

Journal Pre-proof

Espen expert statements and practical guidance for nutritional management of individuals with sars-cov-2 infection

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PII: S0261-5614(20)30140-0

DOI: <https://doi.org/10.1016/j.clnu.2020.03.022>

Reference: YCLNU 4212

To appear in: *Clinical Nutrition*

Received Date: 24 March 2020

Accepted Date: 24 March 2020

Please cite this article as: Barazzoni R, Bischoff SC, Krznaric Z, Pirlich M, Singer P, endorsed by the ESPEN Council, Espen expert statements and practical guidance for nutritional management of individuals with sars-cov-2 infection, *Clinical Nutrition*, <https://doi.org/10.1016/j.clnu.2020.03.022>.

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1 **ESPEN EXPERT STATEMENTS AND PRACTICAL GUIDANCE FOR NUTRITIONAL MANAGEMENT**
2 **OF INDIVIDUALS WITH SARS-CoV-2 INFECTION**

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27 **ABSTRACT**

28 The COVID-19 pandemic is posing unprecedented challenges and threats to patients and
29 healthcare systems worldwide. Acute respiratory complications that require intensive care unit
30 (ICU) management are a major cause of morbidity and mortality in COVID-19 patients. Patients
31 with worst outcomes and higher mortality are reported to include immunocompromised
32 subjects, namely older adults and polymorbid individuals and malnourished people in general.
33 ICU stay, polymorbidity and older age are all commonly associated with high risk for
34 malnutrition, representing per se a relevant risk factor for higher morbidity and mortality in
35 chronic and acute disease. Also importantly, prolonged ICU stays are reported to be required
36 for COVID-19 patients stabilization, and longer ICU stay may per se directly worsen or cause
37 malnutrition, with severe loss of skeletal muscle mass and function which may lead to disability,
38 poor quality of life and additional morbidity. Prevention, diagnosis and treatment of
39 malnutrition should therefore be routinely included in the management of COVID-19 patients.
40 In the current document, the European Society for Clinical Nutrition and Metabolism (ESPEN)
41 aims at providing concise guidance for nutritional management of COVID-19 patients by
42 proposing 10 practical recommendations. The practical guidance is focused to those in the ICU
43 setting or in the presence of older age and polymorbidity, which are independently associated
44 with malnutrition and its negative impact on patient survival.

45

46

47 INTRODUCTION

48 The breaking of a COVID-19 pandemic is posing unprecedented challenges and threats to
49 patients and healthcare systems worldwide (1-5). The disease primarily involves the respiratory
50 tract (1-5) but it may deteriorate to multi-organ failure and be fatal (3). Acute respiratory
51 complications that are reported to require prolonged ICU stays are a major cause of morbidity
52 and mortality in COVID-19 patients, and older adults and polymorbid individuals have worst
53 outcomes and higher mortality (1-5). ICU stays, and particularly their longer duration, are per se
54 well-documented causes of malnutrition, with loss of skeletal muscle mass and function which
55 in turn may lead to poor quality of life, disability and morbidities long after ICU discharge (6).
56 Many chronic diseases such as diabetes and cardiovascular diseases and their clustering in
57 polymorbid individuals (7) as well as older age per se (8) are also very commonly associated
58 with high risk and prevalence of malnutrition and worse outcomes. Causes of ICU- and disease-
59 related malnutrition include reduced mobility, catabolic changes particularly in skeletal muscle
60 as well as reduced food intake, all of which may be exacerbated in older adults (6-8). In
61 addition, inflammation and sepsis development may further and primarily contribute to
62 enhance all the above alterations in the presence of SARS-CoV-2 infections. Most importantly,
63 appropriate nutritional assessment and treatment are well-documented to effectively reduce
64 complications and improve relevant clinical outcomes under various conditions including ICU
65 stays, hospitalization, several chronic diseases and in older adults (6-8).

66 Based on the above observations prevention, diagnosis and treatment of malnutrition should
67 be considered in the management of COVID-19 patients to improve both short- and long-term
68 prognosis. In the current document, the European Society for Clinical Nutrition and Metabolism

69 (ESPEN) aims at providing concise experts statements and practical guidance for nutritional
70 management of COVID-19 patients, with regard to those in the ICU setting or in the presence of
71 older age and polymorbidity, which are all independently associated with malnutrition and its
72 negative impact on patient survival. The recommendations are based on current ESPEN
73 guidelines and further expert advice. As there are no dedicated studies on nutrition
74 management in COVID-19 infection, the following considerations can currently only be based
75 on the best of knowledge and clinical experience.

76

77 **PREVENTION AND TREATMENT OF MALNUTRITION IN INDIVIDUALS AT RISK OR INFECTED**
78 **WITH SARS-COV-2**

79 ***Statement 1***

80 ***Patients at risk for poor outcomes and higher mortality following infection with SARS-COV-2,***
81 ***namely older adults and polymorbid individuals, should be checked for malnutrition through***
82 ***screening and assessment. The check should initially comprise the MUST criteria* or, for***
83 ***hospitalized patients, the NRS-2002 criteria.***

84 ****Must criteria: see <https://www.bapen.org.uk/screening-and-must/must-calculator>***

85 *****NRS-2002 criteria: <https://www.mdcalc.com/nutrition-risk-screening-2002-nrs-2002>***

86 Identification of risk and presence of malnutrition should be an early step in general
87 assessment of all patients, with regard to more at-risk categories including older adults and
88 individuals suffering from chronic and acute disease conditions. Since malnutrition is defined
89 not only by low body mass but also by inability to preserve healthy body composition and

90 skeletal muscle mass, persons with obesity should be screened and investigated according to
91 the same criteria.

92 Sets of criteria such as MUST or NRS-2002 have been long used and validated in general clinical
93 practice or in specific disease settings or conditions for malnutrition risk screening. For further
94 assessment of positive patients various tools have been used and are accepted in clinical
95 practice. These include but not limited to the Subjective Global Assessment criteria, the Mini
96 Nutritional Assessment criteria validated for geriatric patients, the NUTRIC score criteria for ICU
97 patients (8,9). A recent document globally endorsed by clinical nutrition Societies worldwide
98 has introduced the GLIM (Global Leadership Initiative on Malnutrition) criteria for malnutrition
99 diagnosis (10). GLIM proposed a two-step approach for the malnutrition diagnosis, i.e., first
100 screening to identify “at risk” status by the use of validated screening tools such as MUST or
101 NRS-2002, and second, assessment for diagnosis and grading the severity of malnutrition (Table
102 1). According to GLIM, diagnosis of malnutrition requires at least 1 phenotypic criterion and 1
103 etiologic criterion.

104 The above considerations appear to be fully applicable to patients at risk for severe SARS-CoV-2
105 infection or hospitalized for COVID-19 infection, since poor outcomes in COVID-19 are reported
106 in patients that are most likely to present with malnutrition (such as older adults and comorbid
107 individuals). Preserving nutritional status and preventing or treating malnutrition also
108 importantly has the potential to reduce complications and negative outcomes in patients at
109 nutritional risk who might incur in COVID-19 in the future. In particular, COVID-19 can be
110 accompanied by nausea, vomiting and diarrhea impairing food intake and absorption (2), thus a
111 good nutritional status is an advantage for people at risk for severe COVID-19. In a recent

112 review about potential interventions for novel coronavirus based on the Chinese experience
113 authors suggested that the nutritional status of each infected patient should be evaluated
114 before the administration of general treatments (11).

115 Looking at influenza infections, particular predictors of mortality could be identified by
116 multivariate analysis such as type of virus (OR 7.1), malnutrition (OR 25.0), hospital-acquired
117 infection (OR 12.2), respiratory insufficiency (OR 125.8) and pulmonary infiltrate on X-ray (OR
118 6.0) were identified as predictors (12). It should be considered that also malnourished children
119 are at increased risk for viral pneumonia and life-threatening outcome of infection. For
120 example, it has been shown that pneumonia and malnutrition are highly predictive of mortality
121 among children hospitalized with HIV infection (13).

122

123 **Statement 2**

124 ***Subjects with malnutrition should try to optimize their nutritional status, ideally by diet***
125 ***counseling from an experienced professionals (registered dietitians, experienced nutritional***
126 ***scientists, clinical nutritionists and specialized physicians).***

127 Retrospective analysis of data available on the 1918 influenza pandemic revealed that disease
128 severity depended on viral and host factors. Among the host factors associated with variations
129 in influenza morbidity and mortality age, cellular and humoral immune responses, genetics and
130 nutrition played a role (11). Malnutrition and famine were associated with high disease severity
131 and was related to mortality also in the younger population. Undernutrition remains a problem
132 for viral pandemics of the twenty-first century and beyond. Indeed, chronic malnutrition was
133 thought to have contributed to the high morbidity and mortality seen in Guatemalan children

134 during the 2009 influenza pandemic (12). In a future virus pandemic, we might face a “double
135 burden” of malnutrition, when both undernutrition and overnutrition will promote severity of
136 disease. It is now well accepted that obesity increases one’s risk of being hospitalized with, and
137 dying from, an influenza virus infection, and that obesity inhibits both virus-specific CD8+ T cell
138 responses and antibody responses to the seasonal influenza vaccine (11). The challenge for
139 future virus pandemics is therefore not only to protect those affected by undernutrition, but
140 also the growing number of people living with obesity (11). This is particularly important for the
141 WHO European Region as in many European countries obesity and overweight affects 30-70%
142 of the population. (14) In a recent Japanese study, malnutrition and pneumonia were identified
143 as the prognostic factors in influenza infection, which are amenable to medical intervention.
144 Using Cox proportional hazards modeling with prescribed independent variables, male sex,
145 severity score, serum albumin levels, and pneumonia were associated with survival 30 days
146 from the onset of influenza (13).

147 We provide suggestions based on various ESPEN Guidelines, with particular regard to those on
148 polymorbid internal medicine patients (7) and those on geriatrics (8). We refer the reader to
149 the full guidelines for specific recommendations in various specific conditions that could be
150 encountered in association with COVID-19. The presence of at least two chronic diseases in the
151 same individual can be defined as polymorbidity and is also characterized by high nutritional
152 risk. Older adults are at higher risk due to combinations of higher prevalence of comorbidities,
153 aging-associated changes in body composition with gradual loss of skeletal muscle mass and
154 function (sarcopenia), additional factors including oral and chewing problems, psycho-social
155 issues, cognitive impairment, low financial income. Obese individuals with chronic diseases and

156 older age are at risk for reduced skeletal muscle mass and function and should therefore be
157 fully included in the above recommendations. Dietary restrictions that may limit dietary intake
158 should be avoided. For COVID-19 patients the counseling process could be performed using
159 teleconference, telephone or other means when appropriate and possible, in order to minimize
160 the risk of operator infection that could lead to infection of further patients and operators.

161 **Energy needs** can be assessed using indirect calorimetry if safely available with ensured sterility
162 of the measurement system, or as alternatives by prediction equations or weight-based
163 formulae such as:

164 (1) 27 kcal per kg body weight and day; total energy expenditure for polymorbid patients
165 aged >65 years (recommendation 4.2 in ref. 7)

166 (2) 30 kcal per kg body weight and day; total energy expenditure for severely underweight
167 polymorbid patients (recommendation 4.3. in ref. 7)*

168 (3) 30 kcal per kg body weight and day; guiding value for energy intake in older persons, this
169 value should be individually adjusted with regard to nutritional status, physical activity
170 level, disease status and tolerance (recommendation 1 in ref. 8)

171 *The target of 30 kcal/kg body weight in severely underweight patients should be cautiously
172 and slowly achieved, as this is a population at high risk of refeeding syndrome.

173 **Protein needs** are usually estimated using formulae such as:

174 (1) 1 g protein per kg body weight and day in older persons; the amount should be
175 individually adjusted with regard to nutritional status, physical activity level, disease
176 status and tolerance (recommendation 2 in ref. 8).

177 (2) ≥ 1 g protein per kg body weight and day in polymorbid medical inpatients in order to
178 prevent body weight loss, reduce the risk of complications and hospital readmission and
179 improve functional outcome (Recommendation 5.1 in ref. 7).

180 **Fat and carbohydrate needs** are adapted to the energy needs while considering an energy ratio
181 from fat and carbohydrates between 30:70 (subjects with no respiratory deficiency) to 50:50
182 (ventilated patients, see below) percent.

183

184 ***Statement 3***

185 ***Subjects with malnutrition should ensure sufficient supplementation with vitamins and***
186 ***minerals.***

187 Part of the general nutritional approach for viral infections prevention is supplementation
188 and/or adequate provision of vitamins to potentially reduce disease negative impact (15).

189 As potential examples, vitamin D deficiency has been associated with a number of different
190 viral diseases including influenza (16-19), human immunodeficiency virus (HIV) (20) and hepatitis C
191 (21), while other studies questioned such a relation for influenza (22,23). The COVID-19 was
192 first identified in Winter of 2019 and mostly affected middle-aged to older adults. Future
193 investigations should confirm whether insufficient vitamin D status more specifically
194 characterizes COVID-19 patients and is associated to their outcome. In support to this
195 hypothesis, decreased vitamin D levels in calves have been reported to enhance risk for bovine
196 coronavirus infection (24).

197 As another example, vitamin A has been defined as “anti-infective” vitamin since many of the
198 body's defenses against infection depend on its adequate supply. For example, vitamin A

199 deficiency is involved in measles and diarrhea and measles can become severe in vitamin A-
200 deficient children. In addition, it has been reported that vitamin A supplementation reduced
201 morbidity and mortality in different infectious diseases, such as measles, diarrheal disease,
202 measles-related pneumonia, HIV infection, and malaria. Vitamin A supplementation also may
203 offer some protection against the complications of other life-threatening infections, including
204 malaria, infectious lung diseases, and HIV. In experimental models, the effect of infection with
205 infectious bronchitis virus (IBV), a kind of coronaviruses, was more pronounced in chickens fed
206 a diet marginally deficient in vitamin A than in those fed a diet adequate in vitamin A (25).

207 In general, low levels or intakes of micronutrients such as vitamins A, E, B6 and B12, Zn and Se
208 have been associated with adverse clinical outcomes during viral infections (26). This notion has
209 been confirmed in a recent review from Lei Zhang and Yunhui Liu (15) who proposed that
210 besides vitamins A and D also B vitamins, vitamin C, omega-3 polyunsaturated fatty acids, as
211 well as selenium, zinc and iron should be considered in the assessment of micronutrients in
212 COVID-19 patients.

213 While it is important to prevent and treat micronutrient deficiencies, there is no established
214 evidence that routine, empirical use of supraphysiologic or supratherapeutic amount of
215 micronutrients may prevent or improve clinical outcomes of COVID-19. Based on the above
216 combined considerations, we suggest that provision of daily allowances for vitamins and trace
217 elements be ensured to malnourished patients at risk for or with COVID-19, aimed at
218 maximizing general anti-infection nutritional defense.

219

220 **Statement 4**

221 ***Patients in quarantine should continue regular physical activity while taking precautions.***

222 Reducing infectious risk is achieved best by quarantine at home, which is heavily recommended
223 presently for all people at risk of COVID-19 and also for those infected with a rather moderate
224 disease course. However, prolonged home stay may lead to increased sedentary behaviors,
225 such as spending excessive amounts of time sitting, reclining, or lying down for screening
226 activities (playing games, watching television, using mobile devices); reducing regular physical
227 activity and hence lower energy expenditure. Thus quarantine can lead to an increased risk for
228 and potential worsening of chronic health conditions, weight gain, loss of skeletal muscle mass
229 and strength and possibly also loss of immune competence since several studies have reported
230 positive impact of aerobic exercise activities on immune function. In a recent paper. Chen et al
231 (27) conclude: "... there is a strong rationale for continuing physical activity at home to stay
232 healthy and maintain immune system function in the current precarious environment. Exercise
233 at home using various safe, simple, and easily implementable exercises is well suited to avoid
234 the airborne coronavirus and maintain fitness levels. Such forms of exercise may include, but
235 are not limited to, strengthening exercises, activities for balance and control, stretching
236 exercises, or a combination of these. Examples of home exercises include walking in the house
237 and to the store as necessary, lifting and carrying groceries, alternating leg lunges, stair
238 climbing, stand-to-sit and sit-to-stand using a chair and from the floor, chair squats, and sit-ups
239 and pushups. In addition, traditional Tai Ji Quan, Qigong exercises, and yoga should be
240 considered since they require no equipment, little space, and can be practiced at any time. The
241 use of eHealth and exercise videos, which focuses on encouraging and delivering physical
242 activity through the Internet, mobile technologies, and television are other viable avenues for

243 maintaining physical function and mental health during this critical period.” Under particular
244 precautions, even outdoor activities can be considered such as garden work (if a own garden is
245 present), garden exercise (i.e. badminton), or walking/running in the forest (alone or in small
246 family groups while maintaining a distance of 2 m minimum to others). Every day > 30 min or
247 every second day > 1h exercise is recommended to maintain fitness, mental health, muscle
248 mass and thus energy expenditure and body composition.

249

250 **Statement 5**

251 ***Oral nutritional supplements (ONS) should be used whenever possible to meet patient’s***
252 ***needs, when dietary counseling and food fortification are not sufficient to increase dietary***
253 ***intake and reach nutritional goals, ONS shall provide at least 400 kcal/day including 30 g or***
254 ***more of protein/day and shall be continued for at least one month. Efficacy and expected***
255 ***benefit of ONS shall be assessed once a month.***

256 We suggest that general guidance on prevention and treatment of malnutrition by using ONS is
257 fully applicable to the context of COVID-19 infection (see also recommendations 2.1-2.3 in ref. 7
258 and recommendations 23, 26 and 27 in ref. 8). Individuals infected with SARS-Cov2 outside of
259 the ICU should therefore be treated to prevent or improve malnutrition. The oral route is
260 always preferred when practicable. We refer to individual guidelines for optimization of calorie
261 targets. Nutritional treatment should start early during hospitalization (within 24-48 hours).
262 Especially for older and polymorbid patients whose nutritional conditions may be already
263 compromised, nutritional treatment and targets should be met gradually to prevent refeeding
264 syndrome. ONS provide energy-dense alternatives to regular meals and may be specifically

265 enriched to meet targets in terms of protein as well as micronutrients (vitamins and trace
266 elements) whose daily estimated requirements should be regularly provided. When compliance
267 is questioned, more frequent evaluation of treatment and potential indication to modify ONS
268 could be needed (e.g. weekly). Nutritional treatment should continue after hospital discharge
269 with ONS and individualized nutritional plans; this is particularly important since pre-existing
270 nutritional risk factors continue to apply and acute disease and hospitalization are likely to
271 worsen the risk or condition of malnutrition.

272

273 **Statement 6**

274 ***In polymorbid medical inpatients and in older persons with reasonable prognosis, whose***
275 ***nutritional requirements cannot be met orally, enteral nutrition (EN) should be administered.***

276 ***Parenteral nutrition (PN) should be considered when EN is not indicated or unable to reach***
277 ***targets.***

278 Enteral nutrition should be implemented when nutritional needs cannot be met by the oral
279 route, e.g if oral intake is expected to be impossible for more than three days or expected to be
280 below half of energy requirements for more than one week. In these cases, the use of EN may
281 be superior to PN, because of a lower risk of infectious and non-infectious complications (see
282 also recommendation 3.1 in ref. 7 and recommendation 29 in ref. 8). Monitoring for EN
283 potential complications should be performed. There are no limitations to the use of enteral or
284 parenteral nutrition based on patient age or diagnosis, in the presence of expectable benefit to
285 improve nutritional status.

286

287 NUTRITIONAL MANAGEMENT IN ICU PATIENTS INFECTED WITH SARS-COV-2

288 We provide here recommendations based on the recent ESPEN guidelines on nutritional
289 therapy in the ICU (6) and on the respiratory therapy stages guided by the patient's condition
290 (4). The nutritional consideration should consider the respiratory support allocated to the ICU
291 patient as shown in Table 2.

292 Pre intubation period**293 Statement 7**

294 ***In COVID-19 non-intubated ICU patients not reaching the energy target with an oral diet, oral***
295 ***nutritional supplements (ONS) should be considered first and then enteral nutrition***
296 ***treatment. If there are limitations for the enteral route it could be advised to prescribe***
297 ***peripheral parenteral nutrition in the population not reaching energy-protein target by oral***
298 ***or enteral nutrition.***

299 NIV: In general, only a minority (25-45%) of patients admitted in the ICU for monitoring, NIV
300 and post extubation observation are reported to be prescribed with oral nutrition as shown in
301 the Nutrition Day ICU survey (28). Reeves et al. (29) also reported energy-protein intake in
302 ARDS patients treated with NIV to be inadequate. It should be pointed out that airway
303 complications may occur with longer median non-invasive ventilation duration in NIV patients
304 treated with enteral feeding (30). The recommendation to start enteral feeding could be
305 impaired by the fact that placement of nasal gastric tube (NGT) for nutrition may result in 1) air
306 leakage that may compromise the effectiveness of NIV; 2) stomach dilatation that may affect
307 diaphragmatic function and affect NIV effectiveness (31). The above observations may account
308 at least in part for highly inadequate implementation of enteral nutrition which may result in

309 patient starvation especially in the first 48 hours of ICU stay and higher risk of malnutrition and
310 related complications (32). Peripheral parenteral nutrition may be therefore considered under
311 these conditions.

312 FNC and HFNC: Patients oxygenated through nasal cannula may be commonly deemed
313 medically appropriate to resume oral alimentation (33). Few studies described the
314 implementation of nutritional support when this technique is used. However limited evidence
315 indicates that calorie and protein intake may remain low and inadequate to prevent or treat
316 malnutrition in HFNC patients (34, and own unpublished data). Overlooking administration of
317 adequate calorie-protein may result in worsening of nutritional status with malnutrition and
318 related complications. Adequate assessment of nutrient intake is recommended with treatment
319 with oral nutrition supplements or with enteral nutrition if oral route is insufficient.

320

321 **Ventilated period**

322 When HFNC or NIV have been applied for more than two hours without successful oxygenation,
323 it is recommended to intubate and ventilate the patient. The ESPEN recommendations (6) are
324 fully applicable with the same goal to prevent deterioration of nutritional status and
325 malnutrition with related complications. In agreement with the ESPEN guidelines on nutrition in
326 ICU (6), we summarize suggestions for COVID-19 intubated and ventilated patients as follows:

327 **Statement 8**

328 ***In COVID-19 intubated and ventilated ICU patients enteral nutrition (EN) should be started***
329 ***through a nasogastric tube; post-pyloric feeding should be performed in patients with gastric***

330 ***intolerance after prokinetic treatment or in patients at high-risk for aspiration; the prone***
331 ***position per se does not represent a limitation or contraindication for EN.***

332 *Energy requirements:* Patient energy expenditure (EE) should be determined to evaluate energy
333 needs by using indirect calorimetry when available. Isocaloric nutrition rather than hypocaloric
334 nutrition can then be progressively implemented after the early phase of acute illness. If
335 calorimetry is not available, VO_2 (oxygen consumption) from pulmonary arterial catheter or
336 VCO_2 (carbon dioxide production) derived from the ventilator will give a better evaluation on EE
337 than predictive equations.

338 *Energy administration:* hypocaloric nutrition (not exceeding 70% of EE) should be administered
339 in the early phase of acute illness with increments up to 80-100% after DAY 3. If predictive
340 equations are used to estimate the energy need, hypocaloric nutrition (below 70% estimated
341 needs) should be preferred over isocaloric nutrition for the first week of ICU stay due to reports
342 of overestimation of energy needs

343 *Protein requirements:* During critical illness, 1.3 g/kg protein equivalents per day can be
344 delivered progressively. This target has been shown to improve survival mainly in frail patients.
345 For persons with obesity, in the absence of body composition measurements 1.3 g/kg “adjusted
346 body weight” protein equivalents per day is recommended. Adjusted body weight is calculated
347 as ideal body weight + (actual body weight - ideal body weight) * 0.33 (6). Considering the
348 importance of preserving skeletal muscle mass and function and the highly catabolic conditions
349 related to disease and ICU stay, additional strategies may be considered to enhance skeletal
350 muscle anabolism. In particular, controlled physical activity and mobilization may improve the
351 beneficial effects of nutritional therapy.

352

353 **Statement 9**

354 ***In ICU patients who do not tolerate full dose enteral nutrition (EN) during the first week in the***
355 ***ICU, initiating parenteral nutrition (PN) should be weighed on a case-by-case basis. PN should***
356 ***not be started until all strategies to maximize EN tolerance have been attempted.***

357 *Limitations and precautions:* Progression to full nutrition coverage should be performed
358 cautiously in patients requiring mechanical ventilation and stabilization.

359 - *Contraindications:* EN should be delayed:

- 360 • in the presence of uncontrolled shock and unmet hemodynamic and tissue perfusion
361 goals;
- 362 • in case of uncontrolled life-threatening hypoxemia, hypercapnia or acidosis,

363 - *Precautions during the early stabilization period:* low dose EN can be started:

- 364 • as soon as shock is controlled with fluids and vasopressors OR inotropes, while remaining
365 vigilant for signs of bowel ischemia;
- 366 • in patients with stable hypoxemia, and compensated or permissive hypercapnia and
367 acidosis;

368

369 *General comments:* When patients are stabilized and even in prone position, enteral feeding
370 can be started ideally after measuring indirect calorimetry targeting energy supply to 30% of
371 the measured energy expenditure. Energy administration will be increased progressively.
372 During emergency times, the predictive equation recommending 20 kcal/kg/day could be used
373 and energy increased to 50-70% of the predictive energy at day 2 to reach 80-100% at day 4.

374 The protein target of 1.3 g/kg/day should also be reached by day 3-5. Gastric tube is preferred
375 but in case of large gastric residual volume (above 500 mL), duodenal tube should be inserted
376 quickly. The use of enteral omega-3 fatty acids may improve oxygenation but strong evidence is
377 missing. If intolerance to enteral nutrition is present, parenteral nutrition should be considered.
378 Blood glucose should be maintained at target levels between 6-8 mmol/l, along with monitoring
379 of blood triglycerides and electrolytes including phosphate, potassium and magnesium (6).

380

381 **Post-mechanical ventilation period and dysphagia**

382 Patients no longer needing mechanical ventilation have high incidence of swallowing problems
383 and consequent dysphagia which may strongly limit oral nutrient intake, even at a time of
384 general improvement of clinical conditions. The following considerations therefore can be
385 applied also to the COVID-19 patient population after extubation.

386 ***Statement 10***

387 ***In ICU patients with dysphagia, texture-adapted food can be considered after extubation. If***
388 ***swallowing is proven unsafe, EN should be administered. In cases with a very high aspiration***
389 ***risk, postpyloric EN or, if not possible, temporary PN during swallowing training with removed***
390 ***nasoenteral tube can be performed.***

391 The post-extubation swallowing disorder could be prolonged for to up to 21 days mainly in the
392 elderly and after prolonged intubation (35, 36), which makes this complication particularly
393 relevant for COVID-19 patients. As much as 24% of older patients were reported to be feeding
394 tube-dependent three weeks after extubation (37). The presence of severe post extubation
395 dysphagia was associated with severe outcome including pneumonia, reintubation and hospital

396 mortality. Recently, 29% of 446 ICU patients had prolonged postextubation swallowing disorder
397 at discharge and some postextubation swallowing disorder has been shown 4 months after
398 discharge (38). Authors have recommended referring patients recognized to have swallowing
399 issues for swallowing evaluation, in order to prevent oral nutrition complications (39, 40).
400 Considering tracheostomy, most of the patients may be able to return to oral intake after this
401 procedure although prolonged tracheal cannula may delay the start of adequate oral nutrient
402 intake (41). Supplemental PN has not been extensively studied in this population but could be
403 considered if energy protein targets are not reached.

404

405 **ICU-acquired weakness (ICUAW)**

406 The long-term prognosis of patients surviving intensive care is affected by physical, cognition
407 and mental impairment that occur following ICU stay (42). Loss of skeletal muscle mass and
408 muscle function may be tremendous and a major problem in ICU survivors (43). This may
409 particularly apply to older adults and comorbid patients that are more prone to present with
410 pre-existing catabolic conditions and impaired skeletal muscle mass and function; in addition,
411 these patient groups may be more presumably prone to develop more intense catabolic
412 responses due to COVID-19 and to ICU conditions at large. Prolonged reported duration of ICU
413 stay above two weeks for many COVID-19 patients is likely to further enhance muscle-catabolic
414 conditions. Appropriate energy delivery avoiding overfeeding and adequate protein
415 administration are critical to prevent this severe loss of muscle mass and function (see
416 Statement 2 and related commentary). Although definitive guidance cannot be made on
417 additional specific treatments potentially due to lack of high-quality studies, recent evidence

418 seems to indicate potential positive impact of physical activity with supplemental amino acids
419 or their metabolites (44,45).

420

421 **Final considerations**

422 Nutrition intervention and therapy needs to be considered as an integral part of the approach
423 to patients victim of SARS-CoV-2 infection in the ICU setting, internal medicine ward setting as
424 well as in general healthcare. Ten recommendations are proposed to manage nutritional care in
425 COVID-19 patients (Figure 1). At each step of the treatment, nutritional therapy should be part
426 of patient care, with regard for older adult, frail and comorbid individuals. Optimal outcome can
427 be improved implementing adherence to recommendations to ensure survival of this life-
428 threatening disease as well as better and shorter recovery, particularly but not limited to the
429 post-ICU period. A comprehensive approach associating nutrition to life-support measures has
430 potential to improve outcomes particularly in the recovery phase.

431 While healthcare workers are busy providing personal protective equipment (PPE) for their staff
432 and training on how to use them or increasing the number of ventilators, it is also important to
433 train them on how to address the nutritional aspects of these patients. We suggest
434 stakeholders such as WHO, Ministry of Health, Nutritionists, Public Health experts develop a
435 mechanism to share this knowledge with relevant healthcare workers. Also hospital
436 procurement officers and others could consider these nutritional requirements as essential
437 needs in resource allocation process. Patients with malnutrition are more likely to be from
438 lower socio-economic groups and addressing malnutrition is an essential step in leaving no one
439 behind in this fight against the COVID 10 pandemic.

440 **Conflict of interests**

441 The authors declare that they have no competing interests for the content of this paper.

442

443 **Acknowledgements**

444 The authors gratefully acknowledge drs Joao Breda and Kremlin Wickramasinghe from the

445 WHO European Office for Prevention and Control of Noncommunicable Diseases, WHO

446 Regional Office for Europe, Moscow, Russian Federation, for providing thorough evaluation of

447 the manuscript with very useful and constructive comments and suggestions.

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595

596 **Table 1.** Phenotypic and etiologic criteria for the diagnosis of malnutrition, adapted from (9).

Phenotypic Criteria		Etiologic Criteria	
Weight loss (%)	>5% within past 6 months or >10% beyond 6 months	Reduced food intake or assimilation**	50% of ER > 1 week, or any reduction for >2 weeks, or any chronic GI condition that adversely impacts food assimilation or absorption
Low body mass index (kg/m ²)	<20 if < 70 years, or <22 if >70 years Asia: <18.5 if < 70 years, or <20 if >70 years	Inflammation***	Acute disease/injuryd, or chronic disease-related
Reduced muscle mass	Reduced by validated body composition measuring techniques*		

597 Abbreviations: GI, gastro-intestinal; ER, energy requirements.

598 *Muscle mass can be assessed best by dual-energy absorptiometry (DXA), bioelectrical
599 impedance analysis (BIA), CT or MRI. Alternatively, standard anthropometric measures like mid-
600 arm muscle or calf circumferences may be used (see
601 <https://nutritionalassessment.mumc.nl/en/anthropometry>). Thresholds for reduced muscle
602 mass need to be adapted to race (Asia). Functional assessments like hand-grip strength may be
603 considered as a supportive measure.

604 **Consider gastrointestinal symptoms as supportive indicators that can impair food intake or
605 absorption e.g. dysphagia, nausea, vomiting, diarrhea, constipation or abdominal pain. Reduced
606 assimilation of food/nutrients is associated with malabsorptive disorders like short bowel
607 syndrome, pancreatic insufficiency and after bariatric surgery. It is also associated with
608 disorders like esophageal strictures, gastroparesis, and intestinal pseudo-obstruction.

609 ***Acute disease/injury-related: Severe inflammation is likely to be associated with major
610 infection, burns, trauma or closed head injury. Chronic disease-related: Chronic or recurrent
611 mild to moderate inflammation is likely to be associated with malignant disease, chronic
612 obstructive pulmonary disease, congestive heart failure, chronic renal disease or any disease
613 with chronic or recurrent Inflammation. Note that transient inflammation of a mild degree does
614 not meet the threshold for this etiologic criterion. C-reactive protein may be used as a
615 supportive laboratory measure.

616

617 **Table 2.** Nutritional support depending on the respiratory support allocated to the ICU patient.

Setting	Ward	ICU Day 1-2	ICU Day 2-	Ward rehabilitation
Oxygen Therapy and mechanical ventilation	No or consider O2 support (High) Flow Nasal Cannula	FNC followed by mechanical ventilation	Mechanical ventilation	Possible extubation and transfer to ward
Organ Failure	Bilateral pneumonia, thrombopenia	Deterioration of respiratory status; ARDS; possible shock	MOF possible	Progressive recovery after extubation
Nutritional support	Screening for malnutrition; oral feeding/ONS, enteral or parenteral nutrition if needed	Define energy and protein target In case of FNC or NIV, administer energy/protein orally or enterally and if not possible	Prefer early enteral feeding Protein and mobilization	Assess dysphagia and use oral nutrition if possible; if not: enteral or parenteral nutrition Increase protein intake and add

		parenterally		exercise
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618

619 According to the progression of the infection, a medical nutritional therapy is proposed in

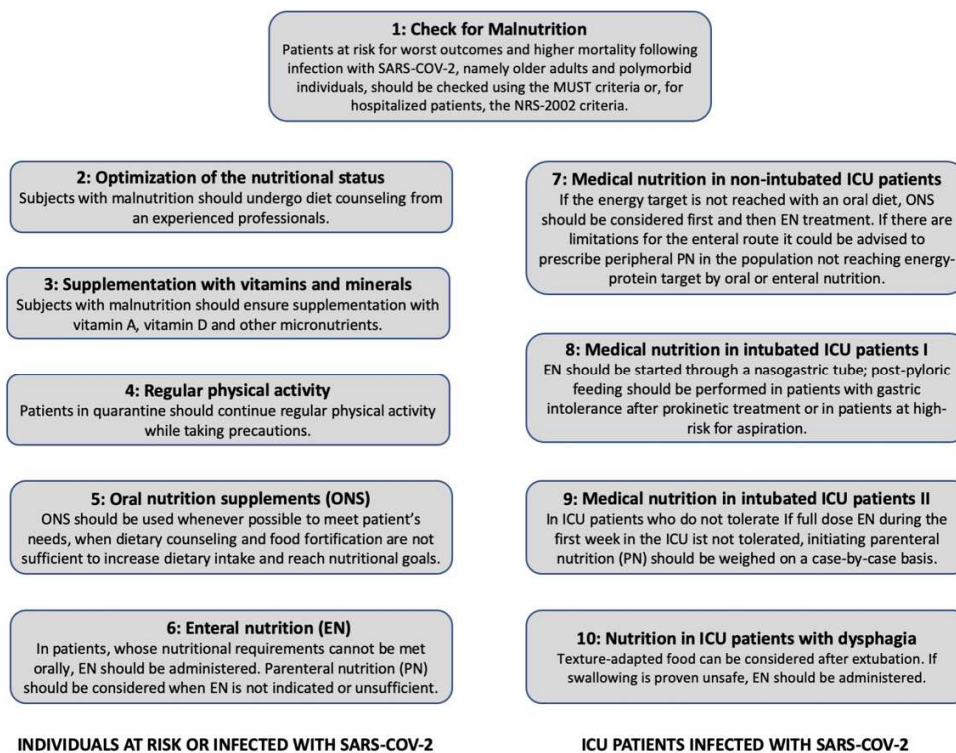
620 association with the respiratory support in the intensive care setting. Abbreviations: ICU,

621 intensive care unit; FNC, flow nasal cannula; MV, mechanical ventilation; ARDS, acute

622 respiratory distress syndrome; MOF, multiorgan failure; ONS, oral nutritional supplement.

623

Journal Pre-proof



624
625 **Figure 1.** Nutritional management in individuals at risk for severe COVID-19, in subjects
626 suffering from COVID-19, and in COVID-19 ICU patients requiring ventilation. For details, see
627 text.

628