Clinical Nutrition ESPEN 49 (2022) 544–550

Contents lists available at ScienceDirect

Clinical Nutrition ESPEN

journal homepage: http://www.clinicalnutritionespen.com

Protocol

Nutritional support protocol for patients with COVID-19

Jéssica Viana Hinkelmann*, Natália Alves de Oliveira, Daniela Falcão Marcato, Allana Rúbio Ramos Oliveira Costa, Arícia Mendes Ferreira, Marcilene Tomaz, Thalita Jhennyfer Rodrigues, Anangelly Paula Mendes

Santa Casa de Misericórdia de Juiz de Fora, Minas Gerais, Brazil

A R T I C L E I N F O

Article history:
Received 28 February 2021
Accepted 3 March 2022

Keywords:
COVID-19
Coronavirus
SARS-CoV-2
Nutrition therapy
Nutritional assessment

S U M M A R Y

Background & aims: COVID-19 is a hypercatabolic disease with possible pulmonary and gastrointestinal symptoms, and consequent deterioration of the nutritional status and the worst clinical prognosis. This study presents a protocol to guide the nutritional care of adult and elderly people non-critically and critically ill with COVID-19.

Methods: A critical review of the literature was carried out in the databases PubMed, Scielo, Bireme, and Science Direct, in search of articles and guidelines that presented assessment criteria and nutritional conduct for COVID-19 and Severe Acute Respiratory Syndrome (SARS), as well as guidelines for managing the symptoms presented by patients.

Results: The results are recommendations based on the literature and the professional experience of nutritionists who provide nutritional assistance to individuals hospitalized with COVID-19 since the beginning of the pandemic in Brazil. We present tools and suggestions for assessing the nutritional status, calculating nutritional needs, initiating nutritional therapy and monitoring tolerance to it, nutritional monitoring during hospitalization, and guidelines for hospital discharge.

Conclusion: Patients with COVID-19 are at nutritional risk. A complete nutritional assessment (anthropometric, dietary, and laboratory assessment) enables the establishment of an individualized nutritional approach in order to contribute to better clinical and nutritional prognoses.

1. Introduction

The Coronavirus disease (COVID-19) is an acute respiratory syndrome caused by the Coronavirus 2 (SARS-COV-2), responsible for the current pandemic and global public health outbreak. Infected individuals may be asymptomatic, develop mild symptoms (such as cough, chills, fever, fatigue, and dyspnea) or severe ones (such as sepsis, acute respiratory distress syndrome-ARDS, heart failure, and septic shock), in addition to multiple organs dysfunction due to the acute inflammatory process [1–3]. This generates catabolic stress and increases nutritional needs, which, associated with comorbidities such as diabetes, cardiovascular diseases, and old age, augment the risk of malnutrition and related complications [2,4].

The deterioration of the nutritional status can also occur as a result of reduced food intake, deficient absorption, and the loss of nutrients caused by extra-pulmonary symptoms, especially nasal and gastrointestinal ones, including diarrhea, nausea, vomiting, abdominal pain, anorexia, anosmia/hyposmia, ageusia, and dysgeusia [5–7].

Malnutrition is a serious public health problem that can cause immunological depletion, functional disability (due to depletion of muscle mass and strength), and poor quality of life, with consequently increased hospital stays, risk of clinical and pulmonary complications, readmission to the Intensive Care Unit (ICU), and the worst clinical prognosis. Therefore, the screening, diagnosis, and treatment of malnutrition are essential for all patients with COVID-19, especially those with longer ICU stays [1,8].

Thus, the present study aims to establish a nutritional monitoring protocol for patients hospitalized with COVID-19, highlighting the main guidelines and scientific papers on the subject.

* Corresponding author. Santa Casa de Misericórdia de Juiz de Fora. Av. Barão do Rio Branco, 3353 - Passos, 36021-630, Juiz de Fora - Minas Gerais, Brazil.
E-mail address: je.hinkelmann@hotmail.com (J.V. Hinkelmann).

https://doi.org/10.1016/j.clnesp.2022.03.002
2405-4577/

2. Materials and methods

The study is a critical literature review carried out by the Nutrition staff of a philanthropic hospital in Juiz de Fora, Minas Gerais, Brazil, seeking to establish a nutritional assistance protocol for adults and the elderly, non-critically and critically ill with COVID-19. The review sought to establish tools and guidelines for assessing the nutritional status, calculating the nutritional needs, initiating nutritional therapy and monitoring tolerance to it, and nutritional monitoring during hospitalization, as well as guidelines that must be provided to patients at the time of hospital discharge.

The literature review was conducted in the following databases: PubMed, Scielo, Bireme, and Science Direct. A search for papers and guidelines that presented criteria for the assessment and nutritional conduct for COVID-19 and Severe Acute Respiratory Syndrome (SARS) was made, as well as regarding the management of the signs and symptoms presented by patients, using the keywords “COVID-19”, “SARS-COV-2”, “nutritional therapy”, “dietary intake”, “nutritional assessment”, “nutritional screening” and “sarcopenia”.

3. Results and discussion

3.1. Nutritional assessment

The diagnosis of the nutritional status must be based on the assessment of nutritional screenings, laboratory tests, current diseases, physical examination, dietary and anthropometric assessments, thus guiding the establishment of an individualized nutritional approach [9].

3.1.1. Nutritional screening

All individuals must be evaluated within 72 h after admission to the infirmary room and after 48 h in the ICU [3]. We suggest using the Nutritional Risk Screening (NRS-2002) to identify non-critically ill patients at nutritional risk [11], since this has been related to the increased incidence of intestinal and renal failure, respiratory and urinary tract infections, hyperglycemia, morbidity, and mortality in hospitalized patients [11], also presenting high sensitivity and good predictive validity in elderly people with COVID-19 [12,13]. It is worth mentioning that factors such as body temperature and a dose of corticosteroids should be considered when scoring the severity of the disease [10]. As recommended by the European Society of Parental and Enteral Nutrition (ESPEN), we suggest that all critically ill patients with more than 48 h of admission to the Intensive Care Unit (ICU) should be considered at nutritional risk.

Information regarding the history of the current disease, comorbidities, laboratory tests, and medicines of nutritional relevance can be collected from the electronic medical record. If nutrition professionals cannot perform the nutritional assessment in person, teleservice with the patient and intermediation with members of the interprofessional team who are already at the bedside are supported [14,15]. Information on weight loss before hospital admission and reduction of food intake of patients in the ICU bed can be obtained through the psychological and medical staff with the patient's family members.

3.1.2. Anthropometric assessment

To prevent the spread of COVID-19 and ensure the safety of patients and professionals, physical contact with infected patients should be avoided [14,15]. Thus, in the case of lucid and oriented patients, we suggest that the weight and height should be reported for the later calculation of the Body Mass Index (BMI) to be classified according to specific cutoff points for adults and the elderly [16,17]. In the case of those bedridden or on an ICU bed, the weight and height must be estimated using the formula proposed by Chumlea et al. (1988), employing the knee height (KH) and arm circumference (AC), which are taken with the aid of a tape measure for individual use or disposable to avoid in-hospital contamination [18]. The AC should be performed weekly to monitor the patient's nutritional status.

Secondary sarcopenia is defined as loss of strength, mass, and muscle performance caused regardless of the individual's age. Low muscle strength likely indicates sarcopenia, and the diagnosis is confirmed when there is low muscle quality and quantity [19]. Individuals infected with COVID-19 are at risk due to the inflammatory process (that influences muscle protein synthesis), reduced physical activity and anorexia (mainly due to reduced protein intake) [20–22]. Thus, we suggest that the assessment of muscle mass depletion should be carried out based on measurements of the calf circumference (CC), and that of muscle strength should be based on the measurement of handgrip strength with the aid of a manual digital dynamometer [19,23,24].

3.1.3. Dietary assessment

Individuals with COVID-19 should be questioned at the time of the nutritional screening and during hospitalization about the presence of nasosinusal and gastrointestinal symptoms that influence food consumption [5–7,25].

Instruments for investigating food consumption are used to estimate whether the intake is appropriate or inappropriate, providing subsidies for the development and implementation of nutritional plans. The 24-h recall (24h-R) and the journal or food record are the most used instruments in hospital environments to assess current consumption and estimate absolute or relative values of energy and nutrient intake. The food record is preferred in our institution, and consists of descriptions of the food and the quantities consumed in 24 h, and an illustrated form adapted to the portions used in the food service can be employed [26]. It is worth mentioning the importance of training members of the multiprofessional team to properly register the food and volumes consumed. In the case of patients on enteral or parenteral nutritional support, the total volume of diet administered on the day must be recorded.

3.2. Nutritional approach

The nutritional approach must be established after a complete nutritional assessment, considering not only COVID-19 but also the comorbidities and injuries presented by the patient, the number of hospitalization days before the ICU, the energy balance since hospital admission, and the risk for refeeding syndrome [27,28].

3.2.1. Feeding routes: oral

The oral feeding route should be preferred in patients able to consume 70% of their needs between the third and the seventh day of hospitalization, considering the nutritional needs presented in session 3 (Nutritional Needs), without risk of vomiting or aspiration [27]. If meeting the nutritional needs is not possible, or the patient presents nutritional risk through screening, oral supplements should be used [29].

The meals provided by the hospital must consist of unprocessed or minimally processed foods, including culinary preparations using them as a base and all food groups, so as to ensure an appropriate supply of macronutrients and micronutrients, which has been associated with good results in the treatment of COVID-19 and the complications resulting from symptoms disease, as well as better prognosis, given the relevant role of nutrition in strengthening the immune system [2,30].

Appropriate nutritional support in terms of micronutrients, vitamins (mainly A, C, E, D, and the B complex), omega-3, and trace elements (such as selenium, zinc, and iron), helps the immune system's general functioning, control of inflammatory processes, oxidative stress, and nutritional status [1,2,31]. These nutrients' main role is through their action in the differentiation, proliferation, maturation, and function of the cells that make up the immune system, in addition to the development and maintenance of physical barriers such as mucus. However, studies on supplementation in the prevention or treatment of COVID-19 are still controversial, of low quality, and without proven safety, with the risk of reducing or suppressing the immune and anti-inflammatory response [32–34].

Considering the relationship between nutrients and their metabolism, it is important to offer these nutrients and trace elements through foods [32]. Thus, patients on an oral diet should receive 4 or more servings of fruits and vegetables per day (sources of antioxidants, vitamins, minerals, and phytochemicals), 2 to 4 servings of fish per week, as well as an appropriate supply of whole grains, dairy products, poultry, and beef [1]. Water intake should also be monitored, especially in cases of hydroelectrolytic imbalances and gastrointestinal symptoms such as diarrhea and vomiting [35].

A systematic screening of hypovitaminosis D must be performed for individuals at risk for it, such as obese and elderly people, and those with chronic non-communicable diseases and long hospital stays since the deficiency of this vitamin makes these patients more susceptible to infection by COVID-19 and to developing the severe form of the disease [36,37]. In addition to its immunomodulatory and anti-inflammatory potential, the vitamin has a neuroprotective effect and can prevent neurological complications related to the disease [37,38]. Individuals with 25-hydroxyvitamin D < 12 ng/mL should receive a single dose of 500,000 IU cholecalciferol [27]. Those with values < 20 ng/mL should be supplemented with 50,000 IU/week, and if ≥ 20 and <30 ng/mL with 25,000 IU/week [29]. It is noteworthy that studies on vitamin D supplementation in the prevention of COVID-19 or better clinical prognosis of those individuals already infected are limited and controversial, and it is important to assess the ratio of costs and benefits before administering the supplement, especially in patients with hypovitaminosis D and in the group of risk for disability [39–41].

Patients with caloric intakes below 60% of their nutritional needs and those at nutritional risk should receive nutritional supplements orally [29,42]. Those malnourished, sarcopenic, with insufficient protein intake, or in the post-ICU rehabilitation phase may need protein supplements to meet the needs of this macronutrient [35]. Considering the available literature, whey protein supplements are suggested to increase protein intake, as it has anabolic, immunomodulating, antioxidants, and high digestibility properties [29].

In the case of patients feeding orally, it is important to favor a balanced diet. The intake of simple sugars and refined carbohydrates, with a high glycemic index, must be restricted, given that these individuals may have hyperglycemia and hyperinsulinemia induced by medicines, infectious processes and/or comorbidities [36]. Electrolytes, such as sodium, potassium, magnesium, and calcium, should be monitored frequently as they are associated with the severity of the disease, and nutritional therapy must be adjusted according to the serum values [43,44].

3.2.1.1. Oral nutritional support according to the oxygen supplementation. Oxygen supplementation is needed due to hypoxemia, ventilator failure, or both, which may occur in an invasive or non-invasive way depending on the severity and cause of the respiratory failure. Whenever possible, non-invasive respiratory support should be the method of choice, and it can be provided by low-flow (LFNC) or high-flow (HFNC) nasal cannulas, face masks (simple, Venturini, without rebreather), and non-invasive positive pressure ventilation (NIPPV) [45,46]. However, tolerance to the non-rebreather mask can be negative due to the discomfort and feeling of claustrophobia, leading to its frequent removal and interruption of treatment, in addition to influencing food consumption [45].

Patients who need mechanical ventilatory support and orotracheal intubation require specific nutritional care after extubation. About 10–67% of these patients present swallowing disorders, which are associated with reintubation, pneumonia, longer hospital stays, and increased mortality [27,47]. The evolution of weaning from the enteral to oral diet after extubation requires attention, given the possibility of dysphagia and odynophagia.

Therefore, a speech-language assessment of swallowing (deglutition screening) must be performed post-extubation to safely resume the oral diet, even in patients intubated for less than 48 h, since there is a risk of silent aspiration, that is, the lack of a cough reflex [48,49]. It is up to the nutritionist to adjust the characteristics of the diet according to the consistency allowed by the speech therapist, pre-existing comorbidities, or electrolyte disorders [2,27]. Patients must be kept on enteral nutritional therapy until oral intake provides at least 75% of nutritional needs for 3 consecutive days [50].

In the presence of dysphagia and, therefore, the immediate contraindication of the oral diet, the enteral nutrition must be maintained, and risk assessment for aspiration must be carried out. If there is a high risk of aspiration, the positioning of the post-pyloric enteral catheter is indicated or, in case of intolerance to the enteral nutrition or hardship in attaining the goals, parenteral nutrition is suggested [2,27].

Thus, nutritional therapy and the consistency of the diet may vary according to the type of oxygen support required (Table 1). Neglecting the proper administration of calories and proteins can result in worsening the nutritional status and its correlations [2,51].

3.2.2. Enteral feeding

In the case of patients who are not able to eat orally for more than 3 days, or those with an oral intake below 50% of their energy needs for more than one week, enteral nutritional therapy should be applied. Gastric positioning is recommended, as it is more physiological and reduces the exposure of health professionals to the virus, the post pyloric route being preferable in cases of high gastric residual volume (>500 mL) [2]. Parenteral nutrition should

Table 1
Nutritional recommendations according to the type of respiratory support in patients with COVID-19.

Oxygen support	Nutritional support
Ambient air/binasal catheter	Oral diet: free, mild consistency, or according to the patient's preference; High-calorie and/or high-protein oral supplement in nutritional risk or food intake <60% of caloric needs for 2 days; Enteral or parenteral nutrition, if necessary.
Non-rebreather mask	Oral diet: homogeneous creamy or pasty consistency, or thin pasty for consumption with the aid of a straw, in order to facilitate the intake, avoid effort, and desaturation; High-calorie and/or high-protein oral supplementation; Enteral or parenteral nutrition, if necessary.
Mechanical ventilation	Early enteral nutrition; Parenteral nutrition, if necessary.
Extubation	Assess dysphagia and if possible, oral diet; Enteral nutrition in case of risk of bronchoaspiration.

Adapted from: Barazzoni R et al., 2020 [2]; Weber TK et al., 2020 [52].

be used if the gastrointestinal tract is contraindicated or unable to adjust the nutritional goals [2].

Patients in the ICU should receive nutritional support within 24–36 h of admission to the sector or 12 h after orotracheal intubation and the beginning of mechanical ventilation [2,14]. Enteral nutrition should be offered continuously, reducing the risk of diarrhea and the exposure of health professionals to the virus [14].

Absent in the literature was a standardization of the enteral diet interruption time before and after extubation, with studies suggesting that the most important thing is the assessment of symptoms and breathing patterns, with or without the need for reintubation [48,53]. Segaran et al. (2016) suggest that the enteral diet be paused 4 h before and after airway procedures, such as making a tracheostomy and extubation [54]. However, in our hospital, the medical and physiotherapeutic teams defined the interruption of the enteral diet 1 h before extubation as a protocol, returning after 1 h or stabilizing the respiratory condition at full volume.

The enteral diet formula must be polymeric and hyperproteic (>20% protein) in the initial phase of critical illness. Fiber free formulas may be better tolerated in patients with gastrointestinal dysfunction. Protein, fiber, and probiotic modules can be used when necessary and indicated. Soy oil should be used with caution in critically ill patients receiving parenteral nutrition, in view of the risk of hypertriglyceridemia, especially in those patients using propofol [14].

3.2.3. Propofol

In the case of individuals infected with SARS-Cov-2 who are in the ICU, propofol (2.6 diisopropylphenol) has been used for deep and continuous sedation, and to perform the endotracheal intubation procedure [55]. Due to the lipids used to emulsify the drug, it is classified as a supplier of non-nutritional calories, since lipid emulsions based on 10% soy oil provide 1.1 kcal/mL [56]. Thus, this infused energy must be counted and properly adjusted to the nutritional plan of patients undergoing enteral and parenteral nutritional therapy, minimizing the risk of hyperlipidemia and hyperalimentation [57,58]. Furthermore, we suggest performing serum triglyceride measurements every 72 h.

3.2.4. Nutritional support in the prone position

Current guidelines have recommended the prone position in patients with COVID-19 and acute respiratory distress syndrome, aiming to improve oxygenation and increase the clearance of bronchial secretions, with reduced lung injury and increased survival rates. The establishment of protocols for the administration and monitoring of nutritional therapy helps improve tolerance to diets, thus contributing to a better clinical and nutritional prognosis [14,42].

The prone position does not contraindicate or limit enteral nutrition and it is not associated with gastrointestinal and pulmonary complications. However, it is recommended that the administration of the diet happens continuously through an infusion pump and, in patients with gastric feeding intolerance, it may be necessary to have a fixed prescription of prokinetics [2,27,42].

The diet should be started after the first hour the patient is in a prone position and maintained for up to 1 h before returning to the supine position. The bedhead should be kept elevated, between 25 and 30° (reverse Trendelenburg), to reduce the risk of bronchoaspiration, facial edema, and intra-abdominal hypertension [14,42,59]. The progression of the enteral diet infusion rate must be according to the patient's tolerance, providing at least 75% of the caloric needs until the 3rd day of the nutritional therapy (Table 2). Oligomeric formulas should be preferable only in cases of severe gastrointestinal disorders, and if these persist, making it impossible to provide at least 60% of energy needs in the first 10 days of the ICU, parenteral nutrition is recommended [2,42,60].

Table 2
Nutritional needs at different stages of critical illness by COVID-19.

	Nutritional recommendation
Initial stage (calories)	**Individuals at risk of refeeding:** 10–20 kcal/kg in the first 24 h; progress 33% of the goal every 1–2 days; Eutrophic: 15–20 kcal/kg/day Obese people: 20 kcal/kg adjusted weight/day or 11–14 kcal/kg current weight/day if BMI 30–50 kg/m^2 and 22–25 kcal/kg ideal weight if BMI >50 kg/m^2 **Observation: make gradual progression until reaching the calculated goal:** 1st day: 25% of caloric needs 2nd day: 50% of caloric needs 3rd day: 75% of caloric needs 4th day: 100% of caloric needs
Late stage (calories)	Eutrophics: 25–35 kcal/kg/day Obese people: 30 kcal/kg adjusted weight/day
Proteins	1st and 2nd day: 0.8–1 g/kg Reach the protein goal between the 3rd and the 4th day, namely: - Eutrophics: 1.2–2 g/kg/day - Obese people: 1.3 g/kg adjusted weight or 2–2.5 g/kg ideal weight/day

Source: Gonzalez-Salazar LE et al. (2020) [65], Barazzoni R et al. (2020) [2], Martindale R et al. (2020) [14] Van Zanten ARH et al. (2019) [67], Koekkoek WACK et al. (2019) [68].

3.3. Nutritional needs

Caloric and protein needs should be adjusted per age, nutritional status, disease severity, gastrointestinal tolerance.

3.3.1. Non critically ill

Recent guidelines recommend that the energy needs of patients with non-critical COVID-19 and undergoing rehabilitation should be performed using indirect calorimetry. However, given the risk of infection and the unavailability of equipment in most hospitals, the use of predictive equations is recommended [2,15]. Several specific conditions can be found in association with the COVID-19 infection which inspire particular attention for patients who have comorbidities and elderly people hospitalized with COVID-19 [52,61].

For elderly people (over 65 years) with comorbidities, the recommendation is to consume 27 kcal/kg of actual body weight per day. In the case of patients with severely malnourishment comorbidities, 30 kcal/kg of body weight per day, with the gradual progression of the contribution to avoid the refeeding syndrome. Those who were discharged from the ICU must receive a high calorie (30–35 kcal/kg of body weight/day) and high protein diet (≥2 g/kg of body weight/day) to ensure their functional recovery [52,62]. Obese patients can receive an adjusted weight of up to 30 kcal/kg in the rehabilitation phase [67].

Regarding macronutrients, ESPEN recommends a protein supply above 1 g/kg of body weight for the prevention of malnutrition, hospital readmission, and risk of complications, and a proportion of calories from lipids and carbohydrates of 30:70 for patients without respiratory failure and 50:50 for those ventilated [2,61].

3.3.2. Critically ill patients

Refeeding Syndrome (RS) is characterized by metabolic and electrolytic changes that occur after the reintroduction of nutritional support or increase in caloric supply after a long period of fasting, with serum reduction of phosphorus, potassium, and/or magnesium; thiamine deficiency may also occur [63]. The consequences of the syndrome include hypercapnia (and consequent difficulty in patient independence from mechanical ventilation), hyperglycemia, and liver failure [57,58].

Individuals with COVID-19 may be at risk for RS, given the reduced food intake due to olfactory dysfunction and gastrointestinal symptoms, with consequent weight loss, of both adipose tissue and muscle mass, in addition to the presence of hydroelectrolytic disorders [5–7,14,25,35,63]. In the initial phase of the critical illness, endogenous energy production associated with an inadequate caloric supply could also contribute to RS [4,64].

Recent guidelines suggest that in patients at risk for RS, nutritional therapy should be started, with an offer of 10–20 kcal/kg in the first 24 h, progressing 33% of the target every 1–2 days, with progression or onset being suspended until reversal of hydroelectrolytic disorders and thiamine supplementation (100 mg/day for 5–7 days) in patients with severe starvation, chronic alcoholism, and signs of deficiency of this vitamin [63].

The American Society of Parenteral and Enteral Nutrition (ASPEN) and ESPEN recommend that the caloric and protein targets for critically ill patients with COVID-19 be the same as those for other patients admitted to the ICU, starting with a low-calorie diet (15–20 kcal/kg/day) in the initial phase of critical illness and reaching 100% of nutritional needs by the fourth day of nutritional therapy, when caloric goals should be recalculated to 25–30 kcal/kg/day [2,65]. However, a recent study carrying out indirect calorimetry in this population showed hypermetabolism after the first week of the critical illness, with nutritional needs superior to those of other eutrophic and obese critically ill patients (Table 2) [66].

Regarding the protein goal, ESPEN recommends a gradual offering, reaching 1.3 g/kg between the third and fifth days, and the adjusted weight for obese people should be considered [adjusted weight = ideal weight + (current weight − ideal weight) * 0.33], considering the Body Mass Index (BMI) of 25 kg/m^2 for calculating the ideal weight in adults and 28 kg/m^2 in the elderly [2]. On the other hand, ASPEN recommends an offer of 1.2–2 g/kg/day, which can reach 2.5 g/kg for obese people, using the ideal weight for calculating this group (Table 2) [14,65].

Those with sepsis or circulatory shock may receive trophic enteral feeding as tolerated, which is contraindicated only in cases of use of vasopressors in increasing doses and gastrointestinal intolerance [14].

3.4. Assessment of tolerance to nutritional support and monitoring

Nutritional monitoring includes physical examination, anthropometric assessment, and gastrointestinal functioning, including the occurrence of diarrhea, intestinal constipation, and vomiting, as well as palpation and abdominal auscultation [69,70].

The interpretation of laboratory tests must be performed daily (Table 3). Albumin and C-reactive protein (CRP) can be used to assess systemic inflammation, with reassessment every 20 days (considering the half-life of albumin) [3,27,71]. Lactate and blood gases should be evaluated daily since tissue hypoperfusion indicated in hyperlactatemia and metabolic acidosis in blood gases contraindicate the initiation or progression of nutritional therapy [3].

Analyses of gastric waste to assess tolerance to enteral diet should be avoided in patients with COVID-19, so as not to expose the staff to contamination. Thus, other clinical conditions must be observed before this measurement, such as the presence of vomiting or aspiration of secretion, similar to the color of the enteral diet in the orotracheal tube and signs of gastrointestinal intolerance (such as abdominal distention, less elimination of flatus and feces, reduced hydro-aerial noises, and metabolic acidosis), when it is recommended to suspend the enteral diet, open the tube for drainage and communicate to the nutrition staff [3,72]. The same should occur if the gastric residue is greater than 500 mL, or if it is less than this value, but associated with other signs of gastrointestinal intolerance [3].

Table 3
Frequency recommendation for monitoring laboratory parameters.

Variable	Frequency
Electrolytes (Potassium, magnesium, phosphate)	1 time/day during the 1st week of NT, and every 12 h in the presence of risk for RS. Then 1 to 2 times/week.
Glucose	Every 4 h for the first 2 days of NT, and every 48 h for stable patients.
Renal function	3 times per week
Liver function	2 times per week
Triglycerides	2 times per week or every 72 h if the patient is using propofol.
Lactate	Daily
Gasometry	Daily
Albumin	Upon admission and every 20 days
CRP	Upon admission and every 20 days

NT: Nutritional Therapy; RS: Refeeding Syndrome.
Source: Thibault R et al. (2020) [73], Da Silva JSV et al., 2020 [63], Singer P et al., 2019 [27], Berger MM et al., 2019 [69].

3.5. Hospital discharge guidance

Patients with chronic non-communicable diseases are part of a risk group that has worse outcomes and higher mortality after the infection by COVID-19 due to the constant inflammatory state and altered innate immune system [2]. They are patients, therefore, who demand individualized nutritional guidance for adequate control of comorbidities and nutritional status after hospital discharge, modulating the immune, inflammatory, and oxidative process [32].

Among the characteristics associated with a diet that positively affects the immune response are proteins (glutamine, arginine, branched-chain amino acid – BCAA's), polyunsaturated fats, low sugar, high fiber, high intake of fruits and vegetables, and adequate consumption of all food group [1]. Among the micronutrients, the most relevant in this scenario are vitamin A, vitamin D, vitamin C, vitamin E, vitamin K, B vitamins, zinc, iron, selenium, and copper. Emphasis should also be given to phytochemicals: polyphenols, carotenoids [32].

COVID-19 often leads to prolonged hospital stays, including in the ICU, with consequent deterioration of the nutritional status and sarcopenia, which influences the quality of life. Oral nutritional therapy has an important role as an effective treatment to reduce these complications, and better rehabilitation results, being recommended the offer of hypercaloric (400 kcal/day) and hyperproteic (30 g of protein/day) nutritional supplements for at least 30 days after hospital discharge when food intake is not sufficient to achieve nutritional goals [2].

General recommendations are the increased fractioning of meals in case of anorexia, a greater intake of protein-rich foods, as well as those sources of the aforementioned vitamins and minerals, such as whole grains, fruits, and vegetables. At the time of hospital discharge, the patient should be instructed on eating habits that influence the signs and symptoms presented, such as xerostomia, anosmia, ageusia, nausea, and diarrhea, as well as on proper food hygiene.

3.6. Quality indicators

Quality indicators are used to accompany the characteristics of the monitored population, manage the care patients are offered, identify adverse events, and direct the training of the nutritional support staff. In our institution, we perform a monthly tabulation and analysis of the clinical data of patients hospitalized with COVID-19, as well as of the caloric goal and adequacy to that in the first 72 h of nutritional therapy, way of feeding, and the use of formulas/modules/nutritional supplements during the hospitalization, gastrointestinal symptoms, and clinical outcome (hospital discharge or death).

4. Conclusion

Regardless of their nutritional statuses at hospital admission, patients with COVID-19 are at nutritional risk. A complete nutritional assessment should include anthropometric, dietary, and laboratorial assessment, as well as a multidisciplinary discussion about the patient's clinical condition. In this way, it is possible to establish an individualized nutritional approach to contribute to better clinical and nutritional prognoses.

Statement of authorship

JVH performed a critical review of the relevant intellectual content. The first author and the others collected and analyzed the data, interpreted the results, wrote the article, worked on the approval of the final version of the present work, and agree to take responsibility for all aspects of the work.

Funding

The study did not present a source of funding.

Declaration of competing interest

No conflict of interest declared.

Acknowledgements

The authors would like to thank the hospital staff for the excellent technical assistance and the patients with COVID-19 who have moved us in the incessant search for knowledge.

References

[1] Zabetakis I, Lordan R, Norton C, Tsoupras A. COVID-19: the inflammation link and the role of nutrition in potential mitigation. Nutrients 2020;12(5):1–28.
[2] Barazzoni R, Bischoff SC, Breda J, Wickramasinghe K, Krznaric Z, Nitzan D, et al. ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection. Clin Nutr 2020;39:1631–8.
[3] McClave SA, Taylor BE, Martindale RG, Warren MM, Johnson DR, Braunschweig C, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: society of critical care medicine (SCCM) and American society for parenteral and enteral nutrition (A.S.P.E.N.). J Parenter Enteral Nutr 2016;40(2):159–211.
[4] Preiser JC, Ichai C, Orban JC, Groeneveld ABJ. Metabolic response to the stress of critical illness. Br J Anaesth 2014;113(6):945–54.
[5] Cha MH, Regueiro M, Sandhu DS. Gastrointestinal and hepatic manifestations of COVID-19: a comprehensive review. World J Gastroenterol 2020;26(19):2323–32.
[6] Mercante G, Ferreli F, De Virgilio A, Gaino F, Di Bari M, Colombo G, et al. Prevalence of taste and smell dysfunction in coronavirus disease 2019. JAMA Otolaryngol Neck Surg 2020:1–6.
[7] da Costa KVT, Carnaúba ATL, Rocha KW, de Andrade KCL, Ferreira SMS, de L Menezes P. Olfactory and taste disorders in COVID-19: a systematic review. Braz J Otorhinolaryngol 2020. S1808-8694(20)30066-30075.
[8] Correia MITD, Perman MI, Waitzberg DL. Hospital malnutrition in Latin America: a systematic review. Clin Nutr 2017;36(4):958–67.
[9] Lee ZY, Heyland DK. Determination of nutrition risk and status in critically ill patients: what are our considerations? Nutr Clin Pract 2019;34(1):96–111.
[10] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003;22(4):415–21.
[11] Mercadal-Orfila G, Lluch-Taltavull J, Campillo-Artero C, Torrent-Quetglas M. Association between nutritional risk based on the NRS-2002 test and hospital morbidity and mortality. Nutr Hosp 2012;27(4):1248–54.
[12] Silva DFO, Lima SCVC, Sena-Evangelista KCM, Marchioni DM, Cobucci RN, de Andrade FB. Nutritional risk screening tools for older adults with COVID-19 : a systematic review. Nutrients 2020;12(10):2956.
[13] Zhao X, Li Y, Ge Y, Shi Y, Lv P, Zhang J, et al. Evaluation of nutrition risk and its association with mortality risk in severely and critically ill COVID-19 patients. J Parenter Enteral Nutr 2021;45(1):32–42.
[14] Martindale R, Patel JJ, Taylor B, Warren M, McClave SA. Nutrition therapy in the patient with COVID-19 disease requiring ICU care. Am Soc Parenter Enter Nutr 2020;(Cdc):1–8.
[15] CFN. Boas práticas para a atuação do nutricionista E do técnico em nutrição E dietética durante a pandemia do novo coronavírus (COVID-19). Cons Fed e Reg Nutr 2020;3:15.
[16] OPAS. Organização Pan-Americana da Saúde. XXXVI Reunión del Comitê Asesor de Ivestigaciones en Salud – Encuestra Multicêntrica – Salud Beinestar y Envejecimeiento (SABE) en América Latina e el Caribe [Informe preliminar]. Washington, D.C: Organización Panamericana de la Salud; 2001. p. 19.
[17] World Health Organisation (WHO). Body mass index (BMI) classifications, 1998 [Internet]. 2017 [cited 2019 Jun 4]. Available from: http://www.saude.gov.br/component/content/article/804-imc/40509-imc-em-adultos.
[18] Chumlea WC, Guo S, Roche AFSM. Prediction of body weight for the nonambulatory elderly from anthropometry. J Am Diet Assoc 1988;88(5):564–8.
[19] Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48(1):16–31.
[20] Morley JE, Kalantar-zadeh K, Anker SD. COVID- 19 : a major cause of cachexia and sarcopenia ? J Cachexia Sarcopenia Muscle 2020;11(4):863–5.
[21] Welch C, Greig C, Masud T, Wilson D, Jackson TA. COVID-19 and acute sarcopenia. Aging Dis 2020;11(6):1345–51.
[22] Wang P, Li Y, Wangc Q. Sarcopenia: an underlying treatment target during the COVID-19 pandemic. Nutrition 2021;84:111104.
[23] Real GG, Frühauf IR, Sedrez JHK, Dall'Aqua EJF, Gonzalez MC. Calf circumference: a marker of muscle mass as a predictor of hospital readmission. J Parenter Enteral Nutr 2018;42(8):1272–9.
[24] Bielemann RM, Gigante DP, Horta BL. Birth weight, intrauterine growth restriction and nutritional status in childhood in relation to grip strength in adults: from the 1982 Pelotas (Brazil) birth cohort. Nutrition 2016;32(2):228–35.
[25] Pellegrino R, Cooper KW, Di Pizio A, Joseph PV. Corona viruses and the chemical senses: past, present, and future. Chem Senses 2020:bjaa031.
[26] Fisberg RM, Marchioni DML, Colucci ACA. Avaliação do consumo alimentar e da ingestão de nutrientes na prática clínica. Arq Bras Endocrinol Metabol 2009 Jul;53(5):617–24.
[27] Singer P, Blaser AR, Berger MM, Alhazzani W, Calder PC, Casaer MP, et al. ESPEN guideline on clinical nutrition in the intensive care unit. Clin Nutr 2019;38(1):48–79.
[28] Wernerman J, Christopher KB, Annane D, Casaer MP, Coopersmith CM, Deane AM, et al. Metabolic support in the critically ill: a consensus of 19. Crit Care 2019;23(1):1–10.
[29] Caccialanza R, Laviano A, Lobascio F, Montagna E, Bruno R, Ludovisi S, et al. Early nutritional supplementation in non-critically ill patients hospitalized for the 2019 novel coronavirus disease (COVID-19): rationale and feasibility of a shared pragmatic protocol. Nutrition 2020;74:1315.
[30] Fernández-Quintela A, Milton-Laskibar I, Trepiana J, Gómez-Zorita S, Kajarabille N, Léniz A, et al. Key aspects in nutritional management of COVID-19 patients. J Clin Med 2020;9(8):2589.
[31] Zhang L, Liu Y. Potential interventions for novel coronavirus in China: a systematic review. J Med Virol 2020;92(5):479–90.
[32] Iddir M, Brito A, Dingeo G, Fernandez Del Campo SS, Samouda H, La Frano MR, et al. Strengthening the immune system and reducing inflammation and oxidative stress through diet and nutrition: considerations during the COVID-19 crisis. Nutrients 2020;12(6):1562.
[33] Calder P, Carr A, Gombart A, Eggersdorfer M. Optimal nutritional status for a well-functioning immune system is an important factor to protect against viral infections. Nutrients 2020;12(4):1181.
[34] Feng Z, Yang J, Xu M, Lin R, Yang H, Lai L, et al. Dietary supplements and herbal medicine for COVID-19: a systematic review of randomized control trials. Clin Nutr ESPEN 2021;44:50–60.
[35] Cena H, Maffoni S, Braschi V, Brazzo S, Pallavicini C, Vietti I, et al. Position paper of the Italian association of medical specialists in dietetics and clinical nutrition (ANSISA) on nutritional management of patients with COVID-19 disease. Med J Nutrition Metab 2020;13:1–5.
[36] Cooper ID, Crofts CAP, DiNicolantonio JJ, Malhotra A, Elliott B, Kyriakidou Y, et al. Relationships between hyperinsulinaemia, magnesium, vitamin D, thrombosis and COVID-19: rationale for clinical management. Open Hear 2020;7(2):e001356.
[37] Jain A, Chaurasia R, Sengar NS, Singh M, Mahor S, Narain S. Analysis of vitamin D level among asymptomatic and critically ill COVID-19 patients and its correlation with inflammatory markers. Sci Rep 2020;10(1):20191.
[38] Xu Y, Baylink DJ, Chen C-S, Reeves ME, Xiao J, Lacy C, et al. The importance of vitamin d metabolism as a potential prophylactic, immunoregulatory and neuroprotective treatment for COVID-19. J Transl Med 2020;18(1):322.

[39] Ma H, Zhou T, Heianza Y, Qi L. Habitual use of vitamin D supplements and risk of coronavirus disease 2019 (COVID-19) infection: a prospective study in UK Biobank. Am J Clin Nutr 2021;113(5):1275–81.
[40] Butler-Laporte G, Nakanishi T, Mooser V, Morrison DR, Abdullah T, Adeleye O, et al. Vitamin D and COVID-19 susceptibility and severity in the COVID-19 host genetics initiative: a mendelian randomization study. In: Minelli C, editor. PLOS Med, 18; 2021, e1003605. 6.
[41] Brenner H. Vitamin D supplementation to prevent COVID-19 infections and deaths—accumulating evidence from epidemiological and intervention studies calls for immediate action. Nutrients 2021;13(2):411.
[42] Campos LF, Barreto PA, Ceniccola GD, Gonçalves RC, de Matos LBN, Zambelli CMSF, et al. Parecer BRASPEN/AMIB para o enfrentamento da COVID-19 em pacientes hospitalizados. Braspen J 2020;35(1):3–5.
[43] Lippi G, South AM, Henry BM. Electrolyte imbalances in patients with severe coronavirus disease 2019 (COVID-19). Ann Clin Biochem Int J Lab Med 2020;57(3):262–5.
[44] Sarvazad H, Cahngaripour SH, Eskandari Roozbahani N, Izadi B. Evaluation of electrolyte status of sodium, potassium and magnesium, and fasting blood sugar at the initial admission of individuals with COVID-19 without underlying disease in Golestan Hospital, Kermanshah. New Microbes New Infect 2020;38:100807.
[45] Corley A, Rickard CM, Aitken LM, Johnston A, Barnett A, Fraser JF, et al. High-flow nasal cannulae for respiratory support in adult intensive care patients. Cochrane Database Syst Rev 2017;5(5):CD010172.
[46] Singer P, Rattanachaiwong S. To eat or to breathe? The answer is both! Nutritional management during noninvasive ventilation. Crit Care 2018 Dec 6;22(1):27.
[47] McIntyre M, Doeltgen S, Dalton N, Koppa M, Chimunda T. Post-extubation dysphagia incidence in critically ill patients: a systematic review and meta-analysis. Aust Crit Care 2021;34(1):67–75.
[48] Marvin S, Thibeault S, Ehlenbach WJ. Post-extubation dysphagia: does timing of evaluation matter? Dysphagia 2019;34(2):210–9.
[49] Brodsky MB, Pandian V, Needham DM. Post-extubation dysphagia: a problem needing multidisciplinary efforts. Intensive Care Med 2020;176(1):93–6.
[50] Boullata JI, Carrera AL, Harvey L, Escuro AA, Hudson L, Mays A, et al. ASPEN safe practices for enteral nutrition therapy. J Parenter Enteral Nutr 2017 Jan 5;41(1):15–103.
[51] Stachowska E, Folwarski M, Jamioł-Milc D, Maciejewska D, Skonieczna-Żydecka K. Nutritional support in coronavirus 2019 disease. Medicina (B Aires) 2020;56(6):289.
[52] Weber TK, Leandro-Merhi VA, Bernasconi I, de Oliveira MRM. Nutritional therapy in hospital care of in-patients with COVID-19: evidence, consensus and practice guidelines. Rev Nutr 2020;33:e200212.
[53] Segaran E, Lovejoy TD, Proctor C, Bispham WL, Jordan R, Jenkins B, et al. Exploring fasting practices for critical care patients – a web-based survey of UK intensive care units. J Intensive Care Soc 2018;19(3):188–95.
[54] Segaran E, Barker I, Hartle A. Optimising enteral nutrition in critically ill patients by reducing fasting times. J Intensive Care Soc 2016;17(1):38–43.
[55] Charrière M, Ridley E, Hastings J, Bianchet O, Scheinkestel C, Berger MM. Propofol sedation substantially increases the caloric and lipid intake in critically ill patients. Nutrition 2017;42:64–8.
[56] Buckley CT, Van Matre ET, Fischer PE, Minard G, Dickerson RN. Improvement in protein delivery for critically ill patients requiring high-dose propofol therapy and enteral nutrition. Nutr Clin Pract 2021;36(1):212–8.
[57] Terblanche E, Remmington C. Observational study evaluating the nutritional impact of changing from 1% to 2% propofol in a cardiothoracic adult critical care unit. J Hum Nutr Diet 2021;34(2):413–9.
[58] Hastings J, Ridley EJ, Bianchet O, Roodenburg O, Levkovich B, Scheinkestel C, et al. Does propofol sedation contribute to overall energy provision in mechanically ventilated critically ill adults? A retrospective observational study. J Parenter Enteral Nutr 2018;42(4):748–57.
[59] De Oliveira VM, Weschenfelder ME, Deponti G, Condessa R, Loss SH, Bairros PM, et al. Good practices for prone positioning at the bedside: construction of a care protocol. Rev Assoc Med Bras 2016;62(3):287–93.
[60] Liu R, Paz M, Siraj L, Boyd T, Salamone S, Lite T-LV, et al. Feeding intolerance in critically ill patients with COVID-19. Clin Nutr 2021. S0261-5614(21)180-181.
[61] Cervantes-Pérez E, Cervantes-Guevara G, Martínez-Soto Holguín MC, Cervantes-Pérez LA, Cervantes-Pérez G, Cervantes-Cardona GA, et al. Medical nutrition therapy in hospitalized patients with SARS-CoV-2 (COVID-19) infection in a non-critical care setting: knowledge in progress. Curr Nutr Rep 2020;9(4):309–15.
[62] González-Salazar LE, Guevara-Cruz M, Hernández-Gómez KG, Serralde Zúñiga AE. Nutritional management of the critically ill inpatient with COVID-19. A narrative review. Nutr Hosp 2020;37(3):622–30.
[63] da Silva JSV, Seres DS, Sabino K, Adams SC, Berdahl GJ, Citty SW, et al. ASPEN consensus recommendations for refeeding syndrome. Nutr Clin Pract 2020;35(2):178–95.
[64] Van Dyck L, Casaer MP, Gunst J. Autophagy and its implications against early full nutrition support in critical illness. Nutr Clin Pract 2018;33(3):339–47.
[65] Gonzalez-Salazar LE, Guevara-Cruz M, Hernandez-Gomez KG, Serralde Zuniga AE. Nutritional management of the critically ill inpatient with COVID-19. A narrative review TT - manejo nutricional del paciente hospitalizado criticamente enfermo con COVID-19. Una revision narrativa. Nutr Hosp 2020;34(3):622–30.
[66] Whittle J, Molinger J, MacLeod D, Haines K, Wischmeyer PE, LEEP-COVID Study Group. Persistent hypermetabolism and longitudinal energy expenditure in critically ill patients with COVID-19. Crit Care 2020;24(1):581.
[67] van Zanten ARH, De Waele E, Wischmeyer PE. Nutrition therapy and critical illness: practical guidance for the ICU, post-ICU, and long-term convalescence phases. Crit Care 2019;23(1):368.
[68] Koekkoek Kristine, van Setten Coralien, Olthof LE, Hans Kars JCN, van Zanten ARH. Timing of PROTein INtake and clinical outcomes of adult critically ill patients on prolonged mechanical VENTilation: the PROTINVENT retrospective study. Clin Nutr 2019;38(2):883–90.
[69] Berger MM, Reintam-Blaser A, Calder PC, Casaer M, Hiesmayr MJ, Mayer K, et al. Monitoring nutrition in the ICU. Clin Nutr 2019;38(2):584–93.
[70] Hinkelmann JV, Luquetti SCPD, Aguiar AS, Toffolo MCF. In: Rubio, editor. Diagnóstico e Necessidades Nutricionais do paciente Hospitalizado: da gestante ao idoso. Rio de Janeiro; 2015. p. 272.
[71] McMillan DC. The systemic inflammation-based Glasgow Prognostic Score: a decade of experience in patients with cancer. Cancer Treat Rev 2013;39(5):534–40.
[72] Bankhead R, Boullata J, Brantley S, Corkins M, Guenter P, Krenitsky J, et al. Enteral nutrition practice recommendations. J Parenter Enteral Nutr 2009;33(2):122–67.
[73] Thibault R, Seguin P, Tamion F, Pichard C, Singer P. Nutrition of the COVID-19 patient in the intensive care unit (ICU): a practical guidance. Crit Care 2020 Dec 19;24(1):447.