0.04$) and 30 days ($p<0.02$) in females (Figure 2C and D). As with vitamins A, C and E (Figure 1), the concentration of zinc and selenium received by patients was in line with the recommended by the EAR (see the dotted line in Figure 2). The amount administered to patients did not exceed the tolerable intake limit (UL), as shown in table 2.

At the beginning of administration of these minerals, we observed a concentration closer to the EAR values. From the 10th day these values increased, followed by a decline from the 25th day. Figure 3 shows the difference between the prescribed and administered concentrations of copper (µg/day) and iron (mg/day) patients received during the hospitalization period. Copper and iron presented similar

results to zinc and selenium. In addition, the amount of iron administered to patients did not exceed the maximum tolerable intake level (UL) of 45 mg/day.

The fact that patients did not receive adequate volume of enteral diet, according to the prescription, may have been influenced by interferences during the hospitalization period. In our study, the two most common causes of interruption of infusion of the enteral diet were withdrawal of the tube by the patient and pauses for the drainage of liquids from the gastrointestinal tract, as presented in Table 3.

When a patient withdraws the probe it must be passed on, then an X-ray must be performed to confirm that the probe is correctly positioned. During these procedures, the patient does not receive ENT, which contributes to the difference between prescription and administration of the enteral diet.

Figure 2: Prescribed and administered concentrations of zinc (mg/day) and selenium (µg/day) over a 30-day period in hospitalized patients of both sexes with exclusive enteral nutrition. Dashed line indicates the values predicted by the estimated average requirement (EAR). * P<0.05 (non-parametric analysis, Wilcoxon test).

Table 2. Concentration of micronutrients present in enteral diets and their variability in relation to dietary intake.

Micronutrient Concentration in enteral diets (minimum and maximum) according to EAR		Tolerable intake limit (UL)	Daily recommendation
Vitamin A	600–1850 µg/L	§: 625 µg I: 500 µg	3000 µg
Vitamin C	23–500 mg/L	§: 75 mg I: 60 mg	2000 mg
Vitamin E	13–85 mg/L	§ and I: 12 mg	1000 mg
Zinc	12–24 mg/L	§: 9.4 mg I: 6.8 mg	40 mg
Selenium	66.6–130 µg/L	§ and I: 45 µg	400 µg
Copper	1330–2670 µg/L	§ and I: 700 µg §: 6 mg	10000 µg
Iron	13–27 mg/L	I: 8.1 mg for patients aged 19 to 50 years I: 5 mg for patients aged >50 years	45 mg

Figure 3: Prescribed and administered concentrations of copper (µg/day) and iron (mg/day) over a 30-day period in hospitalized patients of both sexes with exclusive enteral nutrition. Dashed line indicates the values predicted by the estimated average requirement (EAR). * P<0.05 (non-parametric analysis, Wilcoxon test).

Table 3. Intercurrences related to the enteral nutrition of patients during the hospitalization period.

Complications	n=53 (100%)
Exams and procedures	
Probe transfer	8 (15.1%)
X-ray for probe control	8 (15.1%)
Computed tomography	7 (13.2%)
Gastrostomy	5 (9.4%)
Other exams	8 (15.1%)
Mechanics	
Open flask probe for drainage	10 (18.9%)
Removal of the probe by the patient	10 (18.9%)
Repositioning the probe	1 (1.9%)
Obstruction of the probe	6 (11.3%)
Tracheostomy	8 (15.1%)
Withdrawn without reason recorded	7 (13.2%)
Gastrointestinal	
Vomiting	6 (11.3%)
Nausea	2 (3.8%)
Diarrhea	2 (3.8%)
Constipation	—

Source: Researcher's collection.

DISCUSSION

The most frequent disease observed was vascular accident, and its incidence was higher in men. The difference observed with respect to sex was not great, however, several studies confirm the premise that more men are hospitalized in hospitals than women. In a study by Reck-de-Jesus et al²⁹ involving hospitalized patients with exclusive enteral nutrition and the association with anemia and malnutrition, 72.7% of hospitalized patients were male. In another study by Uozumi et al³⁰ involving the administration of the diet via enteral nutrition and its interurrences, 63% of patients were male. In their study analyzing the use of enteral nutrition, Santos³¹ found that 60.9% of patients were men. These data suggest that men, especially in the public service, seek less care.

As for dietary administration, with respect to all micronutrients with antioxidant properties, a greater variation was observed in the 20-day follow-up period. This is probably due to a change in the type of diet prescribed by the nutritionists at the hospital. The greater the variability in the type of diets patients receive, the greater the standard deviation. This is because the micronutrient values vary greatly from one diet to another, which directly impacted what was infused into the patient.

In males, vitamins C and E showed greater variation on the 20th day of follow-up, as three patients specifically received an enteral diet with a higher amount of these nutrients. The age of these patients varied considerably, with patients aged 25, 58 and 74 years. However, although there are more specific diets for the elderly, age was not a criterion in determining the diet chosen for the patients. These patients were in the neurology and internal medicine departments, and the main diseases included cerebral vascular accident, severe encephalopathy, severe parietal frontal tumor and chronic renal failure. The diet chosen for these patients was hypercaloric and hyperproteic with the aim to recover their nutritional status, as both were in a state of hypercatabolism.

In an observational study with 230 adult patients in ENT, it is observed that the daily intake recommendations were satisfactorily achieved for vitamin C, vitamin E, vitamin A, zinc and iron, with a percentage of adequacy in relation to the EAR greater than 90%⁵. In general, diets with higher concentrations of micronutrients with antioxidant properties are immunomodulatory. However, among the types of diets available in the hospital, none were specified as having this property in their description, only that some have higher amounts of micronutrients with antioxidant properties.

The variability of micronutrients in enteral diets should have a greater influence when choosing which type of diet is to be administered to the patient. Individuals with pathologies such as those mentioned above would need to receive higher concentrations of micronutrients with antioxidant properties, as it is recognized in the literature that these diseases are related to oxidative stress. Therefore, a higher concentration of antioxidants could benefit these

patients. In a study by Quian Han et al³² that assessed the intake of vitamins with antioxidant properties, such as vitamin C, deficiency in these micronutrients was found to contribute to a motor deficit and cognitive impairment, which consequently impacts the nutritional status of the patient. However, professionals often place a higher emphasis on caloric density and protein concentration of the diet.

In addition, it is suggested that the labels of enteral diets should provide more information about the major characteristics regarding the nutritional composition in order to better inform the choice of diet by the nutritionist. This fact stands out as the present study shows a very large difference in the concentration of micronutrients in each enteral diet. This fact becomes relevant, as it is necessary to consider the diseases that affect the patient, making the condition liable to require specific amounts of micronutrients.

During the first 5 days of enteral diet administration, we observed that the concentration given to the patients approached the dashed line, suggesting that patients received a concentration closer to the EAR during this period. This was probably due to Resolution no. 63/2000³³, which recommends that in the first days of infusion of the diet by ENT, one should start with a low volume. This premise can be observed in the figures of the present study, in which the values during the first administration period were closer to the EAR recommendation. In the study by Luft⁵ it was observed that diabetic patients had less diet progression during ENT. Still, patients with kidney disease ($p=0.25$), COPD ($p=0.23$), heart failure ($p=0.19$), also had less progression of ENT.

In addition, we must consider that the bioavailability for nutrient absorption may be altered due to the individual's illness. It remains unclear how the absorption of micronutrients in humans is impacted when excess micronutrients are infused simultaneously, in addition to the effect of differences in endogenous concentrations, which extends to the various metabolic conditions of each patient and their associated diseases¹².

In addition, the bioavailability of micronutrients is defined taking into account all of the factors that influence it, as well as specifying the rates of utilization of the nutrient absorbed, their exchange and excretion, which varies considerably. In the present study, we did not measure the serum concentrations of micronutrients with antioxidant activities, which is necessary to determine the bioavailability among hospitalized patients with exclusive enteral nutrition. It is necessary to emphasize that the excess of antioxidants can generate inhibition of cell proliferation, since it contributes to prevent the transient oxidation state, which consequently reduces the adaptation of oxidative stress³⁴.

In regard to complications related to ENT, the most common causes for interruption of the diet included withdrawal of the probe by the patient and the drainage of liquids from the gastrointestinal tract in an open vial probe. However, there were cases in which the cause of interruption of enteral nutrition was unknown, which may

be because it was not recorded in the patient's medical record. According to a study by Uozumi et al³⁰ with a total of 100 patients, the most common complication was undetermined, that is, without a definite cause, with 166 episodes (29%) described in this way.

CONCLUSION

In this study, we found that on several days of follow-up, patients received an enteral diet with a volume lower than the dietary prescription. However, the concentration of micronutrients was inside the daily recommendations by EAR, and did not exceed the UL for healthy individuals.

In addition, our study showed that intercurrents may decrease the volume that must be infused by ENT, thereby interfering with the daily nutrient requirements, which may increase the patient's risk of malnutrition and the length of hospital stay. Therefore, monitoring of enteral nutrition is essential in order to avoid worsening nutritional status during hospitalization.

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