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How the Covid-19 epidemic is challenging our practice in clinical nutrition-feedback from the field

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1 **How the Covid-19 epidemic is challenging our practice in Clinical Nutrition – feedback**
2 **from the field**

3

4 Running title: Covid-19 and clinical nutrition

5

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28

29 **Abstract**

30 The viral epidemic caused by the new Coronavirus SARS-CoV-2 is responsible for the new
31 Coronavirus disease -2019 (Covid-19). Fifteen % of the Covid-19 patients will require
32 hospital stay, and 10% of them will need urgent respiratory and hemodynamic support in the
33 intensive care unit (ICU). Covid-19 is an infectious disease characterized by inflammatory
34 syndrome, itself leading to reduced food intake and increased muscle catabolism. Therefore
35 Covid-19 patients are at high risk of being malnourished, making the prevention of
36 malnutrition and the nutritional management key aspects of care. Urgent, brutal and massive
37 arrivals of patients needing urgent respiratory care and artificial ventilation lead to the
38 necessity to reorganize hospital care, wards and staff. In that context, nutritional screening
39 and care may not be considered a priority. Moreover, at the start of the epidemic, due to mask
40 and other protecting material shortage, the risk of healthcare givers contamination have led to
41 not using enteral nutrition, although indicated, because nasogastric tube insertion is an
42 aerosol-generating procedure. Clinical nutrition practice based on the international guidelines
43 should therefore adapt and the use of degraded procedures could unfortunately be the only
44 way. Based on the experience from the first weeks of the epidemic in France, we emphasize
45 ten challenges for Clinical Nutrition practice. The objective is to bring objective answers to
46 the most frequently met issues to help the clinical nutrition caregivers to promote nutritional
47 care in the hospitalized Covid-19 patient. We propose a flow chart for optimizing the nutrition
48 management of the Covid-19 patients in the non-ICU wards.

49

50 Keywords: malnutrition; oral nutritional supplements; enteral nutrition; peripheral parenteral
51 nutrition; nasogastric tube.

52

53 **General context**

54 The viral epidemic caused by the new Coronavirus SARS-CoV-2 is responsible for the new
55 Coronavirus disease -2019 (Covid-19) [1]. In the Chinese experience, up to 30% of the
56 Coronavirus SARS-CoV-2 (Covid-19) infected patients are presenting with an acute
57 respiratory distress syndrome (ARDS) requiring urgent respiratory and hemodynamic support
58 in the intensive care unit (ICU) [2]. Covid-19 patients develop in 20% of cases a severe
59 pneumonia requiring hospitalization. Because of ARDS, the overall mortality rate during
60 Covid-19 infection is estimated to be around 1 to 2% [2]. The median intra-hospital mortality
61 rate is around 30%.

62 The cross-sectional study by Li et al performed in hospitalized elderly patients with Covid-19
63 reported that 53% of patients were malnourished [3]. This means that nutritional support
64 should be integrated in the global management of the Covid-19 patient. Therefore, we and
65 other members of the French speaking society for clinical nutrition and metabolism (SFNCM)
66 elaborated practical guidance sheets (www.sfnm.org) to help the French speaking health
67 caregivers to manage malnutrition and risk for malnutrition in the Covid-19 patients. Our
68 feedback from the field meant we quickly observed that some of the international guidelines
69 of nutritional screening and support (e.g. from ESPEN, ASPEN) were no longer feasible in
70 daily practice, because of the Covid-19 epidemic totally challenged our usual routine.
71 Moreover, numerous French hospitals face staff reorganisation and sometimes also material
72 shortage. Thus, clinical nutrition practice should adapt, and the use of degraded procedures
73 may unfortunately be the only way.

74 In the first part of this review article, we will report why Covid-19 patients are at high risk for
75 malnutrition, and propose a rationale to emphasize nutritional management as being a key part
76 of the multidisciplinary care of the Covid-19. Based on the experience from the first weeks of
77 the Covid-19 epidemic in France, we then emphasize ten challenges for Clinical Nutrition

78 practice, and suggest a flow chart for optimizing the nutrition management of the Covid-19
79 patients in the non-ICU wards.

80

81 **Why is the Covid-19 patient at high risk for malnutrition**

82 Recent studies or guidelines state that the Covid-19 patient at high risk for malnutrition [3-7].

83 The most severe cases are encountered in particular, but not exclusively, in patients with a

84 chronic disease (such as organ failure, obesity with body mass index ≥ 35 [8,9], type 2

85 diabetes 2 or cancers), elderly and / or polymorbid conditions [10]. These diseases often mask

86 underlying protein malnutrition and sarcopenia [11,12]. Covid-19 patients should be

87 considered at high risk of malnutrition [3-7], like in other severe respiratory infections

88 characterized by: inflammatory syndrome and hypercatabolism, increased energy expenditure

89 linked to ventilation work [5,6]. In the absence of early and adequate nutritional support, this

90 combination will lead to a rapid deterioration of respiratory muscle function, aggravating the

91 consequences of viral pulmonary damage [4,5]. Hypermetabolism and physical

92 immobilization expose to rapid muscle wasting because of concomitant drastic reduction in

93 food intake [4-7], which is secondary to several factors: anorexia, dyspnea, dysosmia,

94 dysgueusia [13]. Finally, digestive symptoms (diarrhea, vomiting or abdominal pain) [14-17],

95 stress, confinement, organizational problems and staff shortage will contribute to limit meal

96 offering and ingestion. Importantly, obesity is associated with severe forms of the Covid-19

97 infections [8,9]. Obesity is also associated with increased protein catabolism and insulin

98 resistance as compared with non-obese patients [18], and pre-existing obesity may limit the

99 awareness of nursing staff about providing minimal caloric and increased protein supply to

100 these patients.

101 Acute malnutrition induced by Covid-19 infection would therefore be associated with

102 increased loss in muscle mass and weakening of immune defenses which together would

103 contribute to the severity of the Covid-19. The malnutrition phenotypic criteria could be a low
104 body mass index (BMI), a significant weight loss or a low fat-free mass [19]. However, only
105 BMI, already known as very poorly sensitive in diagnosing malnutrition, has been reported in
106 Chinese [20] and New York cohort studies [21]; in these studies, low BMI was not predictive
107 of severe forms; this may reflect the limited number of patients in this BMI range and the fact
108 that obese patients displaying acute malnutrition were not detected. Thus, to our opinion,
109 these findings are not eliminating protein energy malnutrition as a potential risk factor for
110 severe Covid-19 forms, as suggested by a more recent study from Asia [22].

111

112 **Rationale for nutrition support in the Covid-19 patient**

113 *Importance of nutrition support in patients with malnutrition or risk for malnutrition*

114 General guidelines of The European Society for Clinical Nutrition and Metabolism (ESPEN)
115 recommend prescription of nutritional support for medical, polymorbid inpatients at risk of
116 malnutrition [12]. A recent prospective, randomized, unblinded, multicenter trial
117 demonstrated that providing early nutritional support, mostly orally, in hospitalized patients at
118 risk of malnutrition significantly decreased 30-day complications and mortality in comparison
119 to patients on standard hospital diet [23]. The high probability of malnutrition [3-7] and its
120 association with a worse clinical outcome [24] are justifying an active strategy of nutrition
121 screening and support in the Covid-19 patient [4,5,25,26]. This would help the patients
122 reinforcing their immune defenses and potentially limiting the evolution towards a severe
123 form of the disease.

124

125 *Role of nutrition support on immune response*

126 The innate immune response (i.e. humoral immunity and effector T cells) appears to be
127 impaired in the Covid-19 patients [2], and the “cured” patients showed better restoration of

128 the number and function of natural killer lymphocytes and CD8 + T lymphocytes [27]. In
129 severe Covid-19 patients, lymphopenia is common; lymphopenia, innate immune response
130 and antioxidant defenses are also independently worsened by malnutrition, leading to
131 increased risk of complications and ARDS.

132 Provision of sufficient protein intake is critical during acute infection and malnutrition.

133 Amino acids, and in particular glutamine, are essential energy substrates for immune cells
134 such as lymphocytes [28]. Activation of immune cells requires an increase in the intracellular
135 influx of amino acids and an increase in membrane transporters of amino acids [29]. In
136 addition, the intracellular content of glutathione, a tri-peptide with significant antioxidant
137 properties, is a key element in regulating the number and function of lymphocytes [30]. A
138 short fast induces a reduction in the intracellular glutathione content [31], which is also
139 observed in malnourished patients [32,33].

140 Caloric restriction also quickly leads to lymphopenia and atrophy of the lymphoid organs
141 [34,35]. Malnutrition-associated lymphopenia partly explains the increased risk of infectious
142 complications [36]. Therefore, fasting and malnutrition have a negative impact on the immune
143 response.

144

145 *Expected benefits of nutrition support in the Covid-19 patients*

146 Early nutritional support could limit these negative consequences [35,37]. These beneficial
147 effects of refeeding could be due to different mechanisms, including amino acids supply,
148 restoration of the intracellular glutathione content and limitation of protein breakdown.

149 Furthermore, gastrointestinal (GI) symptoms [14-17] can increase the risk of malnutrition and
150 micronutrient deficiencies. Two Chinese case series from 651 to 1,141 Covid-19 patients
151 estimated the prevalence of GI symptoms (nausea, diarrhea, vomiting) from 11.4% to 16%,

152 respectively [38,39]. In an analysis of data from the Hong Kong cohort of patients and a meta-
153 analysis, authors found that 17.6% of Covid-19 patients had GI symptoms and virus RNA
154 fragments were detected in stool samples from 48.1% patient, even in stools collected after
155 respiratory samples became negative [15].

156 In that context of GI Covid-19, it is expected that gut microbiota could be modified and that
157 this could worsen the Covid-19 lung damage. Indeed, rapid and severe changes in the gut
158 microbiota [40], a decrease in gut barrier function and increased intestinal permeability [41]
159 could promote changes in the lung microbiota and worsen lung damage [42] leading to ARDS
160 [43]. Conversely, the protective effect induced by a modification of the intestinal microbiota
161 during a viral infection such as the influenza involved a stimulation of the innate immune
162 response [44]. By stimulating the innate immune response and modifying gut microbiota
163 towards a protective microbiota, early enteral nutrition could provide benefit to Covid-19
164 patients. Indeed, experimental studies have shown favorable changes in the gut microbiota,
165 restoration of the gut barrier function and stimulation of the innate immune response in
166 animals subjected to EN [45,46].

167 Altogether, these data suggest that, in patients infected with the SARS-Cov-2 virus,
168 insufficient nutritional intake could lead to rapid degradation of the intestinal barrier function,
169 of muscle functional capacities and of immune response, which could thus favor secondary
170 onset of signs of severity and progression to ARDS. To face this increased morbidity related
171 to early and rapid malnutrition, intensive oral or enteral nutrition support should be
172 considered. Indeed, a recent meta-analysis showed that early EN reduced the mortality rate
173 and complications, particularly pneumonia, in critically ill patients compared to EN
174 introduced later after insufficient oral refeeding [47]. The mechanisms explaining this benefit
175 of early EN are undoubtedly multiple.

176 Although the risk of malnutrition due to severe hypoxia and high-grade systemic
177 inflammation is high in patients with common severe pneumonia [48], there are currently no
178 specific guidelines for nutrition support. However, pneumonia in Covid-19 patients is usually
179 long in duration and severe, and it is thus expected that EN should limit intestinal damage,
180 stimulate the innate immune response and therefore help limit lung damage, while preserving
181 muscle function, in particular respiratory function.

182

183 **Practical challenges for Clinical nutrition during the Covid-19 epidemic**

184 In an epidemic context, implementation of international guidelines on nutritional screening
185 and care may appear difficult. This is especially the case for enteral nutrition (EN) as a first-
186 line nutrition support. Numerous French hospitals had to face staff reorganisation and
187 sometimes material shortage; in these conditions, clinical nutrition practice should adapt and
188 sometimes be implemented as degraded procedures. Based on the experience from the first
189 weeks of the epidemic in France, we propose here to emphasize ten challenges for Clinical
190 Nutrition practice in Covid-19 patients:

- 191 1- Work modalities of clinical nutrition professionals need to be reorganized.
- 192 2- The nutrition protocols for Covid-19 patients need to be simple and easily applicable.
- 193 3- Screening for malnutrition should be feasible
- 194 4- Energy and protein needs assessment needs to be simple and easily applicable.
- 195 5- Hospital staff should be aware of refeeding syndrome prevention.
- 196 6- Adaptation of hospital food delivery needs to be considered to overcome insufficient food
197 intake.
- 198 7- Misconceptions should be fought, as they are challenging the use of EN.
- 199 8- Clinical situations and organizational constraints that may make EN unfeasible need to be
200 known.

201 9- Parenteral nutrition (PN) may be considered as an alternative to EN.

202 10- Nutritional care could find a place in post-acute care rehabilitation.

203

204 Facing these challenges and barriers, our objective is to propose practical solutions for the
205 clinical nutrition caregivers to promote nutritional care in the hospitalized Covid-19 patient.

206 We also propose a flow chart (**Figure 1**) for optimizing the nutritional management of the
207 Covid-19 patients in the non-ICU wards, including the possible use of PN in the situations
208 where the use of EN as the first line of nutrition support is considered as risky or unfeasible.

209

210 **Challenge 1: Work modalities of clinical nutrition professionals need to be reorganized.**

211 In the context of the Covid-19 epidemic, administrative and political rules are set up to
212 prevent virus propagation among patients and staff. Dedicated teams of healthcare
213 professionals are constituted including physicians, nurses, nurse assistants...chosen according
214 to their expertise in urgent respiratory care and artificial ventilation. In that context,
215 nutritional screening and care is not considered as a priority. The access to the Covid-19
216 hospital wards is restricted to these indispensable and dedicated healthcare professionals to
217 prevent any propagation of the virus.

218 Therefore, unfortunately, in most hospitals, the dietitians and the nutrition support team are
219 not considered indispensable. Also with the objective of preventing virus propagation, the
220 clinical visits with non-Covid-19 hospitalized patients are sometimes restrained as well. As
221 there is almost no way to overcome these administrative rules, clinical nutrition professionals
222 need to reorganize their daily work. In this situation, there is a room for intra-hospital
223 teleconsultations (e.g. dietician is calling the patient through her/his room phone, if clinically
224 able to speak). Phone contacts remain to be kept with nurses and doctors by giving the advices
225 for nutritional management by email or phone. To improve nutritional care, clinical nutrition

226 teams should be involved in the writing and the implementation of clinical nutrition protocols
227 for Covid-19 and non-Covid 19 patients. Institutional support of the importance of nutritional
228 support should be sought.

229

230 **Challenge 2: The nutrition protocols for Covid-19 patients need to be simple and easily**
231 **applicable.**

232 In the French regions most hit by the epidemic, the massive hospital admissions fluxes have
233 made it necessary to commandeer healthcare professionals not familiar with infectious
234 diseases and internal medicine (e.g. surgeons, anaesthesiologists, non-trained nursing staff...).

235 These professionals are also mostly not well aware of clinical nutrition procedures and
236 protocols, such as insertion of nasogastric tube, modalities of prescriptions of enteral or PN.

237 To reduce the risk of virus transmission, the care organization is organized so that a minimum
238 of healthcare givers can intervene at patient bed, as personal protective equipment availability
239 is scarce. They are asked to plan the different cares in one single visit. In that context,
240 combined with the fact that clinical nutrition professionals (challenge 1) are not authorized to
241 assist care givers in the Covid-19 units, there is obviously no or little room for personalized
242 nutritional care, as it should be. It is therefore highly needed that the nutrition protocols for
243 Covid-19 patients are simple and easily applicable. The use of systematic procedure, instead
244 of too complicated decision algorithms, would be preferable for healthcare professionals not
245 familiar with clinical nutrition.

246

247 **Challenge 3: Screening for malnutrition should be feasible.**

248 Based on the above rationale, malnutrition should be actively investigated in the Covid-19
249 patient. However, the recommend full procedure for malnutrition diagnosis appears to be not
250 fully applicable in the context of the Covid-19 epidemic: lack of scales in Covid-19 units, risk

251 of viral transmission secondary to the use of scales, bioimpedance analyser, handgrip
252 dynamometer and usual tools for arm or calf circumference measurement [5]. At best, the
253 phenotypic criteria of the Global Leadership Initiative on Malnutrition (GLIM) [19] and the
254 French Health High Authority [49] could be theoretically collected based on patients' or
255 relatives' interview indicating usual weight and most recent height. However, efforts should
256 be made to measure as soon as possible after admission the actual weight, in order to calculate
257 a recent weight loss and a body mass index. If no data on weight are available, visual
258 inspection of the physical condition of the patient may be enough to diagnose malnutrition in
259 the presence of severe muscle wasting. On the opposite, etiologic criteria are easily identified:
260 i) Covid-19, as an "acute inflammatory disease"; ii) food intake within the past week that
261 could be easily assessed with semi-quantitative methods: an analog scale between 0 and
262 10/10 [50] or consumed portions (0, ¼, ½; 1) during lunch or dinner, as collected in The
263 NutritionDay survey [51]; consuming <7/10 should alert to likely malnutrition [50,52]. So,
264 screening should not aim to collect all possible indicators but rely on one of few criteria
265 which are enough to identify patients already malnourished or at high-risk of becoming
266 malnourished who constitute the target for early intervention.

267

268 **Challenge 4 - Energy and protein needs assessment needs to be simple and easily**
269 **applicable.**

270 Indirect calorimetry is the reference method to assess the energy requirements [10]. In the
271 context of the Covid-19 epidemic, indirect calorimetry using a canopy is generally contra-
272 indicated because the usual decontamination procedures cannot be guaranteed in most wards
273 in an epidemic context [6]. Only in some specialized ICUs, already trained for indirect
274 calorimetry and adequately staffed, could the use of indirect calorimetry be considered for
275 some metabolically unstable patients, e.g. staying more than 10 days in the ICU or those on

276 full PN [6]. In that context, IC devices and virus filters only dedicated for Covid-19 patients
277 only should be used. We recently stated [6]: “To avoid exposure to aerosol and potential virus
278 contamination during IC device connection / disconnection, our recommendations are,
279 previous to connection to the IC device, to put the ventilator on Stand By and to clamp the
280 tube; then connect and when connected to declamp the tube and to restart the ventilator. This
281 way is preventing the potential spread of virus during disconnection / connection.” Even if
282 these technical aspects of indirect calorimetry take time, we believe that, as indirect
283 calorimetry should be targeted on specific patients, they could be implemented.

284 To determine calorie and protein needs, we therefore propose the use of predictive equations
285 according to weight (**Figure 1**). For obese patients (body mass index ≥ 30), adjusted body
286 weight based on the patient's height and ideal weight should be used: adjusted weight = ideal
287 weight + [(actual weight – ideal weight)/4]; ideal weight = $0.9 * (\text{height (cm)} - 100)$ (-
288 106 [female]). For all other patients, it should be the actual body weight, which again
289 underlines the need of measuring patient’s weight, as soon as possible after admission. The
290 ultimate goal is to avoid underfeeding or overfeeding. Patients on EN are more exposed to
291 underfeeding because of digestive symptoms and feeding interruptions, while overfeeding
292 may happen during PN.

293

294 **Challenge 5: Hospital staff should be aware of refeeding syndrome prevention.**

295 The prevention of refeeding syndrome must be systematic [53]. The Covid-19 patient is likely
296 to be malnourished, especially after several days/weeks of evolution. The medical and nursing
297 staff in charge of the Covid-19 patients is often unaware of the deleterious consequences of
298 non-adapted nutrition support, especially the refeeding syndrome. Therefore, every
299 specialized unit receiving Covid-19 patients at the acute phase should have protocols
300 available for the prevention of refeeding syndrome. It includes appropriate supplementation

301 with electrolytes, including magnesium, potassium and phosphorus, vitamins, trace elements
302 and close clinical and biological monitoring: monitoring of energy and protein intakes, weight
303 (if feasible), and electrolytes, including magnesium, potassium and phosphorus [53]. The risk
304 of refeeding syndrome is maximal under the use of PN. A Covid-19 patient's nutrition
305 protocol is proposed in **Figure 1**.

306

307 **Challenge 6: Adaptation of hospital food delivery needs to be considered to overcome**
308 **insufficient food intake.**

309 The organization of hospital food delivery has been modified during the Covid-19 epidemic
310 so that the meal trays are not entering into the patient rooms. This means that food intake
311 monitoring after meal tray retrieval is impossible. Moreover, dieticians have very limited
312 direct access to the patients. Therefore, daily adaptation of food supply to patient's intake is
313 impossible. At best, hospital food intake should be monitored based on patient's interview (as
314 described for screening in challenge 3) but it will not be possible for every patient. Therefore,
315 to strengthen the chance of reaching the energy and protein targets (**Figure 1**), we propose
316 that every Covid-19 patient should systematically receive, from the day of hospital admission,
317 enriched food (higher energy and protein) as available and two oral nutritional supplements
318 each day. This is a simple and systematic protocol in response to Challenge 3. Insufficient
319 food intake is expected to be very frequent in Covid-19 patients: anorexia, dyspnea, post-ICU
320 dysphagia, rapid catabolism and muscular weakness, insufficient human resources to help
321 with the meal and constraints related to isolation. In case food intake would remain
322 insufficient after 48h ($\leq 50\%$ of consumed food or supplements) [51] or analog scale $< 7/10$
323 [50,52]), we propose that nutrition support should be indicated with EN as first line (**Figure**
324 **1**).

325 As recommended [4,5,12,25,26,54], EN through a nasogastric tube should be preferred as a
326 first line nutrition support because of its expected benefits in the Covid-19 patient (see 1st
327 part). However, Covid-19 patients are mostly managed by medical and non-medical staff
328 often not familiar with nutrition support techniques. In our French experience, several
329 objections rose against the use of EN by nasogastric tube in the context of the Covid-19
330 epidemic. These objections are mostly based on wrong opinions (challenge 7), while others
331 are based on actual risks of EN in some clinical situations where usual conditions may not be
332 guaranteed (challenge 8).

333

334 **Challenge 7 – Misconceptions should be fought, as they are challenging the use of EN:**

335 *Misconception 1 - Continuous feeding increases the risks of EN intolerance.*

336 The advantage of continuous EN administration (e.g. 50 ml/h) is to maintain a low gastric
337 volume, contrary to a meal or after an oral nutritional supplement of 200 ml ingested over a
338 few minutes [48]. Continuous feeding may also have a metabolic beneficial effect, since the
339 VCO₂ induced by nutrient oxidation is much more stable and regular by continuous EN than
340 with intermittent meals. Finally, continuous EN is associated with better glycaemic control
341 and less insulin resistance at the acute phase of illness [12].

342

343 *Misconception 2 - The nasogastric tube (NGT) insertion could induce/worsen hypoxemia and*
344 *apnea.*

345 During NGT insertion procedure, the apnea is no longer than that during swallowing and the
346 patient continues to breathe normally. The total apnea time is much shorter during EN
347 infusion than during a normal meal. In other types of dyspneic patients, such as those with
348 amyotrophic lateral sclerosis and a vital capacity lower than 30% of the theoretical, with or
349 without non-invasive ventilation, NGT insertion was perfectly possible, safe and not different
350 from EN through a gastrostomy in terms of day 30 complications [55].

351

352 *Misconception 3 - NGT for EN, once in place, hinders natural nasal ventilation or the fitting*
353 *of oxygen mask.*

354 The use of a fine gauge NGT (CH8 or CH10) is recommended. This size hardly represents
355 more than 1/8th to 1/6th of the diameter of the nasal ostium, and does not interfere with natural
356 breathing. Therefore, oxygen administration is compatible with NGT for EN at the same time.
357 EN through NGT is a common practice for many malnourished patients, even elderly or at
358 home, with respiratory failure: neuromuscular patients, chronic obstructive pulmonary disease
359 stage IV, cystic fibrosis before lung transplantation, long-term oxygen therapy... without any
360 risk of pneumonia or loss of effectiveness of non-invasive ventilation. Adaptation “tips” for
361 Covid-19 patients having oxygen mask and a NGT for EN at the same time are proposed
362 **(Figure 2).**

363

364 **Challenge 8 – Clinical situations and organizational constraints that may make EN**
365 **unfeasible need to be known.**

366 There are obvious clinical situations and organizational constraints increasing the risk of EN
367 complications and the constraints related to NGT and EN are probably higher in Covid-19
368 patients than in standard medical patients:

369

370 *Issue 1 - Despite the absence of data in Covid-19 patients, the risk of EN complications may*
371 *be higher in patients requiring high outflow oxygen.*

372 Many patients are still receiving high flow nasal cannula (HFNC) therapy or non-invasive
373 ventilation (NIV) in many centers [56,57]. From a practical point of view, based on the
374 Chinese experience, these patients are almost not fed orally or enterally. Also, as reported for
375 standard medical patients, older and confused patients, and those with dementia [11] should

376 be considered at increased risk of EN-related aspiration pneumonia. In these situations, if oral
377 intake is insufficient, PN may be indicated earlier than usual, skipping the EN step (see
378 challenge 9) (**Figure 1**).

379

380 *Issue 2 – NGT insertion is associated with a high risk of viral contamination.*

381 Like all contact gestures potentially associated with contaminating aerosol, the healthcare
382 professional inserting NGT for EN must wear strict antiviral protections. However, at the start
383 of the epidemic, mask shortage in some hospital increased the risk of nurse contamination
384 during NGT insertion.

385

386 *Issue 3 – Once NGT is inserted, chest X-ray may not always be feasible.*

387 Some French centers have decided to perform thoracic CT as a systematic assessment of lung
388 injury in the hospitalized Covid-19 patient in dedicated radiology rooms, and chest X-ray has
389 been abandoned. Therefore, bedside chest X-ray control after NGT insertion is more rarely
390 performed, in order to reduce the risk of virus dissemination. Thus, NGT should be ideally
391 inserted before performing the CT to take opportunity of CT to check the good location, but
392 this is likely a rare situation.

393

394 *Issue 4 - In the event of a shortage of pumps with flow regulator, it is necessary to reserve*
395 *them as a priority for the ICUs.*

396 EN should be performed using a pump with flow regulator. In non-intubated patients, it seems
397 preferable not to use EN rather than doing it without pumps with flow regulator, because of
398 the risk of aspiration pneumonia. Indeed, underfeeding is likely to have less severe
399 consequences than aspiration pneumonia. In that context, PN through a peripheral or a central

400 venous line could be indicated (**Figure 1**). Fortunately, most French hospitals have been
401 quickly re-equipped with EN portable pumps so that a shortage is unlikely to happen.

402

403 *Issue 5 - EN exposes to an increased risk of aspiration in case of emergency intubation.*

404 There is no data available regarding this issue. High gastric residual volume has not been
405 shown to be a risk factor for aspiration per se [58]. The risk of aspiration from a non-fasted
406 stomach is probably less with a low output EN than after a full meal. To limit the risk, we
407 advise stomach aspiration with nasogastric tube before any emergency intubation.

408 Facing these issues limiting the feasibility of EN, the French hospitals harder hit by the
409 epidemic, because of work overload and material shortage, were deemed to use degraded
410 procedures. One of them was not feeding the patient or using PN, instead of EN, to avoid
411 NGT insertion and the risk of staff contamination.

412

413 **Challenge 9 –PN may be considered as an alternative to EN.**

414 PN is usually indicated whenever EN is impossible or contraindicated, or in addition to EN as
415 long as it is insufficient (supplemental PN) or not tolerated [12]. Beside these usual PN
416 indications, all the issues reported in Challenges 7 & 8 may lead to consider PN instead of EN
417 for the Covid-19 patient. In any situation, PN should be prescribed using a case by case
418 decision making, putting in balance the malnutrition risk and potential PN side effects (e.g.
419 overfeeding, hyperglycemia over 10 mmol/l, catheter infections, lymphangitis, refeeding
420 syndrome...) that should be prevented [12,59]. Pumps with flow regulator are also needed for
421 PN infusion. If a central venous catheter, most often a peripherally inserted central catheter
422 (PICC), can be inserted in good safety conditions, central PN should be preferred. Instead,
423 peripheral PN could be a short-term alternative, but with a maximal duration of 10 days
424 because of its low nitrogen content, poor venous tolerance and increased nurse workload.

425

426 **Challenge 10 - Nutritional care could find a place in post-acute care rehabilitation.**

427 At the acute phase of the Covid-19, early optimized nutritional care and physical activity are
428 difficult to implement. Many patients may suffer from post-ICU weakness syndrome and
429 severe muscle loss even in non-ICU patients is common. Therefore, the post-acute care
430 rehabilitation is warranted to enhance muscle mass and function, and recovery of the Covid-
431 19 patients. It should combine nutritional care and physical activity. Clinical nutrition
432 professionals should be among the key actors of this rehabilitation. As nutritional evaluation
433 may have been limited in the acute stage, a more thorough nutritional screening should take
434 place before discharge or on admission to the rehabilitation unit. Nutrition support may be
435 then more easily performed in accordance with the international guidelines [4,5]. As the risk
436 of inter-human or contact virus transmission even after a long hospital stay are still unknown,
437 all the procedures should be adapted to the risk of virus transmission.

438

439 **Conclusion**

440 The Covid-19 epidemic mobilizes all the available hospital resources for an optimized care of
441 the patients, including the most advanced ventilation techniques. Nutritional care is a key
442 component of a global care but its implementation may be overlooked or made difficult by the
443 epidemic context. Facing this new disease, our practice in clinical nutrition should therefore
444 adapt, identify different care modalities and, unfortunately, rely on degraded procedures.
445 Despite these limitations, efforts should be developed to provide some oral nutrition support
446 at the early stage and scale up to EN or PN as needed [5,60]. Practical fact sheets have been
447 published by the French-speaking Clinical Nutrition and Metabolism Society
448 (www.sfncm.org) to help clinicians to implement nutritional strategy at the different steps of
449 Covid-19 patients' course, at hospital, during rehabilitation and back home.

450 Although a lot of effort is targeted on antiviral therapy, dedicated trials should evaluate
451 whether early more intensive nutritional intervention could improve the clinical outcome of
452 the Covid-19 patients. Dedicated studies about the nutrition status of the Covid-19 patients are
453 now awaited to enrich our knowledge about the metabolism alterations induced by this new
454 disease and adapt the nutrition support strategy.

455

456 **Statement of authorship**

457 Ronan Thibault, Moïse Coëffier, Francisca Joly, Stéphane M Schneider, Julien Bohé and
458 Pierre Déchelotte drafted the article.

459

460 **Conflict of interest statement**

461 Ronan Thibault received consulting and conference fees: Aguetant, Baxter, BBraun,
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478

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655

656 **Figure legend**

657

658 **Figure 1 – Nutrition protocol for the Covid-19 hospitalized patient under oxygen ≥ 3**

659 **l/min (adapted from sheet 8 – annex - www.sfcnm.org). BMI, body mass index; BW, body**

660 **weight; CVC, central venous catheter; EN, enteral nutrition; ICU, intensive care unit; IV,**

661 **intravenous; NGT, nasogastric tube; PN, parenteral nutrition; PVC, peripheral venous catheter**

662

