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Enteral nutritional support in burn patients: the state of the art

Suporte nutricional enteral ao paciente queimado: o estado da arte

Apoyo nutricional enteral para pacientes quemados: el estado del arte

ABSTRACT

Objective: To analyze the state of the art on enteral nutritional support to critically ill burned patients. **Method:** Integrative literature review conducted with searches in Pubmed, CINAHL and LILACS. **Results**: The search made possible the selection of 28 scientific articles available online and in the English language, which were organized and discussed in six categories: hypermetabolism and enteral nutrition; early enteral nutrition in burned patient; energetic need estimate; supplementation in enteral nutrition; fasting and intraoperative nutrition; food intolerance and sepsis. **Conclusion:** The study provided information on the benefits associated with the introduction of enteral nutrition to the burned patient, investigations on the most appropriate caloric intake, researches on supplemented nutrition and encouragement of practices that do not yet fully participate in the daily hospital, such as intraoperative nutrition. However, the lack of national research aimed at patients with burns was noticeable.

Descriptors: Enteral Nutrition, Burns, Burn Units, Nursing, Review.

RESUMO

Objetivo: Analisar o estado da arte sobre suporte nutricional enteral ao paciente queimado criticamente enfermo. **Método:** Revisão integrativa de literatura realizada com buscas nas bases de dados PubMed, CINAHL e LILACS. **Resultados**: A busca possibilitou a seleção de 28 artigos científicos com disponibilidade online e no idioma inglês, os quais foram organizados e discutidos em seis categorias: Hipermetabolismo e nutrição enteral; Nutrição enteral precoce nas vítimas de queimaduras; estimativa de necessidade enérgica; Suplementação na nutrição enteral; Jejum e nutrição intraoperatória; Intolerância à alimentação e sepse. **Conclusão:** O estudo proporcionou a exposição de diversas informações a respeito dos benefícios associados à introdução de nutrição enteral ao paciente queimado, investigações sobre o aporte calórico mais adequado, pesquisas sobre a nutrição suplementada e incentivo de práticas que ainda não participam totalmente do cotidiano hospitalar, como a nutrição intraoperatória. Entretanto, foi perceptível a carência de pesquisas nacionais voltadas ao paciente com queimaduras.

Descritores: Nutrição Enteral, Queimaduras, Centros de Queimados, Enfermagem, Revisão.

ABSTRACT

Objective: To analyze the state of the art on enteral nutritional support to critically ill burned patients. **Method:** Integrative literature review conducted with searches in Pubmed, CINAHL and LILACS. **Results**: The search made possible the selection of 28 scientific articles available online and in the English language, which were organized and discussed in six categories: hypermetabolism and enteral nutrition; early enteral nutrition in burned patient; energetic need estimate; supplementation in enteral nutrition; fasting and intraoperative nutrition; food intolerance and sepsis. **Conclusion:** The study provided information on the benefits associated with the introduction of enteral nutrition to the burned patient, investigations on the most appropriate caloric intake, researches on supplemented nutrition and encouragement of practices that do not yet fully participate in the daily hospital, such as intraoperative nutrition. However, the lack of national research aimed at patients with burns was noticeable.

Descriptors: Enteral Nutrition, Burns, Burn Units, Nursing, Review.

RESUMEN

Objetivo: Analizar el estado del arte sobre soporte nutricional enteral al paciente quemado críticamente enfermo. **Método:** Revisión integral de literatura realizada con búsquedas en las bases de datos PubMed, CINAHL y LILACS. **Resultados**: A búsqueda posibilitó la selección de 28 artículos científicos disponibles en línea y en el idioma inglés, los cuales fueron organizados y discutidos en seis categorías: hipermetabolismo y nutrición enteral; nutrición enteral precoz en lo paciente quemado; estimación de necesidad enérgica; suplementación en la nutrición enteral; ayuno y nutrición intraoperatoria; intolerancia a la alimentación y sepsis. **Conclusión:** El estudio proporcionó la exposición de diversas informaciones respecto de los beneficios asociados a la introducción de nutrición enteral al paciente quemado, investigaciones sobre el aporte calórico más adecuado, investigaciones sobre la nutrición suplementada e incentivo de prácticas que aún no participan totalmente del cotidiano hospitalario, como la nutrición intraoperatoria. Sin embargo, fue perceptible la carencia de investigaciones nacionales dirigidas al paciente con quemaduras.

Descriptores: Nutrición Enteral, Quemaduras, Unidades de Quemados, Enfermería, Revisión.

Charlise Ferreira Corrêa[1]
0000-0002-8202-0325

Juliana Helena Montezeli[1]
0000-0003-4522-9426

Carolina Rodrigues Milhorini[1]
0000-0001-8228-9327

Andréia Bendine Gastaldi[1]
0000-0002-4081-993X

[1]State University of Londrina, Brasil.

Corresponding author:
Charlise Ferreira Corrêa
E-mail: charlisecorrea@gmail.com

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INTRODUCTION

It is known that morbidity and mortality from external causes is a worldwide public health problem. It should be highlighted burns, which, as explained by the World Health Organization (WHO), are responsible for about 180,000 deaths annually in the world, most of which occur in low- and middle-income countries. Epidemiologically, women are more affected by domestic situations, such as food preparation with the use of stoves, as well as in cases of self-directed or interpersonal violence. In men, burns are more related to the work environment, and most of them present injuries in the thorax and upper limbs[1]. This scenario is also evidenced in Brazil, where these injuries caused the hospitalization of more than 150,000 people in 2019[2] and 144,461 in 2020, with 3,077 deaths in the same year[3].

Due to the aggressiveness in several systems resulting from burn physiopathology, most of these victims are critically ill patients who require specialized care in intensive care[3]. In these patients, individual factors such as age, immune system performance, development of complications and nutritional status may affect prognosis, in addition to those directly related to the burn itself, such as the extent and level of involvement of the affected body area, the degree of injury, the presence of infection and its intense effects on the body, such as damage to the cardiovascular, respiratory and renal systems, as well as possible progression to sepsis[4,5].

The pathophysiological systemic response after burns generates several changes in the general condition of the patient, among them, the increase in basal metabolic rate, which shows a radical exponential growth. Moreover, there is often the possibility of concomitant infection, which also increases the basal metabolic rate[6].

Even if, as a consequence of the release of inflammatory mediators and the stress response, metabolic abnormalities found in burn patients occur, it cannot be disregarded that the length of hospitalization (usually long) also significantly influences the nutritional status of the patient and its depletion can occur within a few days due to the surrounding factors, in addition to the possible aggravation of the suffered trauma[7].

Because of the high energy expenditure and high nitrogen loss, adequate nutritional support for burn patients is essential, since it contributes greatly to increased immunity, wound healing, and reduction of infectious incidences and complications. Therefore, it should be individualized and started early in order to minimize depletion related to hypermetabolism[8].

In Brazil, recommendations for feeding the burn patient follow international guidelines, highlighting 1) Nutritional support should be provided during the acute phase of recovery; 2) enteral nutritional support should be used in preference to parenteral; 3) conventional oral diets or enteral feeding should be started as soon as possible; 4) for patients with more than 20% of body surface area burned, hyperprotein diet is recommended, and adequate calories should be provided to meet energy needs. Adults should receive 1.5 to 2 g of protein per kilogram of body weight per day (g/kg/d), and children should receive 3g/kg/d; 5) energy requirements should be estimated by formulas that use variables such as age, weight and burn size[9,10].

As seen, the nutrition of the severely burned patient is of fundamental importance for his or her recovery and, given its relevance in the overall therapy of these patients, it is inferred that the multidisciplinary team needs to be updated on the scientific evidence surrounding this theme.

The nurse is inserted in this team, whose role goes far beyond the proper positioning of the feeding catheter and extends to the proper management of the prescribed diet volume and other essential care for the patient to receive the desired caloric intake. Extending this reasoning, it is advocated that nurses can be key players in the development and implementation of protocols and policies on enteral nutrition that contribute to the reduction of errors[11].

Accordingly, for the effective translation of knowledge to occur, one must gather and systematize information regarding the specifics of enteral nutritional support offered to critically ill burned patients. Based on these precepts, this research aimed to analyze the state of the art on enteral nutritional support to critically ill burned patients.

METHODS

This is an integrative review that consists of a data search method, in a broad analysis of the literature that contributes to discussions about research processes and results on a given subject. It has the potential to build knowledge in nursing that is fundamental to quality clinical practice, because, in a single access, one has several surveys conducted with results on the desired theme[12].

The following steps were followed: elaboration of the research question, sampling or literature search of the primary studies, data extraction, evaluation of the included primary studies, interpretation of the results, and presentation of the review[12].

In order to construct the guiding question of the literature search, the PICO[13] strategy was used, suppressing the third element (Comparison) of the acronym because it does not apply to the type of study conducted in which Patient (P) = burned patient, Intervention (I) = enteral nutrition and Outcomes (O) = adequate nutrition. Thus, the question was: What is the scientific evidence on the use of enteral nutrition in burned patients to provide adequate nutritional status to such clientele?

The search for studies took place from August to November 2019, in the National Library of Medicine, National Institutes of Health (PubMed), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Latin American and Caribbean Literature in Health Sciences (LILACS).

Enteral nutrition and burns were used, in Portuguese, Spanish and English, as selected descriptors in the *Descritores em Ciência da Saúde*

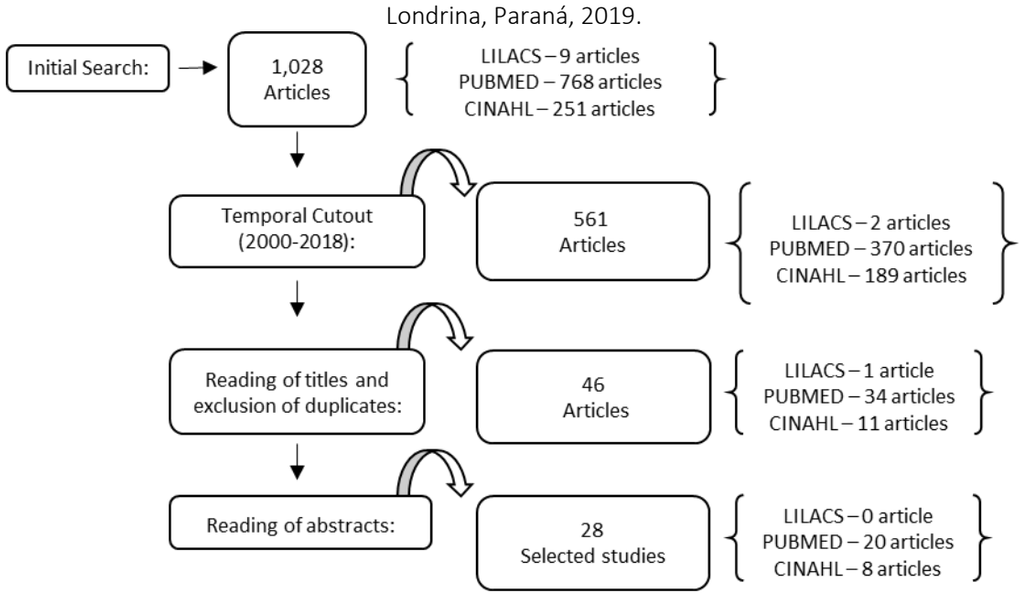
(DeCS) of the Virtual Health Library (VHL) and MeSH Database. The synonyms were also used: Forced Feeding and Enteral Feeding. The combinations used to ensure a broad search were: (enteral nutrition OR enteral feeding OR feeding force) AND burns.

After the survey, the titles and abstracts were read and those that were part of the review were selected. Inclusion criteria for the sample to be analyzed were: being a national or international scientific article with primary data, online availability between the years 2000 and 2018; being in Portuguese, English or Spanish languages; and dealing with issues related to enteral nutrition for burn patients.

Publications whose objectives were not aligned with the specifics of nutritional support for burn patients were excluded, as well as repetitions in more than one database. Secondary studies (such as systematic review), traditional reviews, letter-answer and editorials were also excluded from the sample of this integrative review. The analysis of eligible studies occurred in the same time frame by two independent reviewers.

Figure 1 presents a flowchart demonstrating the operationalization for selecting the studies included in this integrative review.

FIGURE 1: Flowchart of operationalization for selection of the studies included in the integrative review. Londrina, Paraná, 2019.



Source: Data obtained from the study, 2019.

The instrument used to systematize the findings in each of the articles was prepared based on aspects already validated in another study[14], building a specific spreadsheet in order to meet the demands of this investigation.

The data analysis was done in two phases:

1) In the first phase, we identified the location of the article, year and journal of publication, authorship, country where the research was carried out, objective, and method of the study;

2) In the second phase, the articles were analyzed, in an attempt to identify the authors' positions about the theme investigated here. Additionally, discussion categories were built, grouping the articles by thematic similarities.

RESULTS AND DISCUSSION

The integrative review made it possible to find 1,028 articles, of which, after being evaluated and applying the inclusion and exclusion criteria, 28 were included in this review, all published in English. The years with the highest number of publications were 2017, 2014, and 2013, with three studies each.

The country that showed the largest amount of articles produced was the United States, with twelve studies, three of which had the participation of Spain, China and Canada. Then, China, Austria, Lithuania and Australia published two articles for each country, with one from Australia also having a contribution from Canada. Taiwan, Egypt, Iran, Greece, Croatia, India, Vietnam and France published a study each country, which indicates the concentration of scientific work development mainly in the European continent, Asia and North America, as well as underlines the lack of national research on enteral nutrition for burn patients.

Regarding the chosen methods, there were more clinical trials[12], followed by retrospective cohorts[8], prospective cohorts[6], and quasi-experimental study and case-control[1].

The main information about the included articles is shown in Figure 2 below.

Figure 2: Summary of the primary studies included in the integrative review. Londrina, Paraná, 2019.

Authorship/ Year (in chronological order of publication)	Journal/ Database	Country where the study was conducted	Objectives	Method
Coudray-Lucas, Le Bever, Cynober; De Bandt, Carsin (2000)[15]	Critical Care Medicine/ CINAHL	France	To compare the effectiveness on wound healing time in severe burn patients of ornithine alpha-ketoglutarate supplementation in enteral feeding versus an isonitrogen control.	Randomized, controlled, double-blind clinical trial
Noordenbos, Hansbrough, Gutmacher, Doré, Hansbrough (2000)[16]	The Journal of Trauma/ CINAHL	United States	To continuously monitor metabolic demand during excision and wound closure in burn patients.	Non-controlled clinical trial
Andel, Rab, Andel, Felfernig, Hörauf, Felfernig, Schramm Zimpfer (2001)[17]	Journal of the International Society of Burn Injuries/ CINAHL	Austria	To measure the effects of high-calorie early enteral nutrition on intestinal oxygen balance in severely burned patients.	Prospective cohort study
Peng, Yuan, Xiao (2001)[18]	Journal of the International Society of Burn Injuries/ CINAHL	China	To analyze the effects of early enteral feeding on the prevention of enterogenic infection in burn patients.	Randomized controlled clinical trial
Zhou, Jiang, Sun, Wang, Ma, Wilmore (2003)[19]	Journal of Parenteral and Enteral Nutrition/ CINAHL	China and United States	To evaluate the effect of enterally administered glutamine dipeptide (gln) on metabolic, gastrointestinal, and outcome parameters after severe burn injury and third-degree burns ranging from 20% to 40% and no respiratory injury.	Randomized, double-blind, controlled clinical trial
Gudaviciene, Rimdeika, Adamonis (2004)[20]	Medicina (Kaunas)/PubMed	Lithuania	To evaluate whether enteral nutrition reduces the rate of serious complications and complication-related mortality in severe burns.	Prospective cohort study
Peck, Kessler, Cairns, Chang, Ivanova, Schooler (2004)[21]	The Journal of Trauma/ CINAHL	United States	To compare the effects of early versus late enteral feeding on post-burn metabolism.	Randomized controlled clinical trial
Andel, Kamolz, Donner, Hoerauf, Schramm, Meissl, Andel (2005)[22]	Journal of the International Society of Burn Injuries/ CINAHL	Austria	To evaluate whether intraoperative duodenal feeding may put patients at risk of developing splanchnic oxygen imbalance due to compromised intestinal perfusion intraoperatively based on stress and unrecognized hypovolemia.	Case-control study
Rimdeika, Gudaviciene, Adamonis, Barauskas, Pavalkis, Endzinas (2006)[23]	Journal of the International Society of Burn Injuries/ CINAHL	Lithuania	To investigate the relationship between the caloric value of enteral nutrition and the course of treatment.	Prospective cohort study
Lam, Tien, Khoa (2008)[24]	Journal of the International Society of Burn Injuries/ PubMed	Vietnam	To investigate the impact of early enteral feeding on immunological and metabolic aspects and outcomes in 82 severe burn patients.	Randomized controlled clinical trial
Pattanshetti, Powar, Godhi, Metgud (2009)[25]	Indian Journal of Surgery/ PubMed	India	To measure the impact of enteral glutamine supplementation on infectious morbidity and, in turn, hospital stay in burn patients.	Randomized controlled clinical trial
Falder, Silla, Phillips, Rea, Gurfinkel, Baur, Bartley, Wood, Fear (2010)[26]	Journal of the International Society for Burn Injuries/ PubMed	Australia	To study whether thiamine supplementation increases serum thiamine.	Controlled clinical trial
Lu, Huang, Yu, Zhu, Cai, Gu, Su (2011)[27]	Journal of Clinical Biochemistry and Nutrition/ PubMed	China	To evaluate the effect of early enteral feeding compared to parenteral feeding on various outcomes, including translocation of intestinal organisms, gastrointestinal mucosal injury, and the incidence of enterogenic infection in patients with extensive burns.	Retrospective cohort study
Mosier, Pham, Klein, Gibran, Arnoldo, Gamelli, Tompkins Herndon (2011)[28]	Journal of Burn Care & Research/ PubMed	United States	To evaluate compliance with early enteral nutrition, possible barriers to implementation, associated complications, and hospitalization outcomes.	Multicenter prospective cohort study
Holt, Graves, Faraklas, Cochran (2012)[29]	Journal of the International Society for Burn Injuries/ PubMed	United States	To compare single center enteral nutrition practices with guidelines published by the Society of Critical Care Medicine/American Society for Parenteral and Enteral Nutrition with best practices in the first week of hospitalization.	Retrospective cohort study
Kesey, Dissanaike (2013)[30]	Journal of Burn Care & Research/ PubMed	United States	To evaluate the effectiveness of an aggressive nutritional delivery protocol.	Retrospective cohort study
Vicic, Radman, Kovacic (2013)[31]	Asia Pacific Journal of Clinical Nutrition/ PubMed	Croatia	To compare the benefits and safety of introducing very early enteral nutrition compared to the standard diet in burn patients in an intensive care unit.	Randomized controlled clinical trial

Pérez-Guisado, de Haro-Padilla, Rioja, De Rosier, de la Torre (2013)[32]	International Journal of Burns and Trauma/ PubMed	Spain and United States	To determine the relationship of serum albumin levels at 3 to 7 days after burn injury to total burned body surface area, length of hospitalization, and initiation of oral/ enteral nutrition.	Retrospective cohort study
Lavrentieva, Kontakiotis, Bitzani (2014)[33]	Journal of Burn Care & Research/ PubMed	Greece	To investigate the frequency of enteral feeding intolerance in severe septic burn patients, the effect of enteral feeding intolerance on feeding efficacy, the correlation between infection marker (procalcitonin) and nutritional status marker (pre-albumin), and the impact of feeding intolerance on the outcome of septic burn patients.	Prospective cohort study
Mahmoud, Mostafa, Abdel-Khalek, Shalaby (2014)[34]	Annals of Burns and Fire Disasters/ PubMed	Egypt	To evaluate the effect of early enteral feeding supplemented with glutamine and omega-3 fatty acids, as immune system-enhancing diets, on outcomes in patients after severe burns.	Randomized, double-blind, controlled clinical trial
Shields, Brown, Aden, Salgueiro, Mann-Salinas, Chung (2014)[35]	Journal of the International Society for Burn Injuries/PubMed	United States	To examine our change in practice and compare the effect of gradual versus goal restart of enteral nutrition after burn surgery in the hemodynamically stable patient, the caloric supply, incidence of gastrointestinal complications and outcomes.	Retrospective cohort study
Czapran, Headdon, Deane, Lange, Chapman Heyland (2015)[36]	Journal of the International Society for Burn Injuries/ PubMed	Australia and Canada	To evaluate international practices related to nutritional support and outcomes in mechanically ventilated patients with burns.	Multicenter retrospective cohort study
Ostadrahimi, Nagili, Asghari-Jafarabadi, Beigzali, Zalouli, Lak (2016)[37]	Iranian Red Crescent Medical Journal/ PubMed	Iran	To determine the possible protective effect of early and adequate nutritional support on the sequential organ failure assessment score and length of hospital stay in thermal burn victims.	Randomized, double-blind, controlled clinical trial
Conrad, Liberio, Aleem, Halerz, Mosier, Sanford, Balasubramanian, Gamelli (2017)[38]	Journal of Burn Care & Research/ PubMed	United States	To increase the number of days burn service patients receive 100% of prescribed enteral nutrition.	Quasi-experimental study
Heyland, Wischmeyer, Jeschke, Wibbenmeyer, Turgeon, Stelfox, Day, Garrel (2017)[39]	Scars, Burns & Healing/ PubMed	United States and Canada	To provide the rationale and protocol for a large clinical trial of supplemental enteral glutamine in 2700 severe burn patients.	Multicenter, controlled, randomized, double-blind, pragmatic clinical trial.
Varon, Freitas, Goel, Wall, Bharadia, Sisk, Vacanti, Pomahac Sinha, Patel (2017)[40]	Journal of Burn Care & Research/ PubMed	United States	To evaluate the feasibility and safety of providing uninterrupted intraoperative enteric feedings in severely burned patients admitted under the protocol under study	Retrospective cohort study
Chan, Lee, Ou, Cheng, Wang (2018)[41]	Asia Pacific Journal of Clinical Nutrition/ PubMed	Taiwan	To find a practical equation for patients with burns over 50% of their total body surface area in an intensive care unit.	Prospective cohort study
Pham, Collier, Webb, Garner, Gillenwater (2018) [42]	Journal of the International Society for Burn Injuries/ PubMed	United States	To quantify perioperative fasting time, evaluate the effectiveness of a dietary recovery protocol, and identify areas for improvement.	Retrospective cohort study

Source: Data obtained from the study, 2019.

After reading the included studies, they were grouped by similarity of subjects forming categories, so that the exposure of the various authors' research on enteral nutrition offered to burn patients in different aspects could be better developed. Some articles are repeated in more than one category: 1) Hypermetabolism and enteral nutrition[16,20,21,26,33-37,40,42]; 2) Early enteral nutrition in burned patients[17,18,24,27,28,30-33,35,37]; 3) Estimation of energy need[23,26,29,36,38,41]; 4) Supplementation in enteral nutrition[14,19,25,26,34,39]; 5) Fasting and intraoperative nutrition[22,35,36,38,40,42]; 6) Food intolerance and sepsis [27,31,33,38].

Hypermetabolism and enteral nutrition

Burn patients are affected by intense physiological alterations that interfere with their general condition and cause their basal metabolism to increase almost twofold[36] , generating a hypermetabolic state that may persist for up to two years after the burn[37]. The repercussion of these high metabolic demands stimulates increased energy expenditure and inflammatory response causes a reduction in lean body mass and adipose tissue, compromises the immune system and the functioning of the intestinal barrier, delays the injury healing process, and leads to the late development of multiple organ dysfunction syndrome[34,35,37,40]. There is also skeletal muscle catabolism, which involves reduced amino acid uptake, inhibition of protein synthesis, and disruption of myofibrillar proteins that can result in anorexia, cachexia and sepsis[16].

Enteral nutrition is generally recommended for adults with total body surface area affected above 15%[26] and acts as an efficient solution to reduce hypermetabolism and meet the caloric, protein and energy needs of patients with burns. Adequate nutritional supply is fundamental for recovery of the patient's health, with benefits such as preservation of lean body mass, minimization of

mechanical ventilation time and injury healing time, protection of gastric activity and intestinal barrier, reduction of mucosal atrophy, risk of infections and mortality[33,40,42].

Two studies support these benefits and highlight the importance of enteral nutrition. Gudaviciene et al.[20] compared burn patients who received enteral nutrition with those who did not, showing that the enterally nourished group had a lower incidence of pneumonia, pulmonary edema, renal failure, sepsis and mortality. Ostadrahimi et al.[37] evaluated enteral feeding using the Sequential Organ Failure Assessment (SOFA) tool, showing that there was a reduction in the SOFA score, hypermetabolic response, negative oxygen balance, rate of infections and length of hospital stay.

Nevertheless, clinical data from the study by Noordenbos et al.[16], who monitored metabolic expenditure from a tool connected to the mechanical ventilator to measure oxygen consumption and carbon dioxide production, showed that the high protein enteral diet does not limit hypermetabolism and early excision of burn wounds does not attenuate metabolic demands. The same research suggests alternative and supplemented diets as options that may be used to address this issue, and further studies are needed. Another article that reached similar results was that of Peck et al.[21], who looked at enteral feeding and early wound excision compared to late nutrition and excision, evidencing that the group offered early nutrition did not decrease their post-burn hypermetabolism, although they were able to reduce skeletal muscle catabolism.

Early enteral nutrition in burn patients

The early introduction of enteral nutrition is defined by its initiation within the first 24 hours after hospitalization[30], a practice that has been studied and proven its advantages over the years.

Early and continuous feeding is a technique that can increase caloric and protein intake, encourage secretion of digestive enzymes, maintain mucosal integrity, motility, and intestinal blood flow, which helps prevent intestinal hypoperfusion. It also decreases the rate of circulating catecholamines, cortisol, and glucagon, reduces the length of hospital stay and mortality[35,37]. In a study, patients who were introduced to early enteral nutrition showed lower values of albumin, transferrine and C-reactive protein (CRP) concentrations in comparison with those who did not receive it, especially between the fourth and fifth week of hospitalization, the period when the highest concentration indices were found[31]. Peng et al.[18], when analyzing a group using early enteral feeding versus one with late enteral feeding, showed decreased serum levels of endotoxins, tumor necrosis factor alpha (TNF-α) and urinary concentrations of lactulose and mannitol, the latter that may act as accurate markers to assess intestinal permeability that is altered after burns.

However, in the study by Pérez-Guisado et al.[32], the action of serum albumin was followed in the highest period of the catabolic phase in burned patients, which is between the third and seventh day after burn injury, and it was observed that albumin presented as a poor nutritional marker and that its use should be avoided to assess the nutritional status of the patient, since it showed no association between its serum levels with the beginning of enteral nutrition. The authors encourage to relate serum albumin levels in patients with up to 20% of total body surface area burned, during the catabolic stage, to identify the severity of injuries and associate with length of stay, since lower albumin levels represented a higher risk of morbidity and prolonged length of stay in the intensive care unit (ICU).

Enteral nutrition is preferred over parenteral nutrition because of its several advantages[33]. When assessing the different repercussions among burn patients who received early nutrition, one group using enteral and the other parenteral, patients who received enteral nutrition showed increased hemoglobin values and reduced incidence of systemic infection, the latter associated with individuals manifesting a longer time between the latency period and the emergence of the first infection, which enabled an early diagnosis and treatment in adequate period[27]. Another study also produced the same comparison, revealing that on the seventh day of hospitalization, enterally nourished individuals had improved humoral and cellular immunity, with a higher absolute number of TCD4 and TCD8 cells, high levels of immunoglobulins A, G and M (IgA, IgG and IgM), as well as reduced occurrence of gastrointestinal bleeding[24]. Mosier et al.[28] followed up two groups using early enteral nutrition, where one started within 24 hours and the other within 48 hours, observing no difference between them other than the already expected benefits. The authors still encourage offering nutrition within the first 24 hours.

However, Kesey and Dissanaike[30] applied an aggressive early enteral nutrition protocol that resulted in increased ileal size and intolerance to feeding for a long period, which consequently prevented adequate nutritional intake and its benefits. It is hypothesized that splenic hypoperfusion arose as a result of the large amount of nutrition offered while the group of patients was at the peak of their hypermetabolism. The factor of the feeding route as a contributor is also cited, although the American and European Society for Parenteral and Enteral Nutrition states that there is no difference between introducing nutrition by the gastric route compared to the jejunal route. It is also suggested that if the study had followed the patients for a period longer than seven days, as well as applying nutrition at slow and steady rates, it might have achieved different results.

In contrast, Andel et al.[17] observed patients who received early enteral nutrition with high caloric content and analyzed the intestinal oxygen balance by monitoring air tonometry in order to identify the difference between arterial and gastric carbon dioxide gas. Although there was a rapid increase in the amount of nutrition offered, no patient had intestinal oxygen imbalance, indicating that the relatively high nutrition has a protective

function for the intestine due to the distribution of intestinal flow.

Estimation of energy need

The amount of energy essential for health rehabilitation of burn patients is not yet fully defined. Considering that energy requirements are close to 140% of the patient's metabolic rate[26], some authors recommend a prescription of 30 to 40 kilocalories (kcal) per kilogram within 24 hours, while others state that excessive energy estimates may contribute to increased complications and mortality[23]. Regarding the resting energy expenditure prediction calculation, Shields et al.[35] consider Carlson and Miller's equations to be the most accurate, while Holt et al.[29] use Harris-Benedict's formula because it is a widely accepted equation, along with indirect calorimetry calculation, which is a reference for estimating caloric goals in critically ill patients.

Rimdeika et al.[23] studied patients who followed a dietary regimen in which they offered 30 to 35 kcal per kilogram of body weight in 24 hours and patients who received less than 30 kcal daily. The group that followed the regimen started enteral nutrition by an infusion pump at 20 ml per hour for the first eight hours, and if the patient continued to tolerate the diet well, the speed was increased by 20 ml every eight hours. As a result, the patients had reduced incidence of pneumonia, sepsis, mortality, and hospital treatment time. Chan et al.[41] support this dietary regiment when performing a similar study, evidencing that 35 kcal per kilogram of body weight enables patients to reach up to 53% of total energy needs during the first week of treatment, being considered the ideal formula to establish nutritional support. It also showed that the average protein intake is equivalent to 22% of the total energy needs, being delivered 1.9 grams of protein per kilogram of body weight, as well as every 1% increase in energy expenditure corresponds to an increase in the wound healing rate. However, the formula in this study was applied to young patients with more than 50% of the total body surface area burned, and it is necessary to evaluate whether it would generate the same results in another population, such as the elderly, for example.

Conrad et al.[38] developed an algorithm with the objective of increasing the number of days on which 100% of the prescribed volume of enteral nutrition is achieved. The algorithm was adapted according to the age rather than the weight of the patients, since this could change due to the presence of edema. The maximum infusion dose of nutrition was based on the stomach capacity of each age, thus establishing a maximum rate of 200 ml per hour for adults. The algorithm is based on starting the infusion with 50 ml per hour for two hours, then increasing 50 ml every four hours, and in the absence of high residual stomach quantities, increasing 50 ml every four hours until the prescribed rate is reached. The amount of nutrition not delivered due to procedures such as perioperative fasting, dressing changes, and occupational therapies is calculated, and the hourly rate is increased to double the prime rate.

The implementation of this algorithm was able to increase the period in which patients received 100% of the feeding volume, as well as decrease the length of hospital stay. The use of volume targets, which proved to be higher than the hourly target rate, along with the permanent education of the nursing team to train all professionals to adhere to the new protocol, were factors that influenced this result. However, patients with total burned body surface area greater than 30% developed hypovolemia and hyperglycemia, being added as a conduct to this protocol the practice of an hourly rate of intravenous fluids for eight to twelve hours in the postoperative period, as well as the adjustment of intravenous insulin drip, to avoid these complications[38].

Supplementation in enteral nutrition

Supplemented enteral nutrition, also known as enteric immunonutrition, is a resource that has been increasingly studied, and its main objectives are to improve the immune system, maintain the integrity of the intestinal mucosa, contain the inflammatory process and reduce the development of sepsis[34].

Coudray-Lucas et al.[15] evaluated the action of an amino acid derivative, ornithine α-ketoglutarate (OKG), as a supplement in the nutrition of burn patients for three weeks. OKG supplementation was well tolerated, with 20g being administered in two 10g boluses per day. So far, its mechanism of action is not completely precise, but when metabolized, OKG increases the synthesis of glutamine, arginine and proline, which are related to the reduction of septic complications. When comparing the results between a group that was offered OKG supplement and another group fed with soy protein mixture, a decrease in wound healing time was observed, being a specific action of this substrate and not associated with nitrogen effects. The factor that may be related to this result is the production of arginine, which acts in the deposition of collagen and is a precursor of nitric oxide, leading to the elimination of free radicals and allowing modulation of the immune response. Other factors such as the formation of polyamine, which activates fibroblast proliferation, and the stimulation of OKG in the secretion of growth hormone may also have contributed.

The same study also showed increased levels of transthyretin, a sensitive indicator of the effect of renutrition. There was also a decrease in plasma phenylalanine concentration and the ratio between 3-methylhydristidine and creatinine, indicating a reduction in muscle hypercatabolism and myofibrillar breakdown.

Falder et al.[26] analyzed the supplementation of thiamine, since the continuous lack of this vitamin may cause neuropathies, cardiovascular disorders and possibly excess lactate. With thiamine supplementation, a rapid increase in serum thiamine was evidenced, reaching its plateau in about one week, and a reduction in pyruvate and

lactate levels, which, when increased, are related to increased risk of mortality in burn patients.

Regarding glutamine supplementation, there are several opinions that have been discussed over the years. Pattanshetti et al.[25] observed the differences manifested by burn patients who received an isonitrogenous mixture supplemented with glutamine and patients who maintained their regular diet. A reduction in wound healing time and hospital stay was noted in the supplemented group, as well as a lower incidence of blood infection, where the reason for this is not yet clearly determined. The main hypotheses suggest that the decreased blood infection is associated with the ability of glutamine to prevent intestinal bacterial translocation, or that the supplemented group had a better immune status, while the control group had immunosuppression and progression to bacteremia. The observed decreased mortality risk may or may not be related to supplementation.

Mahmoud et al.[34] support the findings cited, since when following up patients who received early enteral feeding supplemented with 0.3 grams per kilo/day of glutamine and three grams per day of omega-3 fatty acids, they noticed a significant decrease in the incidence of infection and length of hospital stay in comparison to patients who did not receive supplementation. They also exposed reduced serum CRP levels, suggesting modulation of the systemic inflammatory response, and increased pre-albumin levels. In addition, there was improvement in humoral and cellular immune function due to increased total lymphocytes and IgA, IgG, and IgM.

Zhou et al.[19] evaluated the effect of enteral supplementation of the dipeptide L-Alanil-glutamine at a dose of 0.5 grams per kilo/day, and found improvement in wound healing, less weight loss, decreased intestinal permeability, plasma levels of endotoxins, length of hospital stay, and hospital costs. The performance of the dipeptide is still uncertain, but it is suspected that the results found correlate with the activation of protein synthesis and inflammatory response.

However, a large multicenter international clinical trial is underway by Heyland et al.[39] , in which it is intended to evaluate enteral glutamine supplementation in 2,700 burn patients from North America, South America, Europe and Asia. This study states that glutamine supplementation has been shown to be harmful to patient health and may even increase the risk of mortality, while other research shows glutamine to be an advantageous alternative, as in helping to improve cardiac function, insulin sensitivity and protein metabolism, for example, generating conflicting evidence. Thus, the authors plan to apply every four hours, 0.5 grams per kilogram/day of glutamine to patients with body mass index (BMI) less than thirty-five, while the control group will receive an isocaloric serving of maltodextrin combined with water.

Fasting and intraoperative nutrition

Burn patients usually require several surgeries during their hospital stay, which leads them to perform perioperative fasting repeatedly, since it is a common practice that remains perpetuated in the hospital setting, even though there are studies that prove the efficiency of reduced fasting protocols. Other factors that may cause fasting are the intervals for extubation or endotracheal intubation and occurrence of intolerance to enteral nutrition due to large amounts of gastric residual volume and/or abdominal distension[36,42].

One of the main problems in the practice of perioperative fasting is that it often lasts longer than recommended, which directly affects the amount of nutrition and energy required for patient recovery. In the study by Pham et al.[42], a protocol for recovery of calories lost during the perioperative fasting period was applied, and it was evidenced that increasing the target feeding rate can prevent caloric losses, as well as recovery protocols are able to compensate for the prescribed calories to be obtained.

One recommended alternative to correct such caloric deficits is intraoperative nutrition. The Nutrition Support Protocol, in 2010, approved continuous enteral nutrition via post-pyloric tube during non-airway surgeries, and its safety was proven in a study. Intraoperative enteral nutrition meets caloric and protein needs in less time when compared to patients who did not receive it, reduces the total length of hospital stay, days in the ICU, days of mechanical ventilation and does not present an increased risk of aspiration, regurgitation and pneumonia, and there is no association of these complications with surgical positioning[40]. The post-pyloric tube also showed reduced protein and energy deficits when compared to the intragastric route[36].

Another study supporting intraoperative nutrition is that of Andel et al.[22], in which they evaluated the influence of this practice on the risk of splenic oxygen imbalance. Patients who maintained perioperative fasting had a greater difference between arterial and gastric carbon dioxide gas after the initial 3 to 4 hours of the first surgical intervention, while those who received intraoperative nutrition preserved intestinal oxygen balance, as well as decreased caloric needs.

The resumption of enteral nutrition after interruption for surgical procedures is also commonly delayed, which contributes to the development of complications such as weight loss, impaired immune system and delayed wound healing. Shields et al.[35] focused on feeding after initial excision and graft surgery in burn patients, demonstrating that gradual restart of enteral nutrition was more beneficial compared to slow restart, as it was able to achieve a higher percentage of the caloric goal within a 12-hour period. The previously cited article by Conrad et al.[38] also claims that nurses' practice of slow restart causes greater loss of caloric intake, and restarting nutrition two hours after the procedure is recommended.

Food intolerance and sepsis

Intolerance to enteral nutrition can manifest in most burn patients who were introduced to

gastric feeding, compromising the stipulated nutritional demands and causing complications such as aspiration and pneumonia. The risk factors are male, surgical procedures and prone positioning, administration of opioids and catecholamines, gastrointestinal tract dysfunction, inflammatory process, high blood glucose, intracranial hypertension and hydroelectrolytic disorders[33].

Considering the various consequences already mentioned caused by hypermetabolism, the absence of nutrients in the intestinal lumen also acts as a harmful factor to the action of the immune system and inflammatory response, since gastrointestinal bacterial translocation is generally associated with the development of multiple organ failure and sepsis in burn patients[31]. Bacterial translocation occurs when there is mechanical injury to the intestinal mucosa, decreased immune defense or excessive increase of enteric bacteria, and when combined with broad spectrum antibiotic administration and microecological imbalance, may result in enterogenic infections and sepsis[27].

Some authors consider an indicator of food intolerance when the gastric residual volume presents a value between 150 and 500 ml in two moments and in two successive measurements or 500 ml in one measurement, or the occurrence of vomiting, and when the volume is greater than 500 ml, nutrition is interrupted. There is also a recommendation to stop nutrition when the residual volume is less than 500 ml only if the patient presents other signs of associated intolerance[33,38].

A cohort study indicated a high association rate between food intolerance and septic burnout, in which its main indicator was the observation of procalcitonin (PCT) and prealbumin levels. It was evidenced that high levels of PCT concentration and low levels of pre-albumin can be used as early markers of sepsis and intolerance to enteral nutrition, allowing early identification of patients who may develop such complications. It also exposed the correlation between intolerance with the manifestation of septic shock, with reduced nutritional intake, with increased ICU stay, mechanical ventilation period, occurrence of nosocomial pneumonia, SOFA score and mortality[33].

In general, analysis of the articles included shows that some had a restricted population, with a small number of participants, young patients or patients with a certain total burned body surface area, requiring research applied to broader populations to prove the effectiveness of certain practices.

It was also noticed that there was no study focused on the investigation of the ideal composition of enteral nutrition recommended for burn patients, explaining the exact amount of carbohydrates, proteins and lipids, preventing a deeper analysis on this topic.

Thus, although the review now completed synthesizes several important scientific information for the nutrition of burned patients, it has limitations, among them: the need to expand the body of knowledge on this topic, because nutritional therapy for burned patients is a complex therapy that still generates questions such as factors related to the difficulty of progression, strategies to control fasting before and after procedures, association of enteral nutrition to the prognosis of severe burned patients and others. Moreover, there is need for development of studies related to the preparation, administration of enteral diet and nursing care, especially focused on the adult burn patient in intensive care, understanding that the administration of enteral nutrition in this is essential and role of the nursing team.

It is hoped that the evidence compiled in this study may assist the practice of evidence-based nursing and multidisciplinary teams working with the burn patient in intensive care. The use of reviews provides an overview of previous interventions and the development of recent knowledge that can be applied and constantly updated in order to reduce cases of malnutrition and, consequently, contribute to a better prognosis of these patients.

CONCLUSION

Based on the study, it is possible to conclude that enteral nutrition is a practice of extreme importance for the recovery of health in burn patients due to its many benefits. Ways to improve nutrition, such as enteral supplementation, advances, such as intraoperative nutrition, and investigations in search of the ideal energy requirement of nutrition to be administered, are relevant issues that have been showing positive results and may lead to possible future changes in the guidelines, making them more practical and efficient.

Nevertheless, it was observed that the developed articles focus much on technical issues and little on the care of nutrition and its administration itself, such as placement of probes and aspiration of gastric contents, for example. The absence of national studies was also noted, highlighting the scarcity of investigations related to critically ill burned patients in Brazil.

Accordingly, the results of this research seek to introduce an update on the addressed theme and recommend further investigations in the area of Nursing, focusing on the care of nutrition offered to burn patients.

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Patrícia Pinto Braga
Daniel Nogueira Cortez

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