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Review Article

Nutritional management of individuals with SARS-CoV-2 infection during rehabilitation

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Abstract

The combination of poor dietary intake and increased healthcare needs predisposes COVID-19 patients to malnutrition and sarcopenia. The scope of this narrative review is to present epidemiology and etiology of malnutrition and sarcopenia in COVID-19 patients, their consequences as well as the content and delivery mode of optimum nutritional services for malnourished/sarcopenic COVID-19 patients in the rehabilitation setting. This narrative review also summarizes nutritional recommendations, consensus statements and treatment pathways developed by scientific societies for COVID-19 patients. COVID-19 patients are prone to malnutrition and sarcopenia due to inactivity, comorbidities, cytokine response, nutritional deficiencies, anosmia, loss of taste, anorexia and treatment with dexamethasone. Thus, all COVID-19 patients, including those who are overweight or obese, should be regularly screened for malnutrition and sarcopenia at admission to the rehabilitation setting, using a validated tool to identify those with (or at risk of) malnutrition. As a consequence of malnutrition and sarcopenia, COVID-19 patients demonstrate diminished immune potential, lower respiratory function, swallowing dysfunction, and low resilience to metabolic stress. COVID-19 patients have increased energy (27-30 kcal/day) and protein needs (1-1.5 g/kg body weight/day). Personalized nutritional education and counseling, food fortification with energy dense and/or protein rich whole foods or with powdered supplements and use of high protein, energy dense oral nutritional supplements are recommended.

Keywords: COVID-19, Nutrition, Rehabilitation

Introduction

Since the outbreak of COVID-19 on March 11th 2020 and the survival of the first COVID-19 patients, clinicians have struggled to provide optimum rehabilitation services in order to improve survival and recovery after COVID-19[1].

Up to 50% of hospitalized patients with COVID-19 may require rehabilitation after discharge; consequently rehabilitation services are needed more than ever before[2]. Patients with severe infections resulting in respiratory distress, such as severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), experience persistent difficulties for a minimum of a year post recovery[3]. Considering the similarities between COVID-19 infection and SARS and MERS, it is likely that COVID-19 patients will experience similar symptoms. COVID-19 patients treated in critical care are more likely to require post hospital discharge rehabilitation because they are likely to experience respiratory difficulties, anxiety, depression, pain, limitations

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in physical functioning and compromised quality of life[4,5]. Rehabilitation of COVID-19 patients focuses mainly on respiratory improvement, functional and cognitive recovery, decrease of disability, and quality of life improvement[6].

Since the outbreak of the pandemic, researchers with an interest in nutrition, aimed to establish key components of effective nutritional interventions to improve survival and recovery after COVID-19. Approximately a third of COVID-19 patient are admitted to hospital for management, and this segment of COVID-19 patients is more likely to have (or develop during hospitalization) compromised nutritional status[7,8].

Although COVID-19 is a new coronavirus, and thus research on its nutritional management is short term, current literature on the topic emphasizes the discrepancy between patient's nutritional needs and their actual intake. Research on nutritional status of COVID-19 patients demonstrates the importance of effective nutritional management throughout rehabilitation, particularly in those with diminishing nutritional status due to mechanical ventilation, and in those not ventilated but had moderate to severe symptoms affecting their nutritional status. Management guidelines for other coronaviruses with similar symptoms emphasize the effectiveness of timely, measurable, achievable, relevant and specific personalized nutritional care[9].

Aim

This narrative review describes and critically discusses the published research on epidemiology, etiology and consequences of malnutrition and sarcopenia in COVID-19 patients and best clinical practice in nutritional management of COVID-19 patients in rehabilitation.

Materials and Methods

Website search engines and electronic databases (PubMed and Cochrane) were reviewed between July 2020 and November 2020 searching for randomized controlled trials and observational studies published since 2019. Guidelines, recommendations, policy/consensus statements and treatment pathways developed by scientific communities that were intended for healthcare professionals treating patients with COVID-19, were also included. Studies focusing on prevalence of malnutrition and sarcopenia in older adults with COVID-19, on etiology of malnutrition and sarcopenia in older adults with COVID-19, on screening and nutritional management of malnutrition and sarcopenia in older adults with COVID-19 were included. Studies without nutritional assessment nor intervention focus, studies on nutritional management during intensive care unit stay of COVID-19 patients and studies on prevention of sarcopenia and malnutrition were excluded.

Overall, 101 articles were identified and screened on the basis of their title and abstract. A total of 38 articles were included in the final narrative review. The studies included in the final review were analyzed with the use of a data extraction template to identify sarcopenia, malnutrition, setting, screening, assessment and intervention.

Prevalence of malnutrition in covid-19 patients

In acute care, two studies, utilizing the Mini Nutritional Assessment score (MNA score) and assessing 395 hospitalized COVID-19 patients found that 42% of hospitalized patients with COVID-19 were in danger of malnutrition and 28% of these patients were malnourished at the time of assessment[10,11]. Another study examining 114 consecutive, hospitalized COVID-19 patients, using the newly developed Global Leadership Initiative on Malnutrition (GLIM) criteria, concluded that 42% (48/114 patients) were malnourished[7]. Despite the limitations of current scientific literature on the topic, research demonstrates that the prevalence of malnutrition in acute care of patients afflicted by COVID-19 is high, and it is reasonable to assume that malnutrition following acute care would be considerable.

Within the rehabilitation setting, a post-hoc analysis of a prospective observational cohort study of 213 COVID-19 patients, 29% of patients had lost >5% of weight prior to infection[11]. COVID-19 patients that involuntarily lost weight during their illness demonstrated greater systemic inflammation, renal dysfunction and longer disease duration compared to those that remained at their prior to infection weight status[11]. Importantly, patients that lost weight had not returned to their previous weight status at follow-up (a median of 23 days since discharge)[11]. An Italian cohort of 50 COVID-19 patients screened for malnutrition at admission to the rehabilitation ward using the Malnutrition Universal Screen Tool (MUST) showed that 45% were at increased risk of poor nutrition, and 26% of patients had a moderate risk[6,12].

There is a lack of evidence about nutrition status and outcomes for COVID-19 patients at the rehabilitation setting and this constitutes a knowledge gap that needs to be further addressed.

Screening for malnutrition

Current guidelines recommend that health professionals undertake regular nutritional screening as part of routine admittance protocol to the rehabilitation setting. Even if a COVID-19 patient is not identified as at risk or malnourished at their initial screening, periodical reassessment of their nutrition status is recommended[13]. Screening for malnutrition is important for all COVID-19 patients, but particularly in COVID-19 patients with multiple long-term conditions and all adults over 65 years old[9].

Despite the abundance of available screening tools, the Malnutrition Universal Screening Tool ("MUST"), developed by the British Association of Parenteral and Enteral Nutrition (BAPEN), is the screening tool most preferred by clinicians for all age groups across different settings[14]. Yet, clinicians often refrain from screening overweight and obese patients for malnutrition. However, the diagnosis of malnutrition

focuses on weight loss and muscle status, according to GLIM criteria, and not solely on low body mass index[15]. Therefore, the inclusion of obese and overweight patients in the screening process should be emphasized[15].

Despite the universally recognized value of malnutrition screening, social distancing inherent in the management of COVID-19 patients may prohibit clinicians from screening. Nevertheless it should be emphasized that when social distance is required, especially post-discharge, the screening could and should be performed by remote consultation[14]. Strategies such as remote nutritional screening tools recently developed for primary practice should be applied to improve the nutritional management of patients managed at home.

Although MUST ideally requires objective measurements for its completion, recalled and subjective substitute measures could be used to enable the screening process[14,16].

Despite the documented importance of the screening process, its performance is worthless unless it is followed up by nutritional assessment to diagnose and grade the severity of malnutrition using GLIM criteria and referral to a dietitian early for personalized nutritional care[17,18]. There is no malnutrition screening tool specifically modified for use in the rehabilitation setting, the use of any of the available screening tools would benefit COVID-19 patients that have reached the rehabilitation setting with compromised nutritional status.

Etiology of malnutrition

COVID-19 patients demonstrate alterations in their status of nutrition for various reasons, including increased energy use alongside reduced nutrient intake, resulting in negative energy and nutrient balance[9]. Sepsis, pyrexia, and breathing difficulties use a lot of the body's energy resources, macronutrient but also micronutrient needs. At the same time, nutrient intake is lower because of the symptoms of the disease (e.g. breathlessness, excessive coughing, chronic fatigue, impairment of the sense of taste and the sense of smell, swallowing difficulties) and its treatment requirements (e.g. sedation)[9]. Furthermore, COVID-19 symptoms and treatment negatively impact a patient's psychological status (e.g. depression) that may also lead to lowering of volitional food intake. And last, but not least, social isolation that is important for avoidance of infection means people keep away from cohabitants and carers may not visit so frequently, posing obstacles in appropriate food availability and interest in eating[9,13].

Inadequate energy and nutrient intake COVID-19 patients frequently present with symptoms that lower volitional intake.

Respiratory issues faced by patients prohibit usual adequate eating and hydration. In addition, cough and breathing difficulties in conjunction with early satiety, due to gulping air during eating, dry mouth, use of inhalers and frequent mask wearing for oxygen therapy[19]. Hospitalised COVID-19 patients, in particular those with pneumonia, are prone positioned throughout the day and night and may be receiving extracorporeal membrane oxygenation where blood is pumped out of the body to a heart-lung machine that removes carbon dioxide and sends oxygen-filled blood back to tissues in the body. These pose obstacles to both volitional nutrition and enteral (tube feeding) nutrition intake. Furthermore, pharmacotherapy induced diarrhea dictates the lowering of enteral nutrition infusion rates for its management[9].

In addition, many COVID-19 patients lose the senses of taste and smell that are important for volitional food intake for several weeks after infection[9,20]. Fatigue and weakness are frequent symptoms for weeks and months after hospital discharge, thus these patients face difficulties in executing everyday tasks such as shopping and preparation of meals and snacks. It is frequently observed that previously completely independent adults have to depend upon others for shopping and cooking. As a result, patients may alter their nutritional habits by making less than optimal food choices which may provide energy but are not healthy and nutritious. Social distancing and self-isolation might lower carer presence at mealtimes (diminishing social eating opportunities) and may even pose a risk in adequate food provision[9].

In the COVID-19 patients, age and presence of multiple long-term conditions heightens the risk of poor nutritional status[9,21]. These patients are also at greater risk of worse outcome when they are infected with COVID-19[22,23]. Indeed, older age per se is often accompanied with poor nutrition and related worse outcomes[22,23]. For these patients, the synergic effects of the nutritional challenges of COVID 19 infection can be hugely detrimental[22,23].

Special consideration should be placed on nutritional status of COVID-19 patients that required ICU hospitalization as nutritional intake is commonly compromised for a variety of reasons. A long duration of ICU stay is associated with post ICU physical, cognitive and mental impairments[24]. ICU stays longer than 14 days, often reported in COVID-19 patients, is associated with poor nutritional status three months after ICU discharge[25,26]. Loss of skeletal muscle mass and muscle function are common outcomes in ICU survivors[26]. This is seen most commonly in older patients and those with multiple long-term conditions whose nutritional status is poor. Prolonged ICU stays also increase catabolism[25,27].

COVID 19 patients after removal of a feeding tube often experience dysphagia that worsens post ICU nutritional intake. In a recently published Italian cohort of 50 patients assessed at admittance to a rehabilitation ward for dysphagia more than 90% showed some degree of dysphagia[6,12]. Those patients needed texture modified diet and/or nasogastric feeding for safety during swallowing.

Increased energy and nutrient needs

COVID-19 patients demonstrate symptoms such as sepsis and fever that raise energy needs[20]. The high degree

Energy expenditure assumed to be between 27 and 30 kcal/kg/day
Energy and substrate requirements
Protein intake - 1 g/kg/day to 1.5 g/kg/day
Increased ratio of energy from fat to energy from carbohydrates, intended to assist patients with compromised respiratory function
Vitamins and minerals should be supplied in amounts approximately equal to the RDA. Vitamin D supplementation – 400IU/day.
Food fortification via supplements (all macronutrient substrates or only protein in powdered format or via whole food.
ONS - at least 400 kcal/day including 30 g or more of protein/day.
ONS should be prescribed for at least one month and compliance in consumption should be routinely assessed.
Patients with dyshpagia should be offered texture modified ONS
Dietary advice
Dietary advice/Professional counseling (personalized nutritional education and counseling), as distinct from brief and casual nutritional "advice"
RDA: Recommended Daily Allowance; ONS: Oral Nutritional Supplements

Table 1. Nutrition Recommendations for Covid-19 patients.

of inflammation in patients with severe and critical COVID-19 disease is a precipitating factor in malnutrition development.

Endothelial and epithelial cell death combined with vascular leakage trigger production of chemokines and cytokines, and may result in a massive inflammatory reaction causing disturbed tissue homeostasis. Proteolysis and disturbances of metabolism might also lead to the increased production of acute phase proteins namely: tumor necrosis factor-a (TNFα), ferritin, C-reactive protein (CRP), fibroblast growth factor, interleukin (IL-factors), inhibitor of transcription factor nuclear factor kappa B (NF-κB) and interferon-γ[28]. Despite efforts for aggressive nutritional support during prolonged ICU stay, the implications of the inflammation on nutritional status are present, and profound, long after discharge from acute care[29].

Prevalence of sarcopenia in COVID-19 patients

Definition, epidemiology and diagnosis of sarcopenia

Sarcopenia, as defined in the 2019 published European Consensus on definition and diagnosis criteria, is the combination of reduced muscle strength, quantity and/or quality[29]. Handgrip strength, calf circumference, and application of the SARC-F questionnaire are valuable diagnostic tools for sarcopenia screening and should be performed in COVID-19 patients[30]. Older adults are particularly prone to sarcopenia. It is estimated that approximately 10% of older adults living in the community are sarcopenic[30] while this percentage is even higher amongst older adults living in nursing homes, ranging from 6.7% to 81.7% depending on sarcopenia severity category[32]. Sarcopenia leads to motor activity limitations, dysphagia and impaired immunity[30]. Acute sarcopenia can develop within six months of an event that causes stress[31]. A vicious circle of interactions between COVID-19 and sarcopenia are present[30].

Etiology of sarcopenia in older COVID-19 patients

Mechanisms of sarcopenia development in older COVID-19 patients are likely to be the cytokine response related to systematic inflammation (tumour necrosis alpha, interleukin-1 and interleukin-6)[32]. Obesity can be accelerated in already overweight individuals because of lack of physical activity and increased food intake, leading to sarcopenic obesity[33]. Sarcopenia can also be accelerated through critical care admission (loss of muscle mass through inactivity), inadequate protein intake related to anabolic resistance, loss of taste and smell, induction of leptin and thus anorexia, weakness in jaw muscles leading to avoidance of foods that require chewing, extended periods of physical inactivity related to quarantine policies, fatigue and bedrest during illness, use of dexamethasone for COVID-19 treatment, reduced sun exposure and related vitamin D insufficiency[31,33].

Consequences of sarcopenia in older COVID-19 patients

Older adults who are sarcopenic show increased infection rates and a poor prognosis compared to non-sarcopenic adults[30]. Sarcopenia is considered a risk factor for in-hospital pneumonia and community acquired pneumonia and these associations imply that a similar association can be hypothesized for sarcopenia and COVID-19 induced respiratory dysfunction[30]. In addition, the depletion of muscle mass and strength, negatively influences immune potential, swallowing function, respiratory function and response to metabolic stress and thus leads to a dismal prognosis in sarcopenic COVID-19 patients[30].

Strategies for sarcopenia prevention and treatment

Effective strategies for sarcopenia prevention include resistance exercise (summary of evidence-based protocols advise 3 sessions per week, of 2-3 sets of exercise as a

training volume, 7-9 repetitions per set with a training intensity of 51-69% 1 Repetition Maximum), tailored to suit the individuals initial ability and health. Maintenance or growth of muscle mass and strength requires an increase in protein intake distributed across meals and snacks, frequent consumption of proteins of high biologic value, pre-bed protein snacks, dietetic advice on the range of high protein foods. Supplementation with 2.5 g leucine (with lower protein snacks and meals), 5 g of creatinine, and 4 g of fish oils to ensure adequate eicosapentaenoic acid and docosahexaenoic acid intake is important. Finally, consider also vitamin D supplementation with 1000-4000 IU, dependent on level of deficiency[33].

Recommendations for nutritional interventions

The key recommended interventions are presented in Table 1.

Prescription of dietary intake:

Energy requirements: Although indirect calorimetry is the gold standard in estimating resting energy expenditure (REE) it is rarely available for use in a rehabilitation unit. Consequently, in clinical practice, energy requirements are assessed via predictive equations (e.g. Henry, Mifflin), or via simplistic equations, aiming for 27–30 kcal\kg\day, adjusted to personal nutritional status, level of physical activity, clinical status and multiple long-term conditions[28].

Protein requirements: With the exception of patients with chronic renal insufficiency, all other COVID-19 patients should be encouraged to ingest a minimum of 1g\kg\day (up to 1.5 g\kg\day) of protein. It should be emphasized that for combating sarcopenia, and for older adults, current guidelines are higher, encouraging at least 1.2 g\kg\day and optimum of 1.5 g\kg\day[14]. Spreading the protein intake across the day (eg. 30 g per meal) is recommended[14,15,34].

Carbohydrate and lipid requirements: It is recommended to provide more lipids than carbohydrates in patients with respiratory insufficiency[23]. Low glycaemic index carbohydrates have to be considered as well[6].

Micronutrients: The European Society of Parenteral and Enteral Nutrition (ESPEN) recommended a minimum daily intake (RDA) for all micronutrients[27]. Of course, if any specific minerals, vitamins, or trace elements are identified as deficient then higher intakes should be prescribed. In patients with compromised volitional food intake, the use of over-the-counter multivitamin and mineral supplements providing the recommended daily intake in all micronutrients should be prescribed[9,27]. Another focus of the current research activity on COVID-19 and micronutrients, is the association between vitamin D and COVID-19. Guidance from many dietetic associations and scientific organizations, such as ESPEN, discuss decreased vitamin D intake and vitamin D deficiency in populations that do not spend time outdoors, such as residents of long term care facilities[9]. They are advised to supplement their dietary intake with 400 IU of vitamin D on a daily basis. More needs to be understood about nutrition interventions post COVID-19[35].

Dietary advice

The food first approach is considered a core component of effective nutritional care. In the past considerable attention had been placed by the research community on improvement of nutritional status via nutritional support (enteral nutrition or oral nutritional supplements), nevertheless nowadays clinical practice and researchers have shifted their attention to holistic nutritional interventions that merge all available measures (namely nutritional support, and dietary counseling)[9]. Dietary advice incorporating education of the patient or their carer on how to enhance nutrient and energy intake via personalized suggestions for meals and snacks in conjunction with the use of counseling techniques that try to increase adherence to the dietary education component aims to optimize dietary intake and handle the symptoms of COVID-19 that negatively interfere with dietary intake (e.g. fatigue, nausea, loss of taste etc.). Dietary advice should be patient centered to empower to allow them to manage the various aspects of their lifestyle. In provision of dietetic services (education and counseling) face-to face consultations are considered the gold standard, nevertheless it should be emphasized that current technology facilitates communication via other means (e.g. phone or online communication) that may be also be effective. In such instances, virtual consultations can and should be complemented with leaflets and all forms of written materials that would have been required in a face-to face usual consultation[9].

Food fortification should be advised, specifically patient understanding that increasing energy intake without protein and micronutrients is not going to promote good outcomes. Reaching energy requirement goals is easier than reaching protein requirements via food fortification, consequently special care should be placed on this discrepancy. Fortification can be performed by use of supplements in a powdered form added to meals and snacks that provide protein, carbohydrate or lipids or their combination in the desired consistency or by use of whole foods such as powdered milk, grated cheese etc[6,12].

Oral Nutritional Supplements

Despite the proven effectiveness of personalized nutritional education and counseling and their considerable contribution in improving nutrient and energy intake, in several cases patients are not able to reach their energy requirements nor, more importantly, their protein goals. Thus, their nutritional status remains poor or worsens. In such cases, use of oral nutritional supplements (ONS) are recommended[13].

However, the use of supplements are often used as a substitute for the ''food first approach''. In such cases, oral nutritional supplements are of limited benefit, as they

seem to constitute meal replacements and not supplements of fortified meals and snacks[36]. This may be exacerbated by ineffective prescription and poor compliance with prescription when flavor or texture is not of the patients preference. Practice protocols that include a minimum of 400 kcal per day for increase of energy intake and a minimum of 30 g of protein per day and that last at least a month are proposed. Efficacy of ONS should be assessed on a monthly basis. When there are considerations about limited compliance on behalf of the patient, more frequent monitoring e.g. weekly is recommended[36].

When prescribing ONS, the presence of dysphagia should be considered. Swallowing difficulties, that are frequently present post ICU, should lead to special texture modified ONS.

Apart from disease specific products (e.g. ONS enriched with eicosapentanoic acid (EPA) to combat cancer cachexia, or products with low volumes/low protein for renal patients), considerable attention has been placed on non standard products that are enriched with protein, products that are energy dense/low volume and products that combine both these attributes. ONS (composed of all macronutrients) in powdered format require that patients or their carers add to a basic whole food, such as milk, and that they can and are willing to mix them correctly. The use of patient suitability questions is recommended[37,38].

Conclusion

Malnutrition delays rehabilitation and negatively impacts rehabilitation outcomes in COVID-19 patients. Malnutrition is often accompanied by sarcopenia. At the beginning and during rehabilitation, screening and subsequent management of poor nutritional status of patients recovering from COVID-19 infection is important as it impacts the treatment outcome. Nutritional rehabilitation should play an integral part in the management of patients recovering from COVID-19 infection, particularly for the subset of patients that required ICU stay.

Personalized ''food first'' approach, food fortification and supplementation of diet with ONS may combat poor nutrition in COVID-19 patients, particularly in the subset of patients who struggle to consume adequate amounts of low volume protein and energy dense foods, for example, elderly, patients with multiple long-term conditions and patients who have been discharged from intensive care.

Disclaimer

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