Review Article

Nutritional therapy in patients using extracorporeal membrane oxygenation (ECMO): an integrative review

Terapia nutricional em pacientes sob uso de oxigenação por membrana extracorpórea (ECMO): uma revisão integrativa

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ABSTRACT

Introduction: Nutritional therapy (NT) in critically ill patients is a challenge, especially when advanced life support technologies such as extracorporeal membrane oxygenation (ECMO) are used. Due to the scarcity of studies on the management of NT in this population, the aim of this study was to investigate the main nutritional recommendations for critically ill patients using ECMO. **Method:** An integrative literature review was carried out blindly and independently in October and November 2024, in accordance with the PRISMA guidelines. The results were obtained through direct online access using the PubMed and ScienceDirect databases, using the combination of the following English descriptors: extracorporeal membrane oxygenation, nutritional therapy, nutritional requirements and dietary protein. **Results:** A total of 7 articles were selected, with a total sample of 586 participants with a mean age of 55 years. Early NT showed superior outcomes, and adequate nutritional supply (similar to the recommendations for critically ill patients) was associated with better clinical prognosis such as weaning from ECMO, reduced mortality in the intensive care unit and survival until hospital discharge. Assessing the risk of gastrointestinal tract (GIT) dysfunction is necessary in clinical practice. Conclusion: **Conclusion:** There is little evidence, but the provision of adequate NT to critically ill patients, monitoring the critical phases of the disease and routine evaluation of the GIT seem to help in the management of effective NT and better clinical outcomes in patients using ECMO.

RESUMO

Introdução: A terapia nutricional (TN) em pacientes graves é um desafio, principalmente quando são utilizadas avançadas tecnologias de suporte à vida como oxigenação por membrana extracorpórea (ECMO). Devido à escassez de pesquisas acerca da condução da TN neste público, o objetivo deste estudo foi investigar as principais recomendações nutricionais em pacientes graves sob uso de ECMO. **Método:** Uma revisão integrativa da literatura foi realizada de forma cega e independente, em outubro e novembro de 2024, de acordo com as diretrizes PRISMA. Os resultados foram obtidos por acesso direto online utilizando as bases de dados PubMed e ScienceDirect, empregando a combinação dos seguintes descritores em inglês: *extracorporeal membrane oxygenation, nutritional therapy, nutritional requirements* e *dietary proteins*. **Resultados:** Foram selecionados um total de 7 artigos, com uma amostragem de total de 586 participantes com média de idade de 55 anos. A TN precoce apresentou superioridade nos desfechos, bem como a oferta nutricional adequada (similar às recomendações para o paciente crítico) foi associada a melhores prognósticos clínicos como desmame do ECMO, diminuição da mortalidade na unidade de terapia intensiva e sobrevida até a alta hospitalar. Avaliar o risco de disfunção do trato gastrointestinal (TGI) se mostra necessário na prática clínica. **Conclusão:** Existem poucas evidências, contudo a oferta de uma TN adequada ao paciente grave, monitorando as fases de criticidade da doença e avaliação rotineira do TGI parecem auxiliar na condução da TN efetiva e com melhores desfechos clínicos em pacientes sob uso de ECMO.

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INTRODUCTION

Extracorporeal membrane oxygenation (ECMO) is a technique used in intensive care units (ICUs) and specific centers that aims to provide total blood oxygenation and elimination of carbon dioxide (CO_2) combined with ventilation, functioning as the individual's cardiorespiratory system[1].

The use of this technology enables lung rest strategies and cardiovascular support by providing total respiratory support, right ventricular support or complete cardiopulmonary support. ECMO can also be used as rescue therapy, allowing transplants to be performed in cases of hypoxic respiratory failure or cardiogenic shock[2,3].

Technological advances in device design, with simpler and more compact equipment, the use of more biocompatible and efficient membranes for gas exchange have helped to increase the use of these systems in adult patients in recent years[3].

Due to the clinical complexity faced by patients using ECMO and the lack of specific guidelines or recommendations guiding nutritional care, nutritional therapy (NT) may not be prioritized due to hemodynamic instability, directly affecting nutritional status and clinical prognosis[3,4].

The few guidelines on NT emerged after the COVID-19 pandemic, when this tool was overused. However, they still maintain the orientation to follow NT in line with other critically ill patients[5,6]. Given the increased use of this therapy and the need to provide adequate NT to the patient, due to the scarcity of research on the conduct of NT in this public, the objective of this study was to investigate the main nutritional recommendations for the initiation of safe enteral nutritional therapy (ENT) in critically ill patients using ECMO.

METHOD

We followed the guidelines of the Preferred Reporting Items for Systematic Reviews (PRISMA)[7]. The guiding question formed by the acronym PICOS was: what is the scientific evidence on starting nutritional therapy in patients using extracorporeal membrane oxygenation (ECMO)?

Electronic searches were carried out using the combination of the English descriptors: extracorporeal membrane oxygenation, nutritional therapy, nutritional requirements and dietary proteins, through two databases: PubMed and ScienceDirect.

All the titles and abstracts found in the electronic search were analyzed manually by two reviewers, blindly and independently, between october 2th 2024 and november 29th 2024. Discrepancies were resolved by a third author. The reference lists of all relevant articles were examined to identify other eligible studies.

The eligibility criteria for the studies were defined according to the acronym PICOS, considering population, intervention, comparison, outcomes and study design (Table 1):

Tabela 1 – Criteria for inclusion and exclusion of studies according to PICOS.

		Inclusion criteria	Exclusion criteria
P	Population	Adults hospitalized on ECMO therapy	Hospitalized adults using ECMO + other therapies or animal studies
I	Intervention	Starting NT in ECMO patients	Discontinuation or nutritional offer already in progress
C	Comparison	-	-
O	Outcomes	Effects of nutritional therapy on participants' health	Non NT-related outcomes during use
S	Study design	Randomized, cross-sectional clinical trials, among others, that address the results of nutritional therapy in patients with ECMO	Literature reviews, case studies, dissertations, theses, book chapters, abstracts presented at conferences, expert opinions, editor's comments and duplicate references

ECMO = extracorporeal membrane oxygenation; NT = nutritional therapy.

The eligible studies for this review were: a) randomized, cross-sectional clinical trials; b) carried out in adults (18 years old) of both sexes; c) patients were on ECMO; d) published in English, Spanish and Portuguese in the last 5 years; e) studies that should investigate interventions with the start of NT in patients on ECMO, with abstract and full text available between october 2th 2024 and november 29th 2024.

The information about the research was described by the reviewers in Figure 1, presented in the flowchart, describing the search, selection, inclusion and exclusion process.

After searching for studies for the integrative review, those studies described the initiation of nutritional therapy for patients using ECMO. The studies identified in the searches were imported into Endnote Web® software to remove duplicate searches.

Data extraction was carried out independently and included information on authors, year, age, type of study, design, nutritional needs and outcomes. A narrative synthesis was carried out using a table and discussion.

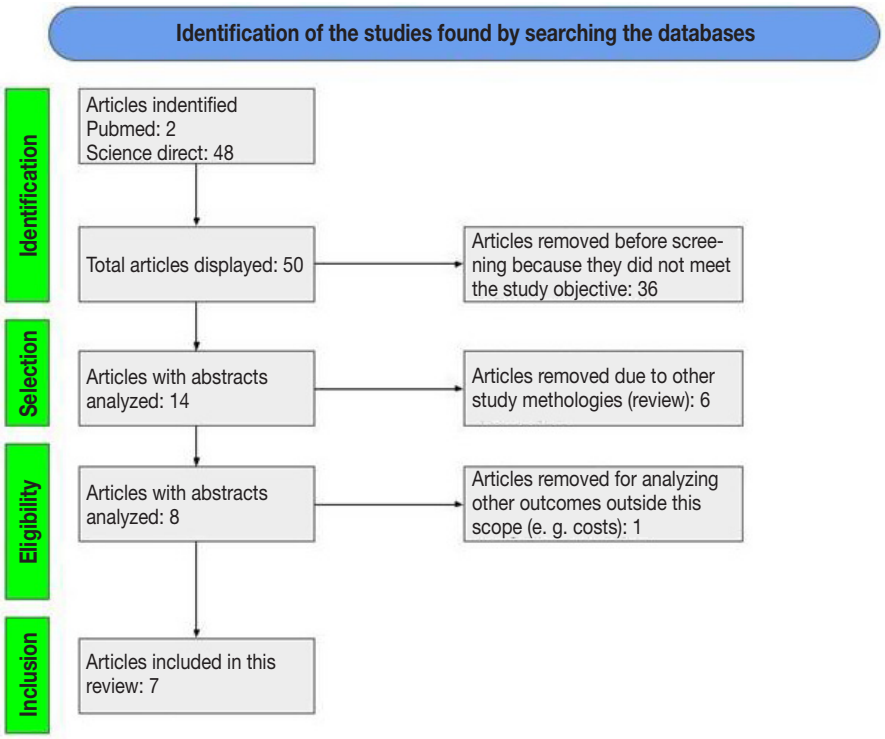

Figure 1 *- Identification of the flowchart for choosing the articles found in the databases according to the PRISMA model.*

RESULTS

A total of 50 studies were found in the databases, with the keywords and filters applied, of which two articles were found in PubMed and 48 in ScienceDirect. After reading the title, 36 studies were excluded as they did not meet the study's objective. Subsequently, six articles were excluded in the second stage for meeting the inclusion criteria with other methodological approaches and/or for having studies on animals/individuals using other therapies.

In the last analysis, eight studies were read in full, and one was excluded for having a methodology and outcomes that differed from the main investigation. As a result, seven articles were included in this integrative review[8-14] , as can be seen in Table 2.

Table 2 – Distribution of references included in the integrative review according to year of publication, country, authors and type of study.

Nº	Author, year/ Country	Research subjects	Study type	Calorie requirements	Protein requirements	Main outcomes
1	Lu et al. 2023[8]/China	65 patients-ECMO VA e VV	Retrospective cohort	25-30 kcal	1,2 g/kg	No description of the total number of days of ECMO use or total ICU stay. The average BMI was eutrophic (24 kg/m²) (54.4%). Early ENT occurred in 55.4% of the sample. Caloric intake on days 3, 7 and 14 was 500 kcal, 1,000 kcal and 1,000 kcal, representing 29.7%, 66.7% and 66.7% of the energy target. Protein intake on days 3, 7 and 14 was 31 g, 40 g and 40 g, representing 36.9%, 56.2% and 56.2% of the protein target. Around 56% of the patients were intolerant of ENT during ECMO, with a higher prevalence in the group that started late (82%).

Continuation Table 2 – Distribution of references included in the integrative review according to year of publication, country, authors and type of study.

Nº	Author, year/ Country	Research subjects	Study type	Calorie requirements	Protein requirements	Main outcomes
1	Lu et al. 2023[8]/China	65 patients- ECMO VA e VV	Retrospective cohort	25-30 kcal	1,2 g/kg	In the early ENT group, the most common reason for ENT intolerance was abdominal distension (22.2%) and high gastric residual volume (8.3%). In the late NE group, the most common reasons were intestinal ischemia (44.8%) and abdominal distension (37.9%). Around 66.1% (n=43) of the patients successfully weaned off ECMO. The rate of successful weaning from ECMO was higher in the early ENT group than in the late ENT group (80.6% vs 48.3%, p=0.006).
2	Gutierrez et al., 2021[9]/EUA	142 patients- ECMO VA	Retrospective cohort	25-30 kcal	1,5 - 2 g/kg	The average BMI found was obesity (31.8 kg/m²) and nutritional risk was assessed using the NUTRIC. Early NEC was performed in 38% of cases, while late NEC was performed in 62%. Standard hypercaloric and hyperproteic formulas were used to start NEC. The targets were reached between the 2nd and third day (45 and 75 hours), with an average of 27.5 kcal/kg/day. There was no difference in the incidence of tracheostomy, pneumonia, gastrointestinal bleeding and ischemia, paralytic ileus between the early and late feeding groups. No description of length of ICU stays and average duration of ECMO.
3	Brisard et al., 2022[10]/ France	112 patients - ECMO VA e VV	Retrospective cohort	20-25 kcal (acute stage) 1,2 g/kg/dia	1,2 g/kg/dia	The average duration of ECMO was 7 days, with no description of the total length of ICU stay. Late start of ENT - between 3 and 6 days after the start of ECMO. No description of BMI. Average achievement of 81% of the calorie target and 74% (33g -121g) of the protein target. Gastrointestinal intolerance occurred in 53% of the study population. The most common cause of intolerance was the presence of gastric residue (31%), followed by diarrhea (31%).
4	Gleixner et al., 2023[11]/ Austria	102 patients- ECMO VV	Retrospective cohort	25 kcal	1,3 g/kg/dia	Overweight and obese BMIs were predominant (50% each). ICU mortality was 41.2%. Average ICU stay is 35 days and use of ECMO 20 days. Calorie intake was between 70 and 80% (27 kcal/kg/day) and protein remained low (0.7 g/kg/day) on all days during ECMO use. ENT was more frequent, with a higher calorie and protein supply when compared to the NPT group.

Continuation Table 2 – Distribution of references included in the integrative review according to year of publication, country, authors and type of study.

Nº	Author, year/ Country	Research subjects	Study type	Calorie requirements	Protein requirements	Main outcomes
4	Gleixner et al., 2023[11]/ Austria	102 patients- ECMO VV	Retrospective cohort	25 kcal	1,3 g/kg/dia	Propofol was considered a considerable source of calorie supply (8.6%). The 102 patients represented around 2,344 days of NT calorie targets were met on 952 (40.6%) days and a protein supply of 1.3 g/kg/day on only 114 (4.9%). Hyperglycemia was the main metabolic complication, present in 1,306 (55.7%) days and hypertriglyceridemia in 801 (34.2%) days of NT. Patients who left the ICU received significantly more calories compared to non-survivors (76.3% vs. 69.8% of calculated needs; p<0.0001) and had more days of NT with adequate calorie supply (42.3% vs. 38.0%; p=0.0394). Patients with a mean calorie supply <70% of calculated needs spent longer on ECMO (26 vs. 14 days; p<0.0001) and had a longer ICU stay (51 vs. 27 days; p<0.0001).
5	Kim et al., 2021[12]/ South of Corea	60 patients- ECMO VA e VV	Retrospective cohort	25 kcal	1,2 g/kg/dia	The average ICU stay was 57 days and the use of ECMO 10 days. There were 55% weaning from ECMO and 50% of patients survived until discharge from the ICU. The average BMI found was overweight (26 kg/m²). Within 6 days of ECMO, 63.2% of patients reached ≥80% of their calorie needs. On day 7 of ECMO, the average calorie and protein intake corresponded to 99.0% and 110.5% of nutritional needs, respectively. Calorie and protein intake did not change significantly on day 14 of ECMO.
6	Hardy et al. 2022[13]/ United Kingdom	58 patients - ECMO VV	Retrospective cohort	25 kcal/kg ideal	1,2 g/kg/dia	The average length of stay was higher among patients who needed ECMO-VV. The average length of stay in the ICU was 20 days, with a survival rate of 74.1%. The average duration of ECMO use was 14 days. The average BMI found in this sample was obesity (31.3 kg/m²). There was a higher percentage of early ENT. The calorie target adequacy of patients on ECMO was 81% and protein adequacy was 74.1%. Data regarding ENT breaks were recorded for patients on ECMO who received <80% of their calorie and protein targets, with almost all of these patients having at least 1 ENT break with a cumulative average of 35 h per patient.

Continuation Table 2 – Distribution of references included in the integrative review according to year of publication, country, authors and type of study.

Nº	Author, year/ Country	Research subjects	Study type	Calorie requirements	Protein requirements	Main outcomes
6	Hardy et al. 2022[13]/ United Kingdom	58 patients - ECMO VV	Retrospective cohort	25 kcal/kg ideal	1,2 g/kg/dia	The presence of gastric residue was higher in the group of ECMO patients (41%), and prokinetics were used in 74% of patients. Planned extubation was the second reason for pauses in ENT (25%).
7	Saijo et al. 2022[14]/ Japan	47 patients- ECMO VA	Retrospective cohort	25 kcal/kg ideal	1,2 g/kg/dia	The median time to start ENT in the ECMO group was 34 hours. The average BMI found was eutrophic (23.6 kg/m²) The average calorie intake was 13 kcal/kg/day and 0.7g of ptn/kg/day. The maximum average supply was 22 kcal/kg/day and 1.2 g of ptn/kg/day. The mortality rate was 32% in the ECMO group and the length of stay in the ICU was 12 days. The duration of ECMO was not detailed. The number of patients with complications from NE was 51%, with diarrhea being prevalent (38%). No correlation was found between the start of early ENT and 30-day mortality. The study found that in 95% of patients using ECMO, it was not necessary to interrupt ENT.

ECMO = Extracorporeal membrane oxygenation; VA = venoarterial; VV = venovenous; ENT = enteral nutritional therapy; PNT = parenteral nutritional therapy; BMI = body mass index; NUTRIC = nutritional risk score for critically ill patients; ICU = intensive care unit; USA = United States of America; ESPEN = European Society for Clinical Nutrition and Metabolism; n = sample size.

The year with the most publications on the subject was 2022, with three studies, followed by 2023 and 2021 tied with two publications each. The studies were carried out on different continents, with three in Asia (South Korea, China and Japan), three in Europe (Austria, France and the United Kingdom), and one in North America (United States of America). The methodology of the selected studies was homogeneous, and all of the studies were retrospective, detailing the start of ENT in patients using ECMO.

A total of 586 participants hospitalized in ICUs using ECMO were included in the study, the smallest with 47 participants and the largest with 142. The mean age was 55 years, with a greater predominance of males (72%; n=423) and the use of both VV-ECMO and VA-ECMO. The length of stay in the ICU ranged from 12 to 85 days, and the use of ECMO from 10 to 20 days. However, three studies did not record this information.

The most common tool for obtaining information on the anthropometric profile was BMI, present in 6 studies and with a higher prevalence of overweight and obesity in the sample. Only one study assessed nutritional risk using the NUTRIC score. All the studies used predictive formulas to calculate patients' nutritional needs.

Early initiation was associated with lower mortality in the ICU and successful weaning from ECMO, although there was no association with the duration of this therapy. Adequate nutritional provision (with recommendations similar to those for other critically ill patients) was associated with better clinical prognosis such as weaning from ECMO, lower mortality, and time in the intensive care unit and survival until hospital discharge.

The nutritional recommendations presented in the studies in this review were based on the guidelines established in the main NT guidelines. There was a prevalence in the proposal of an average calorie intake of 25 kcal/kg/day, with occasional adjustments to a more conservative approach during the critical phase (20 kcal/kg/day) and an adjustment in the late phase (30 kcal/kg/day), with no specific recommendations for patients with obesity.

The aim of protein intake was to reach at least 1.2 g of protein/kg/day in most studies[8,10-14]. However, only Gutiérrez et al.[9] proposed a higher protein intake (1.5 to 2 g of protein/kg/day) for patients using ECMO.

Assessing the risk of gastrointestinal tract (GI) dysfunction in the ICU is necessary in clinical practice, given that in six studies GI complications hindered the achievement

of nutritional goals. The main events were the presence of abdominal distension, gastric residual volume (GRV) and diarrhea, with repercussions in terms of increased time on ECMO and length of stay in the ICU[9-11].

DISCUSSION

Nutritional risk and anthropometric profile

Determining nutritional risk is the first step towards establishing an appropriate nutritional care pathway for hospitalized patients. The lack of validation of appropriate nutritional screening tools for the intensive care population makes it difficult to systematize this process, but today we know the accuracy and sensitivity of using the NUTRIC score for this population[15].

This review found that only Gutierrez et al.[9] used this instrument in their study, identifying a mean score of 5 points, which shows the presence of nutritional risk. The application of this instrument can identify in clinical practice which patients benefit most from receiving aggressive NT (i.e. early and gradual start of NT) according to the patient's clinical evolution, with the aim of reversing the energy deficit and muscle degradation. The concept of early nutritional therapy refers to the start of feeding between the first 24-48 hours of the critically ill patient's hospitalization after hemodynamic stabilization[15,16].

Studies evaluating nutritional risk in patients using ECMO are scarce. However, the study by Zhu et al.[17] aimed to show the effects of the NRS 2002 and NUTRIC score nutritional screening instruments on the mortality of 78 patients using this therapy, suggesting that the screening instruments were considered significant independent risk and prognostic factors for in-hospital 90-day mortality, with the NUTRIC score being more sensitive for this comparison.

In the study by Shin et al.[18], the authors used the NRS 2002 as a nutritional screening tool for ECMO patients and showed that around 86% (n=32) of the sample were at nutritional risk on admission to the ICU. The same study showed that the serum albumin and protein levels of the group that was not at nutritional risk decreased during hospitalization and use of the device in days, with no significant differences between the groups, so periodic reassessment of nutritional risk is necessary in this group.

Overweight and obesity were the most prevalent anthropometric profiles in the participants of four studies included in this study[9,11-13]. Evidence shows that obesity can be an independent risk factor for cardiovascular complications such as hypertension, dyslipidemia and cardiogenic shock[19].

The study by Ludtke et al.[20] found that around 82% of the sample was obese. In the study by Peetermans et al.[21] aimed at evaluating the outcomes in 18,529 obese patients using ECMO, it was observed that cardiovascular, renal and device-related complications (positioning and adequate flow) increased by 15%, 30%, and 25% respectively. However, the same study did not show significance in terms of mortality and length of hospital stay.

The literature points out that obesity can cause respiratory alterations, including a decrease in total lung capacity and functional residual capacity, as well as an increase in pleural pressure and airway resistance, so ECMO therapy in obese patients presents difficulties due to the adequacy of the circuit flow, and risks such as limb ischemia and venous thrombosis[22].

Early nutritional therapy

Early NT was found in four of the studies in this review [8,9,12,14]. The literature shows that early initiation of feeding in critically ill patients can modulate oxidative stress and minimize systemic inflammatory response syndrome (SIRS). In addition, adequate nutritional intake in the first days of the ICU indicates better clinical and functional outcomes in critically ill patients[16].

The research conducted by Santos et al.[23], which sought to assess calorie adequacy and clinical outcome in cancer patients in the ICU, it was observed that 64% of the participants received early ENT. The late ENT group was associated with higher mortality, both in the ICU and in the final clinical outcome with longer total hospitalization and ICU length of stay.

The guidelines of the main nutritional therapy societies[6,24,25] strongly recommend starting NT early, preferably within the first 24-48 hours following the resuscitation and stabilization phase of the critically ill patient. There is no established consensus regarding the start of early ENT in patients on ECMO support. However, it is inferred that the benefits of normocaloric nutrition, in line with the guidelines, are promising and positive in improving outcomes in critically ill patients[8,9].

Two studies[11,12] included in this study did not detail the time period in hours for the start of NT, referring only to "after clinical stabilization". However, only one study[9] showed a late start of the nutritional offer (with an average of three to six days after the start of ECMO), with a high percentage of GI intolerance. The late start of ENT and criticality may also be predictors of GI dysfunction in critically ill patients[26].

Determining energy expenditure and nutritional needs

Determining energy expenditure is the next step in the nutritional assessment of critically ill patients, and it is necessary to establish the patient's nutritional goals during their stay in the ICU. The use of indirect calorimetry is strongly recommended and, in its absence, predictive formulas can be used[27].

The use of predictive formulas is widespread in hospital practices due to their practicality and low cost of use. However, they generally have an accuracy of no more than 70% and can lead to errors due to the real conditions of the patient, such as the veracity of the weight used[28].

In a study by Coradelli et al. [27] with critically ill patients diagnosed with COVID-19 and using mechanical ventilation, it was observed that the maximum variation between the predictive equation and the CI was 587.5 kcal less, thus showing the propensity of the "pocket formula" to underestimate real energy needs.

In patients using ECMO, there are conflicting recommendations regarding the choice of method for determining energy expenditure. The nutritional therapy guideline of the German Nutrition Society[6] suggests that IC should not be used in patients undergoing ECMO, thus using the following recommendation: if BMI <30 kg/m^2, 24 kcal/kg actual body weight/day; if BMI 30-50 kg/m^2, 11-14 kcal/kg actual body weight/day and if BMI >50 kg/m^2, 22-25 kcal/kg ideal body weight/day, this being a consensus of experts.

This recommendation is mainly due to the fact that it is difficult to measure energy expenditure by indirect calorimetry in patients using ECMO, as CO_2 is removed by the extracorporeal membrane, so the calorimeter's spirometric unit cannot accurately capture and quantify gas exchange in a coherent way[6,29].

The protocol "Measuring Energy Expenditure in Ecmo Patients" (MEEP)[29], published in 2018, combined IC measurements and blood samples collected at the inlet and outlet of the device to measure serum oxygen (O_2) and CO_2 content, with subsequent use in the Weir equation[6]. The protocol proved to be viable and none of the predictive equations corresponded to the measured energy expenditure.

Given the absence of consensus on calorie intake in patients using ECMO, the recommendations follow the intake suggested for critically ill patients in their phases, without individualizing the conduct and not considering the use of the device. The Brazilian Society of Parenteral and Enteral Nutrition (SBNPE/BRASPEN), in its opinion on NT in hospitalized patients with COVID-19, recommended an even more prudent approach during the critical phase of patients with acute respiratory distress syndrome (ARDS), with or without ECMO support. The initial calorie intake suggested was 15 to 20 kcal/kg/day, progressing up to 25 kcal/day, with continuous assessment of other clinical parameters and the patient's current nutritional status[5].

Protein intake in patients using ECMO was also similar to protein intake in critically ill patients, in line with the main guidelines[6,24-25]. In the study by Pelekhaty[30], a higher protein supply (infusion of around 2g of protein/kg ideal/day) in obese patients using ECMO reduced the time the device was used and the mortality rate of the sample, corroborating the studies that took part in this review.

Recommendations regarding the ideal protein intake for critically ill patients remain the focus of discussions about NT. The use of biomarkers such as nitrogen balance and the urea/creatinine ratio in patients using ECMO are recommended in clinical practice to assess the use of this substrate[31]. The use of whole/intact protein formulas is recommended in patients with a functioning GI[32], so assessing tolerance and the degree of GI functionality is necessary.

GIT dysfunction associated with nutritional therapy

The integrity of the GIT is important to ensure good tolerance of ENT in the ICU. Some studies show that critical illness can trigger an inflammatory and oxidative response mediated by the largest immune organ in the human body, the intestine. GI dysfunction can lead to non-assimilation of nutrients, intolerance to NE and worse nutritional and clinical outcomes[26].

The concept of GI dysfunction refers to functional impairment, which includes disturbances in GI motility (causing diarrhea, constipation or gastric residue formation), absorption, mucosal integrity, intestinal dysbiosis, increased intra-abdominal pressure and endogenous sepsis (caused by microbial translocation), which in turn can lead to clinical situations such as mesenteric ischemia, with increased mortality[33].

In cardiogenic shock, which is one of the criteria for the use of ECMO, there is a decrease in cardiac output which causes selective vasoconstriction of the mesenteric arterioles in the digestive tract and intestinal congestion due to decreased venous return, thus impairing intestinal perfusion, with consequences for motility and tolerance to NE[34].

The use of ECMO does not contraindicate ENT, but some studies have pointed to a higher frequency of GI events in critically ill patients using this therapy. Corroborating the data found in this study, Renaudier et al. [34] investigated 38 patients at risk of mesenteric ischemia, confirming the presence of this complication in 14 patients (9%). The risk factors found were renal replacement therapy and the presence of a second shock within the first five days of using ECMO. Early initiation of enteral nutrition was negatively associated with mesenteric ischemia.

Among the main gastrointestinal complications associated with the use of ECMO and the critically ill patient is VRG. For some researchers, it may be one of the first signs to warn of intestinal ischemia in patients using vasopressors. In a study by Ridley et al.[35], they found a frequency of 136 episodes of VRG during 1602 days of ENT. Ferrie et al.[36] found that 33 of 86 (38%) patients had elevated VRG in association with abdominal distension or discomfort during ECMO.

For a long time, monitoring VRG was associated with a reduction in the incidence of vomiting and the risk of

bronchoaspiration. However, this practice was discouraged due to the need to interrupt NE, with negative consequences for the nutritional status of this population. Current literature shows that there are no significant differences in the incidence of abdominal distension, diarrhea, ventilator-associated pneumonia (VAP), duration of mechanical ventilation, length of ICU stay and mortality between patients with or without VRG monitoring[37].

The presence of diarrhea was not very evident in the articles that made up this review. However, in the ICU this event can be a common complication of the use of ENT due to the rapid infusion of the diet, the use of hyperosmolar formulas, the use of antibiotics, prokinetics, catecholamines, proton pump inhibitors, laxatives, and Clostridioides difficille infection[38].

Some of the limitations of this review were the lack of multicenter studies and the fact that most of the studies were observational. Thus, some unmeasured confounding factors could affect the parameters observed. In addition, there is divergence in the decision on nutritional supply values, both in critically ill patients and their clinical uniqueness and in patients using ECMO, thus preventing the creation of individualized protocols and recommendations with a high degree of specificity in terms of calorie and protein supply.

CONCLUSION.

The studies analyzed in this review show that patients on ECMO are a challenge for hospital nutrition services, since there is little practical evidence and studies with robust methodologies to guide the development of specific recommendations for this group.

However, following the NT guidelines for critically ill patients, paying attention to the early start of NT, adjusting the nutritional supply according to the stages of the disease and signs of GI dysfunction seem to be mandatory to guide an individualized clinical practice for critically ill patients on ECMO.

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