

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
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4	Running title: Covid-19 and clinical nutrition
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29 Abstract

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

49

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

53 General context

54 The viral epidemic caused by the new Coronavirus SARS-CoV-2 is responsible for the new Coronavirus disease -2019 (Covid-19) [1]. In the Chinese experience, up to 30% of the 55 Coronavirus SARS-CoV-2 (Covid-19) infected patients are presenting with an acute 56 respiratory distress syndrome (ARDS) requiring urgent respiratory and hemodynamic support 57 in the intensive care unit (ICU) [2]. Covid-19 patients develop in 20% of cases a severe 58 59 pneumonia requiring hospitalization. Because of ARDS, the overall mortality rate during Covid-19 infection is estimated to be around 1 to 2% [2]. The median intra-hospital mortality 60 rate is around 30%. 61 62 The cross-sectional study by Li et al performed in hospitalized elderly patients with Covid-19 reported that 53% of patients were malnourished [3]. This means that nutritional support 63 should be integrated in the global management of the Covid-19 patient. Therefore, we and 64 65 other members of the French speaking society for clinical nutrition and metabolism (SFNCM) elaborated practical guidance sheets (www.sfncm.org) to help the French speaking health 66 caregivers to manage malnutrition and risk for malnutrition in the Covid-19 patients. Our 67 feedback from the field meant we quickly observed that some of the international guidelines 68

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

shortage. Thus, clinical nutrition practice should adapt, and the use of degraded procedures

73 may unfortunately be the only way.

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

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

80

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

Recent studies or guidelines state that the Covid-19 patient at high risk for malnutrition [3-7]. 82 The most severe cases are encountered in particular, but not exclusively, in patients with a 83 84 chronic disease (such as organ failure, obesity with body mass index \geq 35 [8,9], type 2 diabetes 2 or cancers), elderly and / or polymorbid conditions [10]. These diseases often mask 85 underlying protein malnutrition and sarcopenia [11,12]. Covid-19 patients should be 86 87 considered at high risk of malnutrition [3-7], like in other severe respiratory infections characterized by: inflammatory syndrome and hypercatabolism, increased energy expenditure 88 linked to ventilation work [5,6]. In the absence of early and adequate nutritional support, this 89 90 combination will lead to a rapid deterioration of respiratory muscle function, aggravating the consequences of viral pulmonary damage [4,5]. Hypermetabolism and physical 91 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, dysgueusia [13]. Finally, digestive symptoms (diarrhea, vomiting or abdominal pain) [14-17], 94 95 stress, confinement, organizational problems and staff shortage will contribute to limit meal offering and ingestion. Importantly, obesity is associated with severe forms of the Covid-19 96 infections [8,9]. Obesity is also associated with increased protein catabolism and insulin 97 98 resistance as compared with non-obese patients [18], and pre-existing obesity may limit the awareness of nursing staff about providing minimal caloric and increased protein supply to 99 these patients. 100

Acute malnutrition induced by Covid-19 infection would therefore be associated with
 increased loss in muscle mass and weakening of immune defenses which together would

contribute to the severity of the Covid-19. The malnutrition phenotypic criteria could be a low 103 104 body mass index (BMI), a significant weight loss or a low fat-free mass [19]. However, only BMI, already known as very poorly sensitive in diagnosing malnutrition, has been reported in 105 106 Chinese [20] and NewYork cohort studies [21]; in these studies, low BMI was not predictive of severe forms; this may reflect the limited number of patients in this BMI range and the fact 107 that obese patients displaying acute malnutrition were not detected. Thus, to our opinion, 108 109 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)

recommend prescription of nutritional support for medical, polymorbid inpatients at risk of

116 malnutrition [12]. A recent prospective, randomized, unblinded, multicenter trial

demonstrated that providing early nutritional support, mostly orally, in hospitalized patients at

risk of malnutrition significantly decreased 30-day complications and mortality in comparison

to patients on standard hospital diet [23]. The high probability of malnutrition [3-7] and its

association with a worse clinical outcome [24] are justifying an active strategy of nutrition

screening and support in the Covid-19 patient [4,5,25,26]. This would help the patients

reinforcing their immune defenses and potentially limiting the evolution towards a severe

123 form of the disease.

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125 *Role of nutrition support on immune response*

126 The innate immune response (i.e. humoral immunity and effector T cells) appears to be

impaired in the Covid-19 patients [2], and the "cured" patients showed better restoration of

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

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

Amino acids, and in particular glutamine, are essential energy substrates for immune cells such as lymphocytes [28]. Activation of immune cells requires an increase in the intracellular influx of amino acids and an increase in membrane transporters of amino acids [29]. In addition, the intracellular content of glutathione, a tri-peptide with significant antioxidant properties, is a key element in regulating the number and function of lymphocytes [30]. A 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 immune143 response.

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132

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
- estimated the prevalence of GI symptoms (nausea, diarrhea, vomiting) from 11.4% to 16%,

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

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

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

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

and complications, particularly pneumonia, in critically ill patients compared to EN

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

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,

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

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

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.
- 6- Adaptation of hospital food delivery needs to be considered to overcome insufficient foodintake.

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

Facing these challenges and barriers, our objective is to propose practical solutions for the clinical nutrition caregivers to promote nutritional care in the hospitalized Covid-19 patient. We also propose a flow chart (**Figure 1**) for optimizing the nutritional management of the Covid-19 patients in the non-ICU wards, including the possible use of PN in the situations where the use of EN as the first line of nutrition support is considered as risky or unfeasible.

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

In the context of the Covid-19 epidemic, administrative and political rules are set up to
prevent virus propagation among patients and staff. Dedicated teams of healthcare
professionals are constituted including physicians, nurses, nurse assistants...chosen according
to their expertise in urgent respiratory care and artificial ventilation. In that context,
nutritional screening and care is not considered as a priority. The access to the Covid-19
hospital wards is restricted to these indispensable and dedicated healthcare professionals to
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 clinical visits with non-Covid-19 hospitalized patients are sometimes restrained as well. As 220 221 there is almost no way to overcome these administrative rules, clinical nutrition professionals need to reorganize their daily work. In this situation, there is a room for intra-hospital 222 teleconsultations (e.g. dietician is calling the patient through her/his room phone, if clinically 223 able to speak). Phone contacts remain to be kept with nurses and doctors by giving the advices 224 for nutritional management by email or phone. To improve nutritional care, clinical nutrition 225

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

229

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

232 In the French regions most hit by the epidemic, the massive hospital admissions fluxes have made it necessary to commandeer healthcare professionals not familiar with infectious 233 diseases and internal medicine (e.g. surgeons, anaesthesiologists, non-trained nursing staff...). 234 235 These professionals are also mostly not well aware of clinical nutrition procedures and protocols, such as insertion of nasogastric tube, modalities of prescriptions of enteral or PN. 236 To reduce the risk of virus transmission, the care organization is organized so that a minimum 237 238 of healthcare givers can intervene at patient bed, as personal protective equipment availability is scarce. They are asked to plan the different cares in one single visit. In that context, 239 240 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 nutritional care, as it should be. It is therefore highly needed that the nutrition protocols for 242 Covid-19 patients are simple and easily applicable. The use of systematic procedure, instead 243 of too complicated decision algorithms, would be preferable for healthcare professionals not 244 familiar with clinical nutrition. 245

246

247 Challenge 3: Screening for malnutrition should be feasible.

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

of viral transmission secondary to the use of scales, bioimpedance analyser, handgrip 251 252 dynamometer and usual tools for arm or calf circumference measurement [5]. At best, the phenotypic criteria of the Global Leadership Initiative on Malnutrition (GLIM) [19] and the 253 254 French Health High Authority [49] could be theoretically collected based on patients' or relatives' interview indicating usual weight and most recent height. However, efforts should 255 256 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 the presence of severe muscle wasting. On the opposite, etiologic criteria are easily identified: 259 260 i) Covid-19, as an "acute inflammatory disease"; ii) food intake within the past week that could be easily assessed with semi-quantitative methods: an analog scale between 0 and 261 10/10 [50] or consumed portions $(0, \frac{1}{4}, \frac{1}{2}; 1)$ during lunch or dinner, as collected in The 262 263 NutritionDay survey [51]; consuming <7/10 should alert to likely malnutrition [50,52]. So, screening should not aim to collect all possible indicators but rely on one of few criteria 264 265 which are enough to identify patients already malnourished or at high-risk of becoming 266 malnourished who constitute the target for early intervention.

267

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

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

full PN [6]. In that context, IC devices and virus filters only dedicated for Covid-19 patients 276 only should be used. We recently stated [6]: "To avoid exposure to aerosol and potential virus 277 contamination during IC device connection / disconnection, our recommendations are, 278 279 previous to connection to the IC device, to put the ventilator on Stand By and to clamp the tube; then connect and when connected to declamp the tube and to restart the ventilator. This 280 281 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 calorimetry should be targeted on specific patients, they could be implemented. 283 To determine calorie and protein needs, we therefore propose the use of predictive equations 284 285 according to weight (Figure 1). For obese patients (body mass index \geq 30), adjusted body weight based on the patient's height and ideal weight should be used: adjusted weight = ideal 286 287 weight + [(actual weight – ideal weight)/4]; ideal weight = 0.9*(height (cm)-100 (male)) (-288 106 [female]). For all other patients, it should be the actual body weight, which again underlines the need of measuring patient's weight, as soon as possible after admission. The 289 290 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 may happen during PN. 292

293

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

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

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

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

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

333

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.*

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

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

from EN through a gastrostomy in terms of day 30 complications [55].

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

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

363

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

There are obvious clinical situations and organizational constraints increasing the risk of EN complications and the constraints related to NGT and EN are probably higher in Covid-19 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

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

standard medical patients, older and confused patients, and those with dementia [11] should

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

379

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

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

385

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

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

393

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

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

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

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

Issue 5 - EN exposes to an increased risk of aspiration in case of emergency intubation. 403 There is no data available regarding this issue. High gastric residual volume has not been 404 405 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. Facing these issues limiting the feasibility of EN, the French hospitals harder hit by the 408 409 epidemic, because of work overload and material shortage, were deemed to use degraded procedures. One of them was not feeding the patient or using PN, instead of EN, to avoid 410 NGT insertion and the risk of staff contamination. 411

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 indications, all the issues reported in Challenges 7 & 8 may lead to consider PN instead of EN 416 417 for the Covid-19 patient. In any situation, PN should be prescribed using a case by case decision making, putting in balance the malnutrition risk and potential PN side effects (e.g. 418 overfeeding, hyperglycemia over 10 mmol/l, catheter infections, lymphangitis, refeeding 419 420 syndrome...) that should be prevented [12,59]. Pumps with flow regulator are also needed for PN infusion. If a central venous catheter, most often a peripherally inserted central catheter 421 (PICC), can be inserted in good safety conditions, central PN should be preferred. Instead, 422 peripheral PN could be a short-term alternative, but with a maximal duration of 10 days 423 because of its low nitrogen content, poor venous tolerance and increased nurse workload. 424

425

426 Challenge 10 - Nutritional care could find a place in post-acute care rehabilitation. At the acute phase of the Covid-19, early optimized nutritional care and physical activity are 427 difficult to implement. Many patients may suffer from post-ICU weakness syndrome and 428 severe muscle loss even in non-ICU patients is common. Therefore, the post-acute care 429 rehabilitation is warranted to enhance muscle mass and function, and recovery of the Covid-430 431 19 patients. It should combine nutritional care and physical activity. Clinical nutrition professionals should be among the key actors of this rehabilitation. As nutritional evaluation 432 may have been limited in the acute stage, a more thorough nutritional screening should take 433 434 place before discharge or on admission to the rehabilitation unit. Nutrition support may be then more easily performed in accordance with the international guidelines [4,5]. As the risk 435 of inter-human or contact virus transmission even after a long hospital stay are still unknown, 436 437 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 the patients, including the most advanced ventilation techniques. Nutritional care is a key 441 442 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 443 adapt, identify different care modalities and, unfortunately, rely on degraded procedures. 444 Despite these limitations, efforts should be developed to provide some oral nutrition support 445 at the early stage and scale up to EN or PN as needed [5,60]. Practical fact sheets have been 446 published by the French-speaking Clinical Nutrition and Metabolism Society 447 (www.sfncm.org) to help clinicians to implement nutritional strategy at the different steps of 448 Covid-19 patients' course, at hospital, during rehabilitation and back home. 449

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	
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457	Ronan Thibault, Moïse Coëffier, Francisca Joly, Stéphane M Schneider, Julien Bohé and
458	Pierre Déchelotte drafted the article.
459	
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461	Ronan Thibault received consulting and conference fees: Aguettant, Baxter, BBraun,
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- 478

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- 655

656 Figure legend

657

- Figure 1 Nutrition protocol for the Covid-19 hospitalized patient under oxygen ≥ 3
- 659 **l/min (adapted from sheet 8 annex <u>www.sfcnm.org</u>). BMI, body mass index; BW, body**
- 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

