Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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The management of patients with coronavirus disease 2019 in intensive care unit (ICU) in low income countries: A review article

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SUMMARY

Background: The novel coronavirus, severe acute respiratory syndrome-CoV-2 (SARS-CoV2)- causing coronavirus disease 19 (COVID-19), outbreak as a world health problem and was declared as a pandemic disease by the world health organization (WHO) in March 2020. Many serious findings have been observed among victims with sever acute respiratory syndrome-CoV-2.
Methods: This review was conducted according to the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) protocol. Search engines like PubMed and PMC through HINARI, Cochrane database, Google Scholar were used to get information about the current evidences on management of coronavirus disease 2019 (COVID-19) in intensive care unit (ICU).
Discussion: Mortality with COVID 19 is associated with geriatric population, the presence comorbidities like hypertension, diabetes mellitus, cardiovascular disease, chronic lung disease, and cancer, acute respiratory failure, higher d-dimer and C-reactive protein concentrations, lower lymphocyte counts, and secondary infections.
Conclusion: The international recommendations on nutrition in the ICU should be followed. Some specific issues about the nutrition of the COVID-19 patients in the ICU should be emphasized. Universal infection prevention precautions (hand hygiene and use

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of personal protection equipment (PPE)) are invaluable during nursing of COVID 19 patients at ICU.

Introduction

The coronavirus disease 2019 (COVID-19) distributes all over the world, the intensive care unit (ICU) staffs should be prepared for the worst yet to come [1]. Coronavirus disease 2019 (COVID-19) arises in the continent of Asia and is the third coronavirus infection in the two decades, after severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS).

A novel coronavirus (severe acute respiratory syndrome—coronavirus 2, SARS-CoV-2) has been distributed throughout the world and resulting acute respiratory failure since December 2019. Most of patients with COVID 19 presents with mild symptoms. Among these, about 5% become critically ill and require intensive care treatment. Acute hypoxemic failure with severe dyspnea and an increased respiratory rate (>30 breaths/min) usually leads to ICU admission. During this time, bilateral pulmonary infiltrates are seen at chest x-ray. Patients often develop a severe acute respiratory distress syndrome (ARDS). Till now there is no specific definitive treatment for COVID 19. Therefore the main goal of supportive treatment is to achieve adequate oxygenation. Early intubation and repeated prone positioning are key elements in treating hypoxemic COVID-19 patients.

Low threshold for intubation and prone positioning were determinant factors for the management of hypoxemic victims with COVID 19 in intensive care unit (ICU). Universal infection prevention precautions (hand hygiene and use of personal protection equipment (PPE)) are invaluable during nursing of COVID 19 patients at ICU [2].

Many serious findings have been observed among victims with sever acute respiratory syndrome-CoV-2 and admitted to intensive care unit. Patients at intensive care unit have higher neutrophil and white blood cell counts and higher levels of D-dimer, creatine and creatine kinase.

The median time from symptom onset to ICU admission has been reported to be 10 days. The median Glasgow Coma Scale (GCS), Acute Physiology and Chronic Health Evaluation (APACHE) II, and Sequential Organ Failure Assessment (SOFA) scores on the day of ICU admission have been calculated and appeared to be: the median GCS score is 15 (IQR, 9–15), SOFA score is 5 (IQR, 3–6), and APACHE II is 17 (IQR, 10–22) [3]. Patients with COVID-19 can progress from asymptomatic or mild illness to acute respiratory failure or multiorgan failure that need intubation and intensive care management.

Healthcare workers (HCWs) and especially Anesthesiologists/Anesthetists are at the frontline of this pandemic diseases and they need updated evidences about staff safety and patient management at ICU [4]. Airway management of patients with COVID-19 is high risk for the transmission of the virus to care givers [5]. The novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the cause of a rapidly spreading illness, Coronavirus Disease 2019 (COVID-19), affecting millions of people around the world [6]. Since the 2019 novel coronavirus disease (COVID-19) outbreak originated from Wuhan, Hubei Province, China, at the end of 2019, it has become a health service challenge to the world.

Among people infected with the novel coronavirus (2019-nCoV), the intensive management of the critically ill patients in intensive care unit (ICU) needs substantial medical resource and adequate drugs, adjunctive agents, respiratory supportive strategies as well as circulation management, multiple organ function monitoring and appropriate nutritional supplementation strategies [7]. The symptom clusters in one population may show overlaps and involvements, a phenomenon that should be deliberately resolved to improve the management efficiency [8].

All medical personnel involved in the management of patients with COVID-19 must take care of airborne transmissions, hand hygiene, donning and doffing of personal protective equipment and all aerosol-generating procedures should be done in an airborne infection isolation room [9]. The goal of this review is extracting informations for evidence based management of critically ill patients with

COVID-19 in ICU in resource limiting settings as the cases admitted to ICU rise with alarming rate in worldwide.

2. Methods

This review was conducted according to the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) protocol. Search engines like PubMed and PMC through HINARI, Cochrane database, Google Scholar were used to extract important information about the current and up to dated evidences on management of coronavirus disease 2019 (COVID-19) in intensive care unit. Using the combinations of the terms including: COVID 19 AND ICU, COVID 19 AND Extubation, COVID 19 OR Corona Virus, COVID 19 AND Airway Management, COVID 19 OR Sever Acute Respiratory Syndrome, COVID 19 AND Staffing, COVID 19 OR SARS-CoV-2, COVID 19 AND weaning. A publication with English language that was done in 2020 was included in this systematic review. Systematic reviews and meta-analysis, randomized control trials, review articles, observational studies, retrospective studies and case reports were included (Fig. 1).

After comprehensive and in-depth appraisal of literatures, evaluation of quality was conducted by categorizing them based on Good clinical practice, GCP, WHO, 2011, into level 1a (Meta-analysis, systematic review of RCTs, Evidence based guidelines) 1b (Systematic review of one RCT), 1c (RCTs), 2a (Systematic review of cohort or case control studies) and 3a (non-analytical studies like case report and case series, clinical audits, commentaries) (Table 1). Finally, conclusion had been drawn based on the level of evidences. This review article has been registered with unique identification number (UIN) of reviewregistry976.

3. Discussion

Since the emerging of COVID 19 worsens, intensive care unit (ICU) staffs need to have a quite high suspicion and a low threshold for diagnostic testing for COVID-19. ICU staffs, Hospital Administrators,

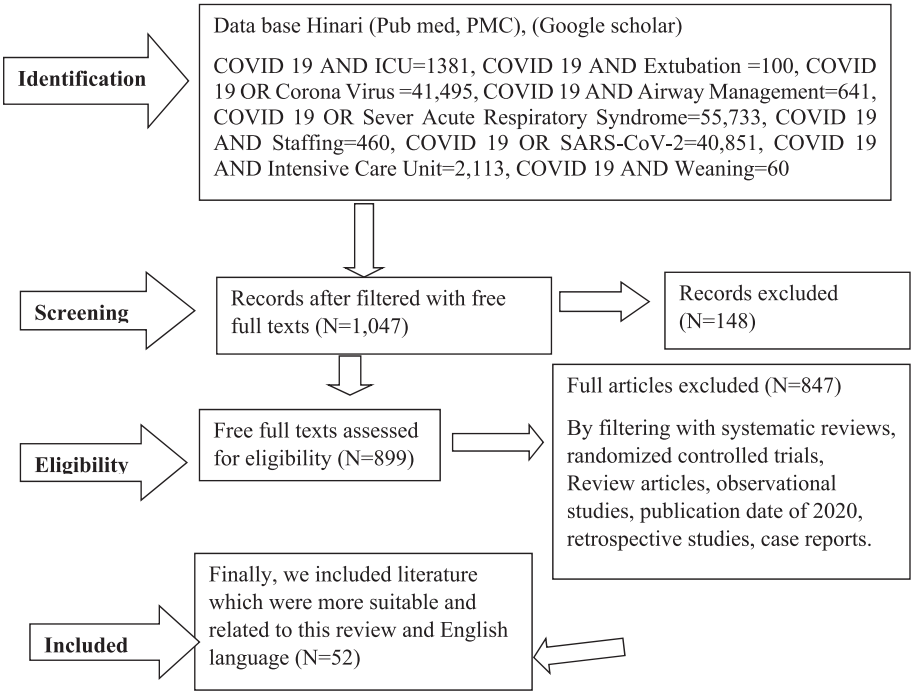


Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-analysis 2009 flow diagram.

Table 1
Levels of evidence and degree of recommendations.

Level	Types of evidence	Degree of recommendation
1a	Meta-analysis, systematic review of RCTs, Evidence based guidelines	Strongly recommended and directly applicable
1b	Systematic review of one RCTs	Highly recommendable and directly applicable
1c	Randomized control/clinical trials	Recommended and applicable
2a	Systematic review of cohort or case control studies	Extrapolated evidence from other studies
3a	Non-analytical studies like case report and case series, clinical audit, commentaries and export opinions	Extrapolated evidence from other studies

Source: Good clinical practice, GCP, WHO, 2011.

Governments and Policy makers must be prepared early for a substantial increase in critical care capacity or risk being attacked by the pandemic badly.

3.1. Clinical features of critically ill patients

World Health Organization suggests that COVID-19 should be suspected in patients with acute respiratory illness and fever plus travel to or residence in an endemic area or contact with a confirmed or suspected COVID-19 case in the 14 days before symptom onset and in patients with severe acute respiratory illness who require hospitalization without an alternative diagnosis that fully explains the clinical presentation [10]. COVID-19 has variety of clinical presentations. Geriatric patients with comorbidities are more vulnerable to severe disease.

The most common symptoms are but not specific: fever, cough, fatigue, and dyspnoea [1,11,12]. Bilateral pulmonary infiltrates are typically seen in. Patients often develop a severe acute respiratory distress syndrome (ARDS). As far as the COVID 19 spread increased badly, the ICU settings should be prepared with staff and adequate resources and everybody should be suspected unless otherwise ruled out with diagnostic testing for COVID-19 [1].

3.2. Admission criteria of patients with COVID 19 to intensive care unit (ICU)

All patients with COVID 19 were not admitted to the ICU. Hence, ICU admissions are dependent on the severity of illness and the ICU capacity of the health-care system. Among COVID 19 cases, about 5% become critically ill and require intensive care treatment. Acute hypoxemic failure with severe dyspnea and an increased respiratory rate (>30 breaths/min) usually leads to ICU admission [1,2]. According to the Swiss Society of Intensive Care Medicine recommendations which basis early warning score recommended that a score of >6 points (age >65 years, fever >39 °C, lymphopenia and neutropenia, lactate dehydrogenase (LDH) increase, increased D-dimers) are candidates for ICU admission [13].

3.3. Management of critically ill patients with COVID-19 in ICU

Considering that the rapid expansion of intensive care units and the high number of healthcare providers of critically ill patients with COVID-19, frequent formal and informal communication among all the groups has been essential. Infection prevention, acute respiratory failure, comorbidities and COVID-19, nutrition management and weaning should be target areas of management of critically ill patients with COVID-19 at ICU [1,9,14].

3.3.1. Infection prevention

Patients with COVID 19 should be treated in isolation rooms ideally with a functional anteroom for donning and doffing of PPE [2]. WHO recommends that PPE for health-care workers providing direct care to patients with COVID-19 including medical masks, gowns, gloves and eye protection with goggles or face shield [15]. All healthcare personnel involved in the management of patients with COVID-19 should follow the universal infection prevention precautions like airborne precautions, hand

hygiene and donning of personal protective equipment. All aerosol-generating procedures should be done in an airborne infection isolation room [9].

Health professionals who are involved in taking care of patients with coronavirus disease 2019 (COVID-19) are at higher risk of acquiring the infection [16]. Aerosol generating procedures, such as non-invasive ventilation (NIV), high-flow nasal cannula (HFNC), bag-mask ventilation, and intubation are of particularly high risk and masks should be N95 or FFP2-equivalent respirators, and gowns or aprons should be fluid resistant [1,17]. Training on the specific steps of donning and doffing PPE, together with hand hygiene is crucial and references for these procedures are widely available [18]. Tracheal intubation is a potentially high-risk procedure for the airway manager [19].

3.3.2. Acute respiratory failure from acute respiratory distress syndrome of COVID 19

High-flow nasal cannula (HFNC) is an emerging therapy for respiratory failure but the extent of exhaled air dispersion during treatment is unknown. Exhaled air dispersion during HFNC therapy versus continuous positive airway pressure (CPAP) on a human patient simulator (HPS) in an isolation room with 16 air changes/hour were studied and concluded that HFNC had high aerosol generating risk [1,20,21]. For patients with COVID-19 who require endotracheal intubation, use of low tidal volume (6 mL/kg per predicted bodyweight) with a plateau airway pressure of less than 30 cm H2O, and increasing the respiratory rate to 35 breaths per min as needed, is the mainstay of lung-protective ventilation [22]. Treatment and therapy options with its current recommendation is displayed by (Table 2).

3.3.3. Nutritional support

The risk of malnutrition of COVID-19 patients is related to chronic pathologies and the reduction of food intake caused by nausea, diarrhea, and the loss of appetite [23]. Optimized nutrition care of the ICU COVID-19 patients is important to maintain GI tract function, sustain immune defenses, and avoid severe loss of muscle mass and function [24]. There is need to include nutrition personnel such as dietitians in the COVID-19 response at the facility level in order to address both immediate and enduring nutrition challenges posed by COVID-19 [25]. At each step of the progression of the disease, ICU patients with COVID-19 should be carefully evaluated in terms of malnutrition risk and medical nutritional support. The tremendous challenges posed by the continuous clinical changes requires adequate answers at each stage. A delay will induce more energy and protein deficit, longer length of stay, and rehabilitation for the survivors. Metabolic control and nutritional support are a cornerstone in the management of critically ill patients with COVID-19 [25]. Nutrition support of a critically ill patient is a form of therapy and positively affects important clinical outcomes [25]. The Covid-19 epidemic

Table 2
Therapeutic options for severe acute respiratory distress syndrome related to coronavirus disease 2019/Clinical management of critically ill patients with COVID-19.

Treatment/Therapy	Recommendations
Put on 100% oxygen until Spo_2 ≥90%, high flow nasal oxygen if mild ARDS	Used for delay intubation
Tidal volume	6 mL/kg
Intubation for worsening respiratory distress or failure, or multiorgan failure	Most experienced operator with full PPE and minimized bag-mask ventilation
Plateau airway pressure	Maintain at <30 cm H2 0 for Mild ARDS; PaO2/FiO2≤300 mm Hg
Moderate ARDS; PaO2/FiO2 ≤200 mm Hg	Provide moderate to higher positive end-expiratory pressure
Severe ARDS; PaO2/FiO2 ≤100 mm Hg	Prone positioning; consider role of neuromuscular blockade
Fluid management	Aim for negative fluid balance of 0·5–1·0 L per day
Antibiotics	For secondary bacterial infections

ARDS = acute respiratory distress syndrome. COVID-19 = coronavirus disease 2019. ECMO = extracorporeal membrane oxygenation. HFNC = high-flow nasal cannula. NIV = non-invasive ventilation. PaO2/FiO2 = partial pressure of arterial oxygen to fraction of inspired oxygen. PPE = personal protective equipment.

mobilizes all the available hospital resources for an optimized care of the patients, including the most advanced ventilation techniques. Nutritional care is a key component of a global care but its implementation may be overlooked or made difficult by the epidemic context. Facing this new disease, our practice in clinical nutrition should therefore adapt, identify different care modalities [25]. Prevention, diagnosis and treatment of malnutrition should therefore be routinely included in the management of COVID-19 patients [26]. The nutritional assessment can be performed with the Malnutrition Universal Screening Tool (MUST) [26]. Nutrition intervention and therapy needs to be considered as an integral part of the approach to patients victim of SARS-CoV-2 infection in the ICU setting [26] (Fig. 3).

For acute respiratory complications that require intensive care unit (ICU) management are a major cause of morbidity and mortality in COVID-19 patients. Patients with worst outcomes and higher mortality are reported to include immunocompromised subjects, namely older adults and polymorbid individuals and malnourished people in general. ICU stay, polymorbidity and older age are all commonly associated with high risk for malnutrition, representing per se a relevant risk factor for higher morbidity and mortality in chronic and acute disease [27].

The nutritional assessment and the early nutritional care management of COVID-19 patients must be integrated into the overall therapeutic strategy. The international recommendations on nutrition in the ICU should be followed [24].

There are insufficient data for the COVID-19 Treatment Guidelines Panel to recommend either for or against the use of vitamin C, vitamin D and zinc for the treatment of COVID-19 in critically ill patients [28]. To cope with the current emergency crisis, its aim is to promptly and pragmatically implement nutritional care in patients with COVID-19, which might be overlooked despite being potentially beneficial to clinical outcomes and effective in preventing the consequences of malnutrition in this patient population [29]. Enteral nutrition (EN) should be preferred over parenteral nutrition (PN) and started within 48 h of admission [24,27].

3.3.4. Considerations of patients with comorbidity and COVID-19

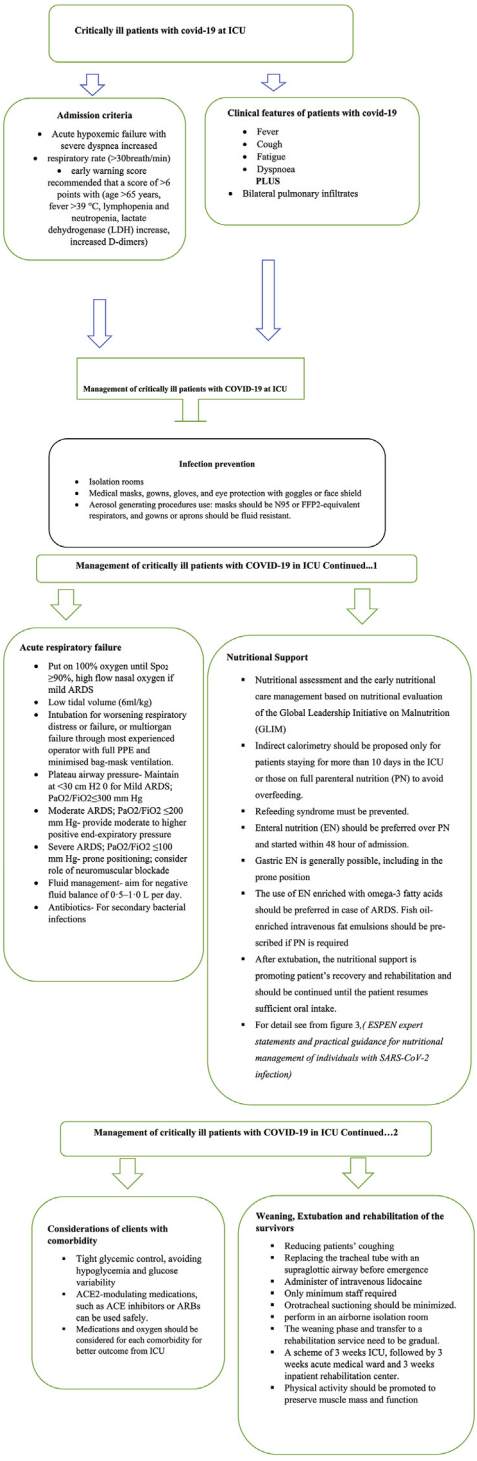
An optimal glycemic control, avoiding acute hyperglycemia, hypoglycemia and glycemic variability may significantly improve the outcome [30]. Continuous tube feeding is the ideal nutrition method for intubated patients with COVID-19 and the main aims of a safe and effective insulin regimen are to reduce contact frequency, reduce glucose variability, minimize risk of severe hypoglycemia, and improve over-all glycemic control [31].

Hypertension was associated with increased composite poor outcome, including mortality, severe COVID-19, ARDS, need for ICU care and disease progression in patients with COVID-19 [32]. Patients with cardiac diseases, hypertension, or diabetes, who are treated with ACE2-increasing drugs, are at higher risk for severe COVID-19 infection and, therefore, should be monitored for ACE2-modulating medications, such as ACE inhibitors or ARBs [33].

Asthma was independently associated with prolonged duration of intubation for coronavirus disease 2019. Asthma together with obesity, another predictor of poor outcome in these patients, places obese patients with asthma at markedly higher risk for a worsened disease course from coronavirus disease 2019 [34]. The prevalence of obesity was 47.5% (49 of 103) in a study conducting on obesity and COVID 19 and a multivariate analysis, severe obesity (BMI $\geq$ 35 kg/m2) was associated with ICU admission (adjusted odds ratio [AOR]: 5.39, 95% CI: 1.13–25.64). Moreover, patients who required IMV were more likely to have had heart disease (AOR: 3.41, 95% CI: 1.05–11.06), obesity (BMI = 30–34.9 kg/m2; AOR: 6.85, 95% CI: 1.05–44.82), or severe obesity (BMI $\geq$ 35 kg/m2; AOR: 9.99, 95% CI: 1.39–71.69). Severe obesity (BMI $\geq$ 35 kg/m2) was associated with ICU admission, whereas history of heart disease and obesity (BMI $\geq$ 30 kg/m2) were independently associated with the use of IMV. It suggest that obesity contributes to clinical manifestations and may influence the progression and prognosis of COVID-19 and it is considered as a potential risk factor of the prognosis of COVID-19 [26]. Significant positive correlations were observed between the total number of COVID-19 infections per million population ($r = 0.46$; $p < 0.001$) and mortality per million population ($r = 0.34$; $p < 0.05$) with respect to country-specific obesity prevalence in 54 countries [35]. Obesity has emerged as a novel risk factor for hospitalization and death due to COVID-19. Several independent studies have observed that people with obesity are at a greater risk of severe disease and death due to COVID-19 [35].

Table 3
Characteristics of sampled review literatures/summary of evidences.

Author (s)/year	Type of article	Participants	Objectives	Conclusions	Recommendations	References
Phua et al., /2020	Systematic review	Critically ill patients with COVID 19	Identifying the challenges and to put recommendations	Management of acute respiratory failure and hemodynamics is key.	Strongly recommended	[1]
Greenland et al., /2020	Systematic review	Health care provider and COVID 19 Patients in ICU	How to keep staff safety and COVID 19 patient management in ICU	Wearing personal protective equipments Intubation for respiratory failure	Strongly recommended	[4]
Swiss Society Of IntensiveCare Medicine/2020	Special article	COVID 19 Patients	Determining the admission criteria of COVID 19 patients in ICU	Based on modified early warning score	Strongly Recommended	[13]
Thibault et al., /2020	Review - a practical guidance	COVID 19 Patients in ICU	Nutritional support for COVID 19 Patients in ICU	Prevention of re feeding syndrome Enteral nutrition should be started within 48 h Parenteral nutrition should be started if enteral nutrition is contraindicated	Strongly recommended	[24]
Kiekens et al., /2020	Special article	COVID 19 patient s in ICU	Acute and post-acute rehabilitation of COVID 19 patients in ICU	Physical activity should be promoted to preserve muscle mass and function	Strongly r ecommended	[50]
L. Roncon et al. Or	Meta-analysis	Diabetic patients with COVID-19 infection	Determining the outcome and risk of ICU admission of COVID 19 with diabetes mellitus	Diabetic patients with COVID-19 infection are at higher risk of ICU admission and poor short-term outcome	Strongly r ecommended	[51]
D'Silva DF et al.	Review article	COVID 19 patients at ICU	How to supplement oxygenafter extubation of COVID 19 patients at ICU	After extubation, non-rebreathed oxygen at a FiO2 of 100% is provided via the ventilator for post-oxygenation	Recommended	[44]


Critically ill patients with covid-19 at ICU
Admission criteria
Acute hypoxemic failure with severe dyspnea increased
respiratory rate (>30breath/min)
early warning score recommended that a score of >6 points with (age >65 years, fever >39 °C, lymphopenia and neutropenia, lactate dehydrogenase (LDH) increase, increased D-dimers)
Clinical features of patients with covid-19
Fever
Cough
Fatigue
Dyspnoea
PLUS
Bilateral pulmonary infiltrates
Management of critically ill patients with COVID-19 at ICU
Infection prevention
Isolation rooms
Medical masks, gowns, gloves, and eye protection with goggles or face shield
Aerosol generating procedures use: masks should be N95 or FFP2-equivalent respirators, and gowns or aprons should be fluid resistant.
Management of critically ill patients with COVID-19 in ICU Continued...1
Acute respiratory failure
Put on 100% oxygen until Spo2 ≥90%, high flow nasal oxygen if mild ARDS
Low tidal volume (6ml/kg)
Intubation for worsening respiratory distress or failure, or multiorgan failure through most experienced operator with full PPE and minimised bag-mask ventilation.
Plateau airway pressure- Maintain at <30 cm H2 0 for Mild ARDS; PaO2/FiO2≤300 mm Hg
Moderate ARDS; PaO2/FiO2 ≤200 mm Hg- provide moderate to higher positive end-expiratory pressure
Severe ARDS; PaO2/FiO2 ≤100 mm Hg- prone positioning; consider role of neuromuscular blockade
Fluid management- aim for negative fluid balance of 0·5–1·0 L per day.
Antibiotics- For secondary bacterial infections
Nutritional Support
Nutritional assessment and the early nutritional care management based on nutritional evaluation of the Global Leadership Initiative on Malnutrition (GLIM)
Indirect calorimetry should be proposed only for patients staying for more than 10 days in the ICU or those on full parenteral nutrition (PN) to avoid overfeeding.
Refeeding syndrome must be prevented.
Enteral nutrition (EN) should be preferred over PN and started within 48 hour of admission.
Gastric EN is generally possible, including in the prone position
The use of EN enriched with omega-3 fatty acids should be preferred in case of ARDS. Fish oil-enriched intravenous fat emulsions should be prescribed if PN is required
After extubation, the nutritional support is promoting patient's recovery and rehabilitation and should be continued until the patient resumes sufficient oral intake.
For detail see from figure 3,(ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection)
Management of critically ill patients with COVID-19 in ICU Continued…2
Considerations of clients with comorbidity
Tight glycemic control, avoiding hypoglycemia and glucose variability
ACE2-modulating medications, such as ACE inhibitors or ARBs can be used safely.
Medications and oxygen should be considered for each comorbidity for better outcome from ICU
Weaning, Extubation and rehabilitation of the survivors
Reducing patients' coughing
Replacing the tracheal tube with an supraglottic airway before emergence
Administer of intravenous lidocaine
Only minimum staff required
Orotracheal suctioning should be minimized.
perform in an airborne isolation room
The weaning phase and transfer to a rehabilitation service need to be gradual.
A scheme of 3 weeks ICU, followed by 3 weeks acute medical ward and 3 weeks inpatient rehabilitation center.
Physical activity should be promoted to preserve muscle mass and function

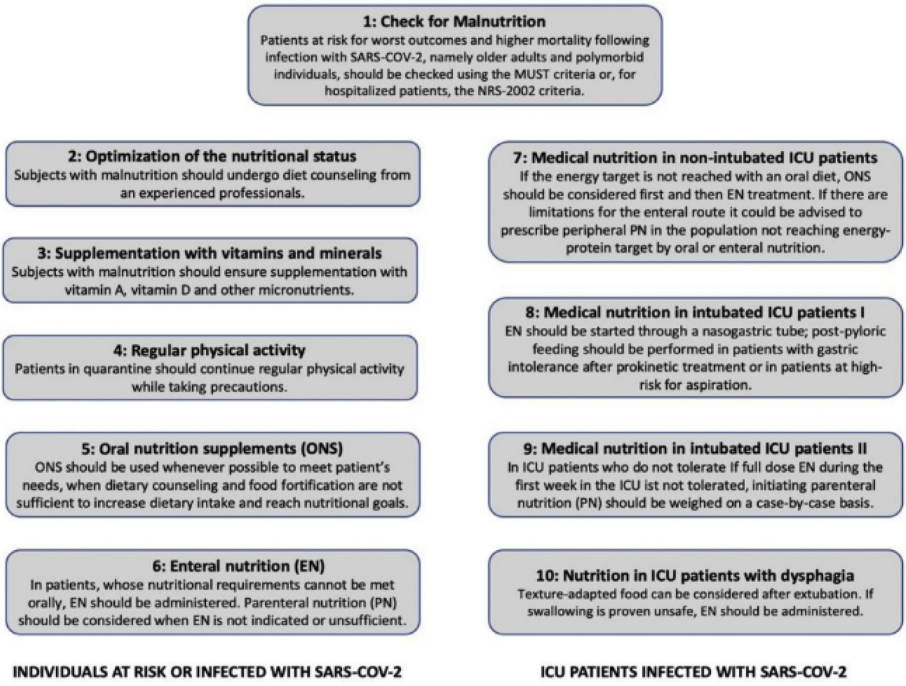


Fig. 3. Nutritional management in individuals at risk for severe COVID-19, in subjects suffering from COVID-19, and in COVID-19 ICU patients requiring ventilation.

Increased vigilance and aggressive treatment of patients with obesity and COVID-19 are warranted [36]. Dyspnoea was the only symptom predictive for severe COVID-19 and ICU admission. Patients with COPD, cardiovascular disease and hypertension were at higher risk of severe illness and ICU admission [37].

COVID-19 may predispose to both venous and arterial thromboembolism due to excessive inflammation, hypoxia, and immobilization and diffuse intravascular coagulation. The 31% incidence of thrombotic complications in ICU patients with COVID-19 infections is remarkably high. The above study findings recommended that strictly applying pharmacological thrombosis prophylaxis in all COVID-19 patients admitted to the ICU and are strongly suggestive of increasing the prophylaxis towards high-prophylactic doses [38].

The proportions of hypertension, cardia-cerebrovascular disease and diabetes in patients with COVID-19 were 17.1%, 16.4% and 9.7% respectively. The incidences of hypertension, cardia-cerebrovascular diseases and diabetes were about twofolds, threefolds and twofolds higher in ICU than in their non-ICU cases respectively. Patients with previous cardiovascular metabolic diseases may face a greater risk of developing into the severe condition and the comorbidities can also greatly affect the prognosis of the COVID-19. On the other hand, COVID-19 can, in turn, aggravate the damage to the heart [39].

In the setting of COVID-19, hypoxemic respiratory failure secondary to the virus itself is common, but the course of the illness may also be complicated by myasthenic exacerbation and resultant

Fig. 2. Clinical management of critically ill patients with COVID-19 in ICU. ARDS = acute respiratory distress syndrome. COVID-19 = coronavirus disease 2019. HFNC = high-flow nasal cannula. NIV = non-invasive ventilation. PaO2/FiO2 = partial pressure of arterial oxygen to fraction of inspired oxygen. PPE = personal protective equipment. EN = Enteral Nutrition. PN = Parenteral Nutrition.

neuromuscular respiratory failure. COVID-19 poses unique challenges to the evaluation and management of patients with myasthenia gravis (MG). Respiratory mechanics, the gold standard of evaluation for neuromuscular respiratory failure and non-invasive ventilation, often used for MG patients with mild or moderate respiratory distress, are avoided in patients with COVID-19 because of the risk of aerosolization of viral particles and viral transmission [40].

COVID-19 may predispose to both venous and arterial thromboembolism due to excessive inflammation, hypoxia, immobilization and diffuse intravascular coagulation [38].

3.3.5. Weaning, Extubation and rehabilitation of the survivors from COVID-19

To reduce the risk of occupational infection with SARS-CoV-2 at the time of weaning from mechanical ventilation, proposed that replacing the tracheal tube with supraglottic airway (SGA) such as i-gel type of laryngeal mask airway before recovery from sedation to reduce environmental distribution of the virus [41]. As D'Silva and colleagues described, oxygen can be applied either with nasal prongs or with a simple oxygen facemask on top of the surgical mask [42].

During extubation, well trained staff for re-intubation (experienced anesthesia providers, respiratory therapists) must be present if an emergency re-intubation is necessary, equipped with personal protective equipment (PPE) and preferably, a powered air-purifying respirator (PAPR). Only minimum staff required for the extubation procedure should be present. All team members should wear PPE including at minimum an N95 facemask and eye-protection. Orotracheal suctioning should be minimized in order to reduce the number of times this potentially aerosolizing procedure is performed. The authors also recommended the use of supplemental oxygen connected in series to two high efficiency particulate air [HEPA] Viral filters. After extubation, non-rebreathed oxygen at a FiO2 of 100% is provided via the ventilator for post-extubation oxygenation [43,44]. Current recommendations for extubation of COVID-19 patients include performance in an airborne isolation room and the advice that “the endotracheal tube be removed as smoothly as is feasible” to avoid coughing and expectoration of virus-laden secretions [45]. Emergence coughing is a challenging issue and a variety of medications have been proposed to prevent it. Administration of intravenous lidocaine (which is readily available) prior to tracheal extubation can effectively reduce emergence coughing without any other significant side-effects [46].

There is current uncertainty regarding the role of tracheostomy for weaning ventilated patients with COVID-19 pneumonia. This is due to a number of factors including prognosis, optimal healthcare resource utilisation, and safety of healthcare workers when performing such a high-risk aerosol-generating procedure [47].

A theme of 3 weeks ICU followed by 3 weeks acute medical ward and 3 weeks inpatient rehabilitation is being considered in one COVID 19 medical center. Patients staying in ICU show several complications, some due to the long period of immobilization and many hours in prone position, as it is advised in case of COVID-19 pneumonia [48].

Early rehabilitation seems not well tolerated, with rapid desaturation. The following issues have been diagnosed up to now: dysphagia, muscle weakness, critical illness myopathy and neuropathy, reduced joint mobility, neck and shoulder pain (due to prolonged proning), difficulty in verticalization, impaired balance and gait, limitations in activities of daily living (ADL), difficult awakening with long-lasting confusional state and psychological problems [49].

Survivors requiring prolonged rehabilitation are more likely to be older and to have preexisting cardiovascular and cerebrovascular disease, which may influence their rehabilitation and outcomes [48,50]. Sample evidences of literatures are summarized below (Table 3).

4. Conclusions and recommendations

Early intubation and repeated prone positioning are key elements in treating hypoxemic COVID-19 patients. Not all critical cases were admitted to the ICU. Procedures that lead to formation of aerosols should be avoided where possible and carried out with utmost precaution. Emergence coughing is a challenging issue and a variety of medications have been proposed to prevent it and Nutritional care is a key component of a global care but its implementation may be overlooked or made difficult by the epidemic context (Fig. 2 and Fig. 3).

Availability of data and materials

Every type of information were found on the principal investigator and corresponding author and could be used whenever required by the journals.

Ethical approval

Not required.

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Author contributions

The author has been contributing in different phases of this work like the selection of topics, extraction of the data from different evidences, preparation and critically appraising of the manuscript.

Declaration of competing interest

The authors declared that they have no competing interest.

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Acronyms and Abbreviations

ARDS	Acute Respiratory Disease Syndrome
COVID	Corona Virus Disease
HFNC	High-flow nasal cannula
PPE	Personal Protective Equipment
ICU	Intensive Care Unit
NIV	Non-Invasive Ventilation
SARS	Sever Acute Respiratory Syndrome

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