Review

aspen LEADING THE SCIENCE AND PRACTICE OF CLINICAL NUTRITION
American Society for Parenteral and Enteral Nutrition

Journal of Parenteral and Enteral Nutrition
Volume 44 Number 8
November 2020 1439–1446

DOI: 10.1002/jpen.1996
wileyonlinelibrary.com
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Challenges of Maintaining Optimal Nutrition Status in COVID-19 Patients in Intensive Care Settings

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Abstract

The coronavirus disease 2019 (COVID-19) pandemic has threatened patients, healthcare systems, and all countries across the globe with unprecedented challenges and uncertainties. According to the latest literature, most patients with COVID-19 have mild symptoms that do not require hospital admissions, and only a small percentage of those hospitalized require intensive care. In the intensive care unit (ICU), a registered dietitian nutritionist (RDN) assists the critical care team by formulating, executing, and monitoring the nutrition strategies and interventions to meet the unique requirements of extremely sick patients. However, because of the novelty of COVID-19, the situation is fluid and guidelines continue to be developed and updated. This article discusses the interim guidelines available for the nutrition support of ICU COVID-19 patients and the challenges the critical care team and RDN may face from a nutrition standpoint. (*JPEN J Parenter Enteral Nutr.* 2020;44:1439–1446)

Keywords

enteral access; nutrition; nutrition assessment; parenteral nutrition; vitamins

Introduction

In <6 months, the coronavirus disease 2019 (COVID-19) pandemic has brought the whole world to its knees.[1,2] As of July 15, 2020, there are a total of 13,560,683 confirmed COVID-19 cases, with 583,523 deaths across the globe.[3] Most patients (99%) have clinically mild symptoms and are likely to recover. The remaining are just 1% of the affected population but constitute 59,511 cases who are critically ill. These patients will need holistic, therapeutic nursing, medical care, and nutrition care.

Recognizing the Problem and Importance of Dietitians During COVID-19

COVID-NET surveillance is a Centers for Disease Control and Prevention (CDC)–affiliated task force that is keeping constant track of COVID-19 cases across the country.[4] The COVID-19 pandemic has significantly affected the healthcare system and infrastructure in both developed and developing countries.[1,5] As per COVID-NET updates, the COVID-19–associated hospitalization rate is 4.6 per 100,000 population; higher rates have been noted with increased age, the highest among patients ≥65 years old. Approximately 90% of the hospitalized patients had 1 or more underlying conditions. The common comorbidities identified are obesity, hypertension, chronic lung disease, diabetes mellitus, cardiovascular disease, and malignancies.[6,7] Almost 4.9%–11.5% of the hospitalized patients (among all the age groups) require intensive care unit (ICU) admission and/or mechanical ventilation. Unfortunately, these figures increase to as high as 31% for individuals 75 years or older.

Patients with COVID-19 might stay in the ICU anywhere from a few days to a couple of weeks, depending upon the severity of disease and recovery. Those who are on mechanical ventilation or are too critically ill to eat need the advice of a registered dietitian nutritionist (RDN) for enteral nutrition (EN) or parenteral nutrition (PN) prescription. EN is an everyday practice of doctors, nurses, and other ICU clinicians and is second nature to RDs working with the critical care population. Currently, during the COVID-19 crisis, our experience at a 350-bed community

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Financial disclosure: None declared.

Conflicts of interest: None declared.

Received for publication June 23, 2020; accepted for publication August 7, 2020.

This article originally appeared online on September 15, 2020.

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hospital located at an urban city (Worcester) in central Massachusetts has also been extremely challenging. With 38 intensive care beds, on average, an RDN manages ~20 or more patients receiving EN daily (unpublished data). These numbers are almost double the average amount of patients who receive EN being managed in ICU settings on usual days. From an RDN's clinical experience, nowadays, the majority of effort, discussion, documentation, and clinical rounds are spent in decision making about the nutrition care of critically ill patients with COVID-19. This underscores the important but often undermined role of the RDNs in a critical care squad. The challenge is greater while dealing patients who have additional medical comorbidities.[8–10]

During the COVID-19 pandemic peak, each RDN in the facility was required to become a critical care dietitian in a short time, requiring intense training via webinars, researching best practices, and competency training in nutrition support. It is the RDN's role to keep abreast of the most recent studies regarding ICU nutrition for the COVID-19 patient and then take that information to practice by educating other members of the critical care team.[9] Additional battles include product shortages and staffing shortages due to hospital census decreasing, though on the front line, the acuity of these patients has skyrocketed.[11] The acuity is higher than any patient population previously seen. As these patients are labile with medical status changing daily, it is imperative that the RDNs provide intensive follow-up daily as well.[12,13]

ASPEN and SCCM Guidelines: A Snapshot

The American Society for Parenteral and Enteral Nutrition (ASPEN) and the Society of Critical Care Medicine (SCCM) recently released guidelines specific to nutrition support therapy of COVID-19 patients admitted in critical care units.[14–16] The recommendation starts with discussing the timing of nutrient delivery, recommending early EN within 24–36 hours of admission to the ICU or within 12 hours of intubation (Figure 1). If early EN is not feasible, PN is recommended to be initiated as soon as possible. Trophic feedings of 10–20 mL/h should be initiated first, advancing slowly over the first week. Total energy intake in the first week does not seem to be the main concern, as 15–20 kcal/kg of actual body weight should be the nutrition prescription. The standing recommendations for protein, 1.2–2 g/kg of body weight, continue.[16]

EN is preferred to PN, though EN should be withheld in the patient who is hemodynamically unstable, requires either escalating/high doses of vasopressors or multiple vasopressors, and/or has rising lactate levels. PN should then be considered with the addition of abdominal distention or pain, dilated loops of the small bowel, pneumatosis intestinalis, or increasing nasogastric outputs within 6–12 hours of trophic feeding initiation. The recommendations do address and condone EN in the patient undergoing prone positioning. A high-protein (>20%) polymeric formula is recommended as the first line of therapy. Monitoring of medications such as propofol, which is suspended in a fat emulsion, should be taken into consideration when prescribing EN or PN, as this influence triglyceride levels and provides 1.1 kcal/kg as fat. Additionally, serum phosphate, magnesium, and potassium levels should be monitored closely for the incidence of refeeding syndrome.[17]

Because COVID-19 is a novel disease, one must take into consideration the physiological changes of what is documented in the literature about patients with acute respiratory distress syndrome (ARDS), pneumonia, and septic shock and those who are critically ill, requiring mechanical ventilation.[18] For example, in addition to ASPEN, the European Society for Clinical Nutrition and Metabolism (ESPEN) base their COVID-19 guidelines on their past guidelines along with expert advice.[19] The majority of patients who are admitted to the ICU have already been "sick" for a few days and likely have underlying conditions. Poor oral intake, gastrointestinal (GI) symptoms, and even underlying malnutrition prior to admission set the patient back from a nutrition standpoint. Those who are critically ill experience a phase of catabolism, and acute phase protein synthesis leads to a loss of lean body mass, electrolyte abnormalities, and alterations in nitrogen balance.[20] Furthermore, for patients requiring a long duration of ICU stay, supportive care from the use of medical nutrition therapy can greatly benefit the patient in the acute phase by providing energy to assist in fighting this battle.

Challenges of Providing EN to COVID-19 Patients in an ICU Setting

EN in the ICU patient provides more than just macronutrients and micronutrients. Even at a trophic rate, EN maintains gut integrity in the intestinal villi by maintaining tight junctions and stimulating blood flow through the intraepithelial cells.[20] Nutrient interaction with mucosal cells and gut-associated lymphoid tissue is thought to play a role in immune functions such as deactivation of viruses.[21] Companies that supply EN formulas have reported a 200% increase in formula sales and demand since the COVID-19 pandemic began. As mentioned above, it is recommended that RDNs use a high-protein formula to feed these patients on mechanical ventilation.[15] However, without the ability to obtain these formulas, meeting patient protein needs specifically is not just difficult but near to impossible for some patients. This is especially true for those who are overweight or obese, in which a case series of patients from hospitals in New York City suggests that 41% of COVID-19 patients have as an underlying condition.[22]

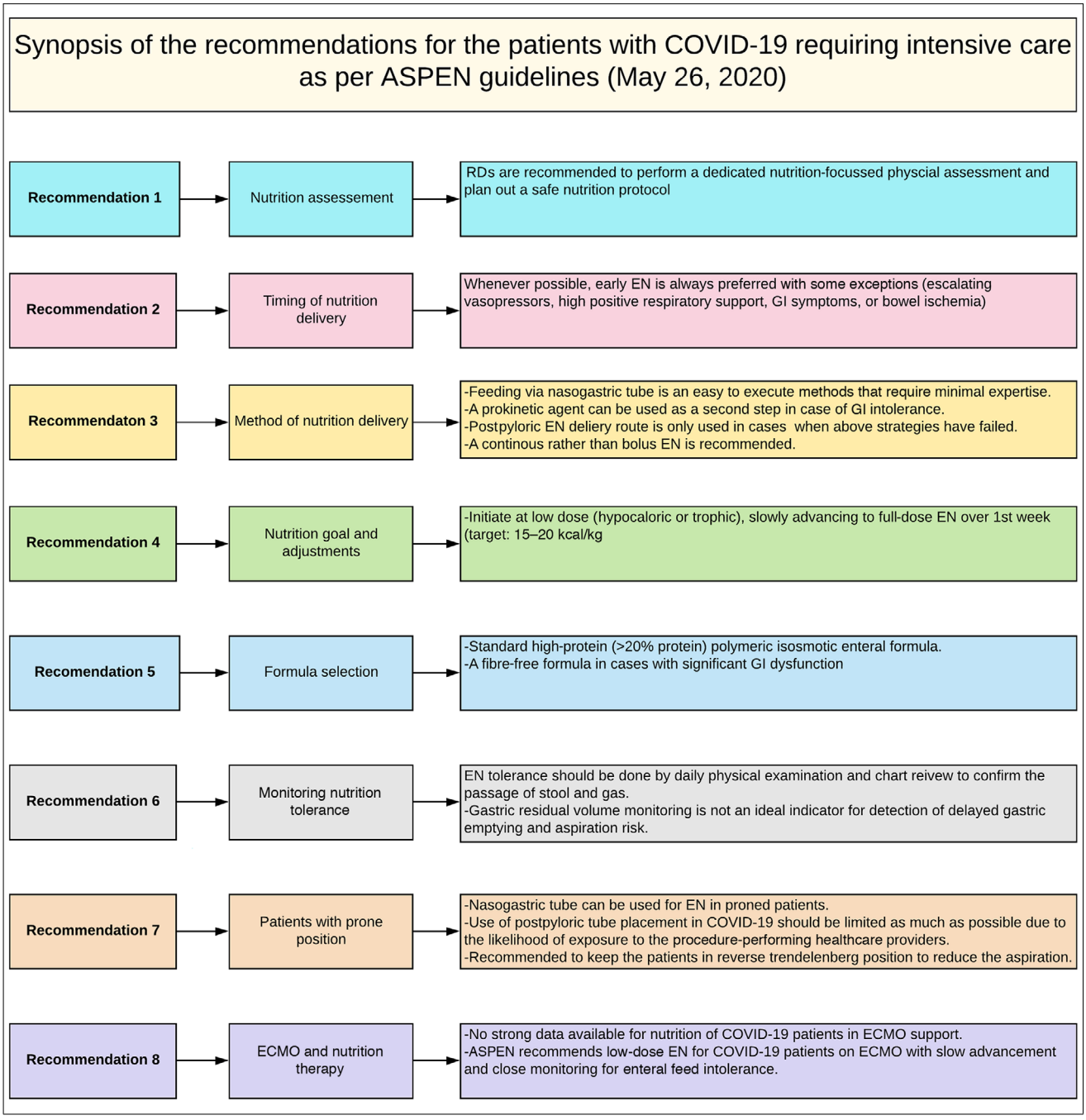

Figure 1. Recommendations for nutrition delivery in critically ill patients with coronavirus disease 2019 (COVID-19) in an intensive care setting. ASPEN, American Society for Parenteral and Enteral Nutrition; ECMO, extracorporeal membrane oxygenation; EN, enteral nutrition; GI, gastrointestinal; RD, registered dietitian. Adapted with permission from Reference 15.

COVID-19 in ICU and the 4 P's: Pressor, Propofol, Paralytics, and Pronation

Studies have shown that not only are critically ill patients with COVID-19 presenting with pneumonia and ARDS but many of them are progressing to sepsis and septic shock as well.[23] A retrospective case series shows that up to 95% of patients receiving mechanical ventilation needed vasopressor support.[24] It is widely known that early EN has been shown to decrease ICU length of stay, decrease mortality, and infection rate as opposed to when it is started later in the hospital stay in non–COVID-19 critically ill

patients.[18,25,26] Although feeding the critically ill patient and taking into consideration vasoactive medications and propofol infusion is common practice for the critical care RDN, challenges arise because EN may be delayed, owing to the high requirement and lengthy time frame of use of vasoactive medications in this patient population.[27]

Executing early nutrition should always be aimed for, and COVID-19 with circulatory shock should not be considered as a contraindication to EN unless there is an accompanying enteral feed intolerance.[28] Prokinetic agents are recommended in such cases to increase the gut motility and improve EN tolerability. The special scenarios when switching to PN is considered are when EN is not feasible, for instance, in (1) a COVID-19 patient on escalating or multiple vasopressors, (2) a COVID-19 patient on high pressure support like continuous positive airway pressure or high positive end-expiratory pressure, (3) bowel ischemia, and (4) COVID-19 with GI involvement (nausea, vomiting, diarrhea, GI bleeding).

After initiation of EN, reaching goal energy and protein—and keeping them there—is a difficult task. As propofol provides energy from fat, the dietetics professional must adjust the rate of EN to compensate for the energy that propofol provides; thus, the patients may not take in their target energy and protein needs while receiving this infusion. This requires consistent communication with nursing staff so that the EN can be titrated to goal as medically appropriate.

Prone Positioning in COVID-19

Prone positioning is one of the interventive care strategies in critically ill patients with ARDS used to prevent lung injury, recruit more alveoli for gas exchange, and improve oxygenation.[29] In COVID-19–related ARDS, prone positioning is being used both in ventilated and nonventilated patients.[30,31] Feeding a patient who is mechanically ventilated and in prone position is a daunting task and a new normal to see in the ICU. Although COVID-19 is a novel disease, practicing prone positioning is a regular exercise by intensivists in patients with ARDS. Similarly, feeding in the prone position has been studied in the past and found to be a safe, practicable exercise without any increased complications.[32] A prokinetic agent may also be used in this situation to improve gut motility and tolerance to EN. Experience from the previously conducted studies have served as a good foundation to execute tube feeding in critically ill COVID-19 patients in prone position as we await further studies specific to our COVID-19 patients.[33–35] ASPEN recommends following the general guidelines of nutrition for ICU patients in COVID-19 as well.

EN may become interrupted or halted during the paralysis and proning process. Small studies referenced in the ASPEN guidelines have shown no significant difference in GI symptoms in feeding the prone patient as opposed to supine, as long as the head of the patient's bed is raised.[4] ESPEN guidelines recommend supplying a small amount (30%) of energy while patients are prone.[13] There is a lack of studies addressing EN for the patient receiving neuromuscular blockers; however, ESPEN guidelines for the critically ill patient suggest EN can be provided in the patient on neuromuscular blockers.

Pronation is one of the most challenging aspects of managing ARDS patients during the COVID-19 pandemic, especially in feeding critically ill COVID-19 patients. There is a common belief among healthcare professionals and nursing staff that feeding in a prone position could be detrimental because of the aspiration risk. One of the job responsibilities of the RDN is to educate the physicians with the current ASPEN recommendations for feeding in the prone position. Typically, tube feeds are held about 1 hour before proning and started thereafter. The maximum rate we have fed a patient in the prone position was 50 mL/h, though the majority of our patients received trophic feeds of 10–20 mL/h while in the prone position. The RDN would follow up multiple times a day to assess whether a patient was going to prone or supine. It was difficult to meet our patient's energy and protein needs when the patient was in the prone position because of the novelty of feeding in the prone position in our facility.

Inability to begin EN due to hemodynamic instability combined with paralytics and the prone positioning could leave patients without nutrition for days, if not weeks, which likely warrants a conversation to consider PN. In combination with the severe fluid overload, electrolyte abnormalities, and the above-mentioned benefit of EN, PN becomes an even less attractive option for clinicians, RDNs, and patient outcomes alike. Only 1 patient, from our experience, needed supplemental PN, as this patient was proned and unproned for hours and days at a time.

Monitoring and Evaluation

After the prescription of EN or nutrition support, the RDN must be vigilant in addressing GI issues, interpreting laboratory results, and addressing interaction with medications. A recent review showed that patients with COVID-19 may develop different degrees (14%–78%) of liver dysfunction.[36] Similarly, Pan et al reported that of the 204 patients with COVID-19, 50% of patients reported digestive symptoms including lack of appetite, diarrhea, vomiting, and abdominal pain.[37] Balancing the opioids and paralytics with EN is a daunting task for the RDN, as gut motility is a moving target and varies with the type and dose of narcotics used; for example, fentanyl can slow GI motility. Prokinetic agents, which are typically used as a motility agent, are suggested to be used in COVID-19 patients, if needed, and strongly considered when feeding in the prone position as discussed

above.[19,34] However, hydroxychloroquine, which was trialed in COVID-19 patients, can interact with metoclopramide, loperamide, and erythromycin and has the potential to cause cardiac arrhythmias like torsades de pointes or prolonged QTc interval. More recently, remdesivir is being used as an experimental drug for COVID-19. Singh et al compiled a critical review of many trials using remdesivir for COVID-19.[38] The clinical benefit appears inconsistent at this time; however, some side effects are bound to occur, as with any drug. Like their review found, a marked increase in Liver function tests (LFTs) has been observed at our facility (unpublished data). As active GI side effects such as vomiting, deranged hepatic, and even renal laboratory values from medications like remdesivir occur, it may be practical to temporarily withhold the EN or PN support and continue to follow up daily.[39]

Additionally, acute kidney injury in ICU patients with COVID-19 can fluctuate electrolytes in the body, more so in patients requiring renal replacement therapy.[22] Nutrition therapy as well can directly alter electrolyte values, and the RDNs must take this into careful consideration when providing medical nutrition therapy.

Signs and symptoms of aspiration must be monitored as well. As this disease is already a detriment to the lung, an aspiration event would only halt the healing process.[40] According to ASPEN, checking for gastric residual volume in this patient population is not preferred, because of exposure concerns and interruption of EN delivery, but monitoring for signs and symptoms such as abdominal distention, vomiting, bowel movements, and flatus is a bedside technique to be done by nurses and physicians during physical assessment.[14]

There is ample evidence that suggests people with diabetes are particularly exposed to a worse prognosis if infected.[41] Blood glucose control can pose another challenge in the ICU COVID-19 for a patient with or without diabetes. As blood glucose levels can already rise owing to metabolic stress, some patients may be administered steroids or medications dispensed in a 5% dextrose and water solution. Conversely, hydroxychloroquine may lower blood glucose levels. Again, the RDN must monitor the amount of carbohydrate being provided from EN or PN and discuss this with the critical care team in a timely fashion.

Strategies for Nutrition Support Allocation During the COVID-19 Pandemic

Worldwide, we have witnessed that even the best healthcare facilities have suffered from shortages in almost all health sectors in providing adequate patient care during the COVID-19 pandemic,[42] such as inadequacy of personal protective equipment (PPE), lack of ICU beds, scarce ventilators, and medication shortages, to name a few.[43] Nutrition care also suffered the brunt of the COVID-19 crisis.[44] Small community healthcare centers who are not used to manage critically ill patients are also providing medical treatment and nutrition care to these patients. Barrocas et al recently discussed the strategies that could be implemented for allocation of the nutrition resources during the COVID-19 crisis, keeping ethical factors into consideration.[11]

In current scenarios, when at many times it might not be possible to provide the ideal nutrition care to all the patients in need, the nutrition support professionals could help the treating team and respective RDNs in collective, informed decision making by using the standardized prognostic and survival parameters.[11] Nutrition support professionals can provide essential input with regards to the type of feed, route of delivery, volume, etc. When scarcity of resources is a major concern, they can triage and evaluate which patients could benefit the most. With regards to enteral-formula shortages, it is difficult to provide or generalize any suggestion, owing to varying resource availability and local practices.

A unique issue during the COVID-19 pandemic for some hospitals and RDNs may be the availability of feeding pumps. With the increase in ICU admissions and the need for mechanical ventilation, more patients need EN as a feeding option. In cases when enteral-feeding pump machines are scarce, the alternative option of gravity bag feeding may be utilized to ensure patients receive timely and adequate EN. Bolus feeding, however, is neither recommended nor feasible in COVID-19 patients, according to the ASPEN guidelines.[27,45]

Protein is one of the most important macronutrients to meet the nutrition need of critically ill patients (both COVID-19 and non–COVID-19). At our center, we frequently used modular for our patients (with a composition of 15 g per 30 mL protein modular). Based on chart review and laboratory results, typically, the RDN would order the protein modular a day ahead. This allows RNs to adjust the timing of giving the modular along with the other scheduled medications to avoid unnecessary exposure. Usually, we would give two 30-mL modulars at a time. Our facility prepared for the potential shortage of feeding pumps and ordered the gravity feeding sets as a backup. So far, we have been able to feed all our patients via the pump and have not required gravity feeding. However, instructions have been provided to the RDNs in the facility for gravity feedings, in case this is needed in the future.

The first line of therapy recommended by the ASPEN guidelines is a high-protein, isotonic formula. Until we have literature regarding which enteral formula should be used in shortage situations, it would be the RDN's clinical judgment to choose which formula next in line, is available in the hospital, and best suits the patient's need. It is unknown whether PN would be preferred over EN in times of enteral-formula shortages, as this topic is not yet studied and needs further research.

Use of Micronutrients and Vitamins in Patients With COVID-19

Vitamins and micronutrients play an indispensable role in various body functions, enzymatic reactions, and immune functions[46,47]. Many clinical trials are underway to study the benefit of vitamin and mineral supplementation in the COVID-19 patients.

Vitamin D has been widely studied in ICU patients prior to the COVID-19 era and now during the COVID-19 pandemic. Use of vitamin D, especially higher doses in ICU settings, has been studied in the past, with conflicting results. Amrein et al (VITdAL-ICU randomized clinical trial) did not find high-dose vitamin D_3 mortality benefit except in the subgroup with severe vitamin D deficiency.[48,49] Hematological parameters have been studied in great depth owing to their prognostic role during previous and current pandemic.[8,50,51] Based on these observations, studies that have focused on anemia and vitamin D deficiency are interlinked in critical care settings. Smith et al did a double-blind, randomized, placebo-controlled trial using high-dose vitamin D_3.[52] Participants were divided into 3 arms: (1) placebo group, (2) 250,000 IU vitamin D_3 group, and (3) 500,000 IU vitamin D_3 group, respectively. They found that the 500,000 IU vitamin D_3 group had significantly increased hemoglobin concentrations over time (P group × time = .01) and a significant drop in serum hepcidin concentrations ($P = .007$) as compared with the placebo group. Based on the literature review, researchers have conflicting opinions on the use of vitamin D in COVID-19 patients.[53–55] A recent review by Grant et al received criticism for their recommendations to use vitamin D_3 (10,000 IU/d for a few weeks followed by 5000 IU/d) by people at risk of COVID-19 to reduce the risk of infection.[53] Hence, without concrete evidence, the risks and benefits must be weighed carefully before giving mega vitamin doses to COVID-19 patients.[56] Early data suggest that vitamins C, D, and A and zinc can be an adjunct to pharmacological management for COVID-19 patients. These vitamins have been studied in the past for their antioxidant properties and role in preventing various medical conditions like coronary artery diseases and hematological conditions.[57,58]

The RDN would not be the provider recommending additional vitamins and minerals for the specific treatment of COVID-19 in our facility. In some instances, extra supplementation may be warranted based on the COVID-19 patient's past medical history or other factors. Examples include a multivitamin with minerals if the patient was unable to meet the recommended daily allowance via enteral feeding and vitamin C 1000 mg and zinc 250 mg for 10 days if the patient had pressure injuries and if their renal function allowed. Thiamin and folic acid would be recommended in the patient who may be at risk for refeeding syndrome with underlying malnutrition.

Table 1. Nutrition Therapy for the COVID-19 Patient: What We Have Learned vs Areas of Further Study.

What we have learned	Additional areas of research
• The dietitian has been playing a vital role in the critical care team during the COVID-19 pandemic • We should approach medical nutrition therapy for the ICU COVID-19 patient as we would a patient with ARDS, pneumonia, or sepsis using what we know in the literature (see ASPEN guidelines) • High-protein EN formulas when able • We must have emergency supplies on hand (gravity bags, extra tubing, formulas in advance) • The dietitian must keep abreast of current nutrition information and continue to educate the critical care team and RD colleagues on best practice, which is EN while prone	• Targeted vitamin and mineral therapy • Specific energy/protein recommendations to be delivered to the COVID-19 ICU patient for best outcomes • Studies to address early vs late EN (or EN in general) in the COVID-19 ICU patient and outcomes such as decreased LOS? Mortality? Complications? Vent days? • Additional studies on the safety and tolerability of EN in the prone and chemically paralyzed COVID-19 patient • Long-term nutrition outcomes for previous COVID-19 ICU patients ◦ Include: Poor oral intake, swallowing difficulties, loss of lean body mass, malnutrition

ARDS, acute respiratory distress syndrome; ASPEN, American Society for Parenteral and Enteral Nutrition; COVID-19, coronavirus disease 2019; EN, enteral nutrition; ICU, intensive care unit; LOS, length of stay; RD, registered dietitian.

Practical Aspects

From a dietetics perspective, as addressed above, the RDNs must follow up with COVID-19 patients in the ICU at least daily, as their status can change quickly. The RDN must find a balance in addressing nutrition issues in COVID-19 patients. RDNs must not overfeed or underfeed, as either could lead to the inability to wean off mechanical ventilation.[20] However, RDNs must provide adequate energy and protein to assist in the hypermetabolic state of these patients. Wound healing and sarcopenia become an issue as patients spend days on mechanical ventilation or bedbound.

Conclusion

In conclusion, it is apparent that there is no one-size-fits-all medical nutrition therapy for critically ill patients with COVID-19. This Review is to provide an outline of what we do currently know and to explore the potential areas of study (Table 1). Consistent monitoring,

evaluation of trends, and constant communication with the multidisciplinary team seem to be some of the most effective ways to assure timely and adequate nutrition is being provided to our COVID-19 patients. The COVID-19 pandemic is a fluid situation, and more literature and recommendations regarding nutrition support in COVID-19 patients are expected to publish in the coming few weeks.[6] It is imperative that the ICU team, including the dietitian, keep abreast of these studies daily to provide optimal care for patients.

Statement of Authorship

K. K. Sahu, L. Gibbs, J. Larrivee, and N. Minnelli equally contributed to the conception and design of the research; L. Gibbs and K. K. Sahu contributed to the design of the research; J. Larrivee, K. K. Sahu, and N. Minnelli contributed to the acquisition and analysis of the data; L. Gibbs and N. Minnelli contributed to the interpretation of the data; and K. K. Sahu and N. Minnelli drafted the manuscript. All authors critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

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