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Implementation of the ESPEN guideline on clinical nutrition in the intensive care unit (ICU): it is time to move forward!

A position paper from the 'nutrition in the ICU' ESPEN special interest group

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Short title: nutrition guideline implementation in the ICU

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Abstract

Nutritional assessment and provision of nutritional therapy are a core part of intensive care unit (ICU) patient treatment. The ESPEN guideline on clinical nutrition in the ICU was published in 2019. However, uncertainty and difficulties remain regarding its full implementation in daily practice. This position paper is intended to help ICU healthcare professionals facilitate the implementation of ESPEN nutrition guidelines to ensure the best care for their patients. We have aimed to emphasize the guideline recommendations that need to be implemented in the ICU, are advised, or are optional, and to give practical directives to improve the guideline recommendations in daily practice. These statements were written by the members of the ICU nutrition ESPEN special interest group (SIG), based on a survey aimed at identifying current practices relating to key issues in ICU nutrition. The ultimate goal is to improve the ICU patients quality of care.

Keywords: malnutrition ; critical illness ; enteral nutrition ; supplemental parenteral nutrition ; body composition; indirect calorimetry.

Introduction

Nutritional assessment and provision of nutritional therapy must be integrated into the overall therapeutic strategy of any intensive care unit (ICU) patient, from the acute to the rehabilitation phases. To achieve these goals, the European Society for Clinical Nutrition and Metabolism (ESPEN) guideline on clinical nutrition in the ICU was published in 2019 [1]. However, based on our clinical experience, its implementation into daily practice has been limited. The fact that this guideline was a consensus coming from discussions between ESPEN experts highlights the diversity in opinion in this area, due in part to lack of scientific evidence. Thus, it is logical to find this diversity also at the bedside.

Based on a survey undertaken among the members of the new created ESPEN special interest group (SIG) on ICU nutrition, the objective of this paper is to discuss the degree of implementation of the ESPEN recommendations on ICU clinical nutrition in the daily practice of experts in the group. Based on the recommendations of the ESPEN guidelines on ICU clinical nutrition [1], we propose to emphasize the guideline recommendations that should be implemented in the ICU, are advised, or are optional according to local practices and clinical judgment, and to give practical directives to improve the implementation of guideline recommendations in daily practice.

This position paper intends to help ICU health professionals to facilitate the implementation of ESPEN guidelines in ICU clinical nutrition to ensure the best care to their patients.

Methods

The ESPEN SIG on ICU nutrition was set up on the proposal of the leader (PS) designed by the ESPEN executive committee. Each SIG member was chosen based on her/his strong experience in the field of ICU and nutrition and their involvement in the daily nutritional care of ICU patients. A survey was developed and sent to all the eight members (7 physicians, 1

dietitian) of the ESPEN SIG on January 2022. The members were asked to give their input regarding their own daily practice (in the ICU where they work) on the different topics addressed by the ESPEN guideline on clinical nutrition [1] (**Supplementary Table 1**): nutritional screening and assessment; feeding route decision making including the use of supplemental parenteral nutrition; use of early or late nutrition support; continuous or intermittent enteral nutrition; use of prokinetics; determination of energy and protein targets; use of urinary urea excretion (to calculate nitrogen balance); use of lipid emulsions, including omega 3 or 9 fatty acids; use of glutamine; use of vitamins and trace elements; monitoring of the achievement of nutritional goals and clinical and biological monitoring; existence of specific protocols (e.g. for glucose control and insulin therapy, surgical, including transplanted, obese, non-intubated, or trauma patients); and use of physical activity. The country where the survey responders work is reported in the legend of the **Supplementary Table 2**.

Based on these answers, degree of implementation of the ESPEN recommendations on clinical nutrition in the ICU was determined. The group then reached a consensus on the nutritional measurements and therapies that:

- should be implemented in the ICU (grade A recommendations);
- are advised (grade B recommendations);
- are optional, according to the local practices, clinical judgment and availabilities (other grade recommendations).

The milestones that need to be achieved for effective implementation are discussed using the survey results and newly published (since the publication of the ESPEN guidelines) scientific evidence.

Survey analysis

The survey results are shown in **Supplementary Table 2** with the main findings summarised below:

Nutritional screening and assessment

The experts report that nutritional screening is performed in 25% of ICUs (n=2/8) on a daily basis. When nutritional screening is done, the Nutritional Risk Screening (NRS)-2002 [2] (n=4/8, 50%) or Malnutrition Universal Screening Tool (MUST) [4] (n=1/8, 12.5%) are used. For nutritional assessment, one centre (12.5%) is using the Global leadership initiative on Malnutrition (GLIM) criteria the diagnosis of malnutrition [4]. Other centres are using the anamnestic body weight (BW) loss, the estimation of BW or physical examination (n=8/8, 100%), including the Subjective Global Assessment (SGA) (n=1/8, 12.5%) [5]. Only one centre (12.5%) is using body composition evaluation at day 3 post ICU admission to evaluate nutritional status. The ICU staff involved in nutritional data collection are either physicians, nurses, dietitians or physiotherapists. Data are always (100%) recorded in the electronic medical file (EMF).

Feeding route decision-making / Use of early or late nutrition support / Continuous or intermittent enteral nutrition

The use of continuous enteral nutrition (EN) through a nasogastric tube is well implemented and protocolized in all ICUs (n=8/8, 100%). In all centres, it is started at admission in intubated patients, or within the first 48 hours, after hemodynamic stabilization. The energy targets prescribed and delivered are recorded into the EMF. Only one centre (12.5%) interrupts EN 4h/day to check for gastric residual volume (GRV).

Use of prokinetics

In case of gastrointestinal (GI) intolerance to EN, prokinetics are used in all centres (n=8/8, 100%). The combination of erythromycin and metoclopramide (n=4/8, 50%), or metoclopramide alone followed by erythromycin alone if the GI intolerance persists (n=3/8, 37.5%) or erythromycin alone (n=1/8, 12.5%), are the most prescribed in the EMF by the intensivist in charge. One expert (12.5%) mentioned the use of post-pyloric feeding in case of GI intolerance to EN not solved with prokinetic agents after three days.

The use of supplemental parenteral nutrition (SPN)

Eighty-seven percent (n=7/8) of centres are using SPN when the patient does not reach their energy target with enteral feeding by day 4 or even day 2 (n=1). One centre is using SPN only when weaning off PN. SPN is delivered through a central venous catheter and is prescribed by the physicians in the EMF. When a specialized dietitian is working in the ICU, they recommend the SPN prescription.

Determination of energy target

The use of indirect calorimetry is not well implemented in the ICUs in which the experts work (n=5/8, 62.5%). It is used on a daily basis in only two centres (25%) despite the ESPEN guidelines on ICU clinical nutrition considering this the reference method for the determination of energy target [1]. The main evoked reason is the fact that there has been a lack of a validated machine until recently [6]. In one centre (12.5%), the implementation is on its way. In the absence of indirect calorimetry, predictive equations are used, such as: the Faisy equation (n=1/8, 12.5%), the Penn state equation (n=1/8, 12.5%), or 20-25 kcal/kg of usual BW (non-obese) or adjusted BW (obese)/day (n=8/8, 100%).

Determination of protein target

The predictive equation 1.3 g/kg usual BW (non obese) or adjusted BW (obese)/day is widely used (n=7/8, 87.5%) as recommended by ESPEN [1].

Use of urinary urea excretion

Only one centre (12.5%) reports measuring urinary urea excretion daily. In 3/8 centres (37.5%), this measure is used for research purposes (n=1/8) or in some specific situations such as long stayers or severe acute pancreatitis (n=2/8). No expert mentioned measuring urinary urea excretion in obese patients, despite the ESPEN guidelines [1] making this recommendation.

Use of lipid emulsions, including omega 3 or 9 fatty acids

All centres (n=8/8, 100%) are using all-in-one PN solutions that integrate the lipid emulsion. One centre (12.5%) reports using hospital pharmacy compounded bags where needed. Opposite practices are observed regarding the use of lipid emulsions containing omega 3 polyunsaturated fatty acids. Some centres are not or rarely using them (n=3/8, 37.5%), whereas others (n=5/8, 62.5%) are using them at each time PN is prescribed according to ESPEN recommendations [1]. This could be due to local policies and availabilities of PN solution that have different omega-3 polyunsaturated fatty acids in their formula, which may differ by country. One centre (12.5%) reports using only olive oil emulsions in ICU patients.

Use of glutamine

Fifty percent (n=4/8) of the centres no longer use glutamine in ICU patients. Fifty percent (n=4/8) of the centres report using glutamine in trauma patients (n=1, 12.5%) and/or patients with wounds (n=2, 25%) or during the acute phase in patients requiring PN (PN is then prepared in compounded bags by the hospital pharmacy) (n=1, 12.5%).

Use of vitamins and trace elements

As recommended by ESPEN [1], all centres (100%) are practicing a systematic supplementation of PN bags with vitamins and trace elements. The addition is generally made by nurses at patient bedside (n=5/8, 62.5%) and prescribed by physicians in the EMF. Two centres (25%) reports prescribing oral or IV vitamins and trace elements (when required) to patients on continuous renal replacement therapy on dietitian or physician's initiative.

Monitoring of achievement of nutritional goals and clinical and biological monitoring

Most centres are monitoring daily (n=6/8, 75%) or weekly (n=1/8, 12.5%) achievement of nutritional goals either via EMFs that automatically calculate the difference between target and delivered energy (n=6/8, 75%) or via a self-made excel spreadsheet (n=1, 12.5%). In one centre (12.5%), monitoring is planned implemented once a new EMF is in use. Centres (n=5/8, 62.5%) undertake clinical and biological (ionogram, phosphate, triglycerides, liver tests) monitoring in patients with PN, and some (n=2/8, 25%) on a daily basis (ionogram, phosphate). Two centres (25%) are specifically focussing on phosphate. In one centre (12.5%), biological monitoring is undertaken twice a week to monitor nutritional status and includes prealbumin.

Existence of specific protocols (e.g. for glucose control and insulinotherapy, surgical, including transplanted, obese, non-intubated, or trauma patients)

Three centres (37.5%) report no specific protocols being in use. Others report that there are specific protocols for transplanted patients (n=2/8, 25%), insulin therapy and glucose control (n=3/8, 37.5%), and nutritional therapy after extubation (n=1/8, 12.5%). No expert mentioned

using specific protocols for trauma, obese or surgical patients, whereas ESPEN states specific recommendations about these topics [1].

Use of physical activity

Eighty-seven percent (n=7/8) of centres report that their ICU patients receive active and passive mobilization by physiotherapists. Two centres (25%) report that this goal could not be achieved because of lack of personnel or practical issues. One centre (12.5%) has implemented cycle ergometry and electrical muscle stimulation when there is no contraindication ((e.g. ischemic heart disease, physical impairment, increase in oxygen requirement).

Expert group consensus for the implementation of nutrition recommendations in the ICU

The consensus is reported below and in **Table 1** according to the three categories and the selected topics.

The ESPEN recommendations that should be implemented

The ESPEN recommendations that should be implemented are the ones with the highest level of evidence: those quoted 'Grade of recommendation: A' in the ESPEN guidelines on ICU nutrition [1].

There were no grade A ESPEN recommendations for the following topics: 'Nutritional screening and assessment', 'Continuous or intermittent enteral nutrition', 'Use of prokinetics', 'Determination of energy target', 'Determination of protein target', 'Use of lipid emulsions, including the use of omega-3 or -9 fatty acids', 'Use of vitamins and trace elements',

‘Monitoring of the achievement of the nutritional goals and clinical and biological monitoring’, and ‘Use of physical activity’.

Feeding route decision making / Use of early or late nutrition support

The grade A ESPEN recommendations 5 and 8 state:

“- If oral intake is not possible, early EN (within 48 h) shall be performed/initiated in critically ill adult patients rather than early PN.

- To avoid overfeeding, early full EN and PN shall not be used in critically ill patients but shall be prescribed within three to seven days.”

These grade A recommendations are well implemented in the ICUs where the SIG experts are working. The recommendation of preferring EN over PN is widely accepted [1,7,8]. A lack of consensus among international academic societies (ESPEN [1] and ASPEN [7]) exists about the best timing to start nutrition support after ICU admission. The main reason is the heterogeneity of the ICU patients (age, severity of disease, medical versus surgical cares, preexisting malnutrition, chronic diseases).

Based on ESPEN recommendations [1] and available international guidelines for nutrition [7], EN should be continuous (see below in the paragraph ‘advised ESPEN recommendations’), then be progressive increased to reach an energy target by day 4-6, depending on tolerance. The polymeric standard EN formulas should be used as first line. If polymeric EN administration is associated with diarrhoea, semi-elemental EN can be tested as second line.

Use of glutamine

The ESPEN recommendation 29 states: “In unstable and complex ICU patients, particularly in those suffering from liver and renal failure, parenteral GLN –dipeptide shall not be administered.”

As a consequence of the REDOX study [9], using high dose glutamine, it is recommended to refrain from IV glutamine administration in patients suffering from renal or liver failure or patients in multi organ failure. Our survey indicates the good implementation of this recommendation. However, an attention point should be to keep glutamine use for patients with trauma or severe wounds.

The existence of specific protocols

The only grade A recommendation is for glucose control and insulinotherapy:

“Recommendation 54: Insulin shall be administered, when glucose levels exceed 10 mmol/l. “

The strategy of glucose control remains a matter of controversy regarding the optimal target [10,11]. Strong evidence is in favour of preventing severe hyperglycemia and to administer intravenous insulin if glucose levels exceed 10 mmol/l [10]. It is also suggested to reach the target glucose level as fast as possible and to avoid variability outside the target range [10]. Persistently high glucose levels should also encourage the physician to consider decreasing the carbohydrate load and using formulas enriched in fat.

The ESPEN recommendations that are advised to implement

The ESPEN recommendations advised to implement are those quoted ‘grade of recommendation: B’ in the ESPEN guidelines on ICU clinical nutrition [1].

There were no grade B ESPEN recommendations for the topics ‘Nutritional screening and assessment’, ‘Determination of protein target’, or ‘Use of physical activity’.

Feeding route decision making, including the use of supplemental parenteral nutrition / Use of early or late nutrition support

The ESPEN recommendations 4 and 6 state:

“- If oral intake is not possible, early EN (within 48 h) in critically ill adult patients should be performed/initiated rather than delaying EN.

- In case of contraindications to oral and EN, PN should be implemented within three to seven days.”

The use of EN as the first line nutritional therapy is well implemented in the ICU [1,7]. The best timing of initiating EN is within 48 hours. There is still debate regarding the amount of EN that should be delivered and about how long we should wait after admission before reaching energy target. Some authors argue that there is a risk of overnutrition if 100% of energy target is delivered before day 4 [12,13]. Others argue [14,15] that it should depend on GI tolerance and patient profile. For example, in a malnourished critically ill patient who could tolerate EN, waiting for four days could increase muscle catabolism and worsen malnutrition.

If EN is insufficient or not tolerated by day 4, initiating PN alone or supplemental PN (SPN), i.e. EN combined with PN, is advised within three to seven days [1]. Both overnutrition [16] and undernutrition [17] are deleterious [16]. To prevent malnutrition and increasing muscle protein catabolism, itself worsening patient outcome, because of no or insufficient EN, PN or SPN is indicated. The timing of initiating PN is advised by day 3 at the earliest to prevent overnutrition/overfeeding and its related complications [1]. The risk of overfeeding complications is the highest in the acute phase of critical illness [12,13], in average during the three first days of ICU stay. PN can be considered in a specific setting (e.g. post complex surgery or malnourished state, and according to each patient's individual situation) and SPN can be considered when EN has a slow progress. This advice is in line with the above one to reach an energy target by day 4-6, depending on the tolerance of the nutrition support.

The European Society for Intensive Care Medicine (ESICM) underlined [18] the following specific situations where EN should be delayed or administered at low dose. These situations are potential indications for SPN. The ESPEN guideline [1] recalled grade B recommendations stated by the ESICM summarizing the specific situations where:

“* EN should be delayed (recommendation 38):

- if shock is uncontrolled and hemodynamic and tissue perfusion goals are not reached, whereas low dose EN can be started as soon as shock is controlled with fluids and vasopressors/inotropes, while remaining vigilant for signs of bowel ischemia;**
- in case of uncontrolled life-threatening hypoxemia, hypercapnia or acidosis, whereas EN can be started in patients with stable hypoxemia, and compensated or permissive hypercapnia and acidosis;**
- in patients suffering from active upper GI bleeding, whereas EN can be started when the bleeding has stopped and no signs of re-bleeding are observed;**
- in patients with overt bowel ischemia;**
- in patients with high-output intestinal fistula if reliable feeding access distal to the fistula is not achievable;**
- in patients with abdominal compartment syndrome; and**
- if gastric aspirate volume is above 500 ml/6 h.**

(Strong consensus (100% agreement))

*** Low dose EN should be administered (Recommendation 39):**

- in patients receiving therapeutic hypothermia and increasing the dose after rewarming;**
- in patients with intra-abdominal hypertension without abdominal compartment syndrome, whereas temporary reduction or discontinuation of EN should be considered**

when intra-abdominal pressure values further increase under EN; and
- in patients with acute liver failure when acute, immediately life-threatening metabolic derangements are controlled with or without liver support strategies, independent on grade of encephalopathy.”

The ESICM recommendation 40 encouraged early EN in specific situations where there could be some reluctance:

“* Early EN should be performed: in patients receiving ECMO, with traumatic brain injury, stroke (ischemic or hemorrhagic), spinal cord injury, severe acute pancreatitis, after GI surgery, abdominal aortic surgery, with abdominal trauma when the continuity of the GI tract is confirmed/restored, receiving neuromuscular blocking agents, managed in prone position, with open abdomen, and regardless of the presence of bowel sounds unless bowel ischemia or obstruction is suspected in patients with diarrhea.”

Continuous or intermittent enteral nutrition

The ESPEN recommendation 9 states: “Continuous rather than bolus EN should be used.”

This grade B recommendation is well implemented in the survey centres. Continuous EN (and also PN when indicated) is advised to ensure the GI tolerance [1], prevent refeeding syndrome [19,20], and facilitate the glycaemic control [10]. The use of dedicated EN protocols handled by nurses on a daily basis should be more efficient than those based on physician prescriptions that are more frequently associated with delay in EN increase. This is emphasizing the need of ICU nurses specifically trained in clinical nutrition.

Use of prokinetics

The ESPEN recommendations 11 and 13 state:

“- In patients with gastric feeding intolerance not solved with prokinetic agents, postpyloric feeding should be used.

- In critically ill patients with gastric feeding intolerance, intravenous erythromycin should be used as a first line prokinetic therapy.”

Our survey suggests that these recommendations are not implemented in practice. The validation of the postpyloric location of the feeding tube could be sometimes difficult as it could be not well visible at the X-ray chest radiography. The survey centres are more using metoclopramide as a first line prokinetic therapy, erythromycin being used as a second line. The reluctance to use erythromycin as a first line prokinetic therapy could be the fact that it is an antibiotic, meaning the risk for generating antimicrobial resistance. In some countries, erythromycin may not be available on the market.

Determination of energy target

The ESPEN recommendation 15 states: “In critically ill mechanically ventilated patients, energy expenditure (EE) should be determined by using indirect calorimetry.”

This grade B recommendation was followed by the statement 2:

“If calorimetry is not available, using VO_2 (oxygen consumption) from pulmonary arterial catheter or VCO_2 (carbon dioxide production) derived from the ventilator will give a better evaluation on EE than predictive equations.”

The use of indirect calorimetry (IC) in the ICU is controversial [21], yet it is the reference method for measuring energy expenditure in [1] and outside [22] the ICU. IC allows setting the energy target during critical illness, even if feeding the patient at 100% of the energy target before day 4 is not recommended (see recommendation 17 below) [1]. In our survey, experts reported that the main limitation of using the IC is access to the device. Whereas new

IC devices are easy to calibrate and to use, easy to clean, giving a rapid answer (within minutes) and there are also monitoring modules giving continuous results available, some practical issues still remaining braking the wide use of IC in the ICU: IC devices are not cheap (25'000 €, £30000); although the measurement may only take 10 minutes in stable patients, it can take hours to actually get to the patient (e.g. avoiding ward rounds, CT scans and other procedures), steady state may not be possible and the results can require careful interpretation. There is a strong need to develop actions in order to make the acquisition of IC easier, e.g. better teaching of ICU nurses and physicians about the practical aspects of IC, better after sales service by the companies to better assist the ICU teams, scientific document to help colleagues to argue towards their administration, discussion with the manufacturers to decrease the costs of the device and related materials. Using the VCO_2 derived from the ventilator as an alternative to IC should not be done without a specific training as the interpretation could be difficult.

We could also argue that there is lack of scientific evidence showing that measuring energy expenditure (EE) with IC improves patient outcome. Few studies have addressed this issue; one showed that patients fed according to measured EE measured experienced a better outcome than patients fed according to EE estimated by predictive equations [23]. Others argue that IC cannot be performed in all patients reducing the possibility of widening its use [21].

The ESPEN recommendations 17 and 19 state:

“- Hypocaloric nutrition (not exceeding 70% of EE) should be administered in the early phase of acute illness.

- If predictive equations are used to estimate the energy need, hypocaloric nutrition (below 70% estimated needs) should be preferred over isocaloric nutrition for the first week of ICU stay.”

These guideline recommendations are mostly based on the idea that the predictive equations overestimate EE, and therefore by using an energy target of 70% over 100% of estimated needs for the first week of ICU stay, the ESPEN guideline authors suggest that ICU patients would then be fed according to 100% of EE measured by IC. Our survey suggests that these recommendations are not widely implemented. The majority of group members report that they aim to meet 100% of the energy target by day 4 whatever the method of EE estimation/measurement used. Regardless of the guideline recommendations and results of our survey, it should not be forgotten that nutrition support should be adapted to each ICU patient (i.e. personalized, according to the evolution of critical illness, nutritional status, and GI tolerance), day-by-day with the ultimate goal to avoid underfeeding or overfeeding.

Use of lipid emulsions, including the use of omega-3 or -9 fatty acids

The ESPEN recommendations 30 and 32 state:

“- High doses of omega-3-enriched EN formula should not be given by bolus administration.

- High doses omega-3 enriched enteral formulas should not be given on a routine basis.”

Our survey indicates a good implementation of this recommendation. When used, polyunsaturated omega-3 fatty acids are rather delivered by the PN route.

Use of glutamine

The ESPEN recommendations 26 and 28 state:

“- In patients with burns > 20% body surface area, additional enteral doses of glutamine (0.3-0.5 g/kg/d) should be administered for 10-15 days as soon as EN is commenced.

- In ICU patients except burn and trauma patients, additional enteral glutamine should not be administered.”

Our survey suggests that improvement may be expected to improve the use of glutamine in patients with trauma and severe wounds (see above paragraph ‘The ESPEN recommendations that should be implemented’).

Use of vitamins and trace elements

The ESPEN recommendations 34 and 35 state:

“- To enable substrate metabolism, micronutrients (i.e. trace elements and vitamins) should be provided daily with PN.

- Antioxidants as high dose monotherapy should not be administered without proven deficiency.”

Our survey suggests that the first recommendation is well implemented in the field. However, information to centres who are not experts in clinical nutrition is still needed, as other surveys have consistently shown that micronutrient prescription with PN is frequently missing [24-26]. It should also be noticed that the practices regarding the second recommendation were not evaluated by our survey.

Monitoring of the achievement of the nutritional goals and clinical and biological monitoring

The ESPEN recommendation 57 states: “In patients with refeeding hypophosphatemia energy supply should be restricted for 48 h and then gradually increased.”

Prevention of refeeding syndrome (RS) is a key part of ICU nutrition care, however, this guideline recommendation only considers the management of already established RS. RS is

reportedly underestimated at ICU admission [19]. ICU patients are often vulnerable (older, polymorbid, malnourished, sarcopenic), and with energy and phosphate deficit before their ICU admission. As a prevention, plasma potassium, phosphorus, and magnesium should be measured before and within 6h of commencing nutrition support and supplemented as needed [20].

Existence of specific protocols

The only grade B recommendation is for trauma patients (**recommendation 50**): “**Trauma patients should preferentially receive early EN instead of early PN.**”

No centre from our survey reported a specific nutrition protocol for trauma patients, because these patients are not constituting the majority of admissions. This recommendation is in line with the general recommendation of preferring EN to PN, in patients who are usually well tolerated EN. The application of this recommendation by trauma ICU centres would be easier by using a protocol.

The ESPEN recommendations that are optional

The ESPEN recommendations that are optional are the ones with the lowest level of evidence: those quoted ‘0’ or ‘good practice point (GPP)’ in the ESPEN guidelines on ICU clinical nutrition [1]. The decisions to implement these recommendations should be made taking into account scientific evidence, local practices and clinical judgment.

There were no ‘grade 0’ or ‘GPP’ recommendations for the following topics: ‘Continuous or intermittent enteral nutrition’

Nutritional screening and assessment

The ESPEN recommendations 1 and 2 state:

“- Medical nutrition therapy shall be considered for all patients staying in the ICU, mainly for more than 48 h

- A general clinical assessment should be performed to assess malnutrition in the ICU, until a specific tool has been validated.

Remark: General clinical assessment could include anamnesis, report of unintentional weight loss or decrease in physical performance before ICU admission, physical examination, general assessment of body composition, and muscle mass and strength, if possible.”

The ESPEN recommendations also contain the following statement 1:

“Every critically ill patient staying for more than 48 h in the ICU should be considered at risk for malnutrition.”

Our survey identified that practices regarding nutritional screening and assessment vary between centres. There is a lack of evidence regarding any beneficial impact of systematic nutritional screening and/or assessment on clinical outcome of ICU patients. However, evaluating nutritional status and low nutritional intakes may be useful to apply individualised nutritional strategies. For example, in the presence of malnutrition, delay in initiating nutritional support could have negative consequences on clinical outcome. Additionally, patients with a chronic disease (such as organ failure, obesity with body mass index ≥ 40 , type 2 diabetes or cancers), older people and/or polyopathologies are at high risk for malnutrition. These diseases often mask underlying protein malnutrition or sarcopenia. Malnutrition is a factor of poor prognosis and should therefore be actively investigated. Identifying malnutrition may also assist with identification of those patients at highest risk for RS [19,20]. Although there is no gold standard for diagnosing malnutrition in the critically ill, the GLIM has been validated in the intensive care setting [27]. By virtue of their illness, most critically ill patients meet at least one etiologic criteria and phenotypic criteria can be measured using

body mass index (BMI), weight loss or reduced muscle mass obtained by CT examination or bioimpedance analysis.

In the absence of being able to obtain a history from patients themselves, efforts should be made to obtain this from patient's relatives to determine recent weight loss before admission, and BMI. If possible, food intake before admission may also be quickly and easily assessed with semi-quantitative methods [28,29]. The research about the methods of body composition assessment, such as bioimpedance analysis or abdominal CT-scan, and measurement of muscle strength by handgrip dynamometry, require further development in the ICU.

Feeding route decision making, including the use of supplemental parenteral nutrition

The ESPEN recommendation 3 states: "Oral diet shall be preferred over EN or PN in critically ill patients who are able to eat."

In ICU patients who are able to eat, particular attention should be given to the monitoring of food intake. This can be done by using semi-quantitative methods [28,29], such as an analogue scale between 0 and 10/10 [28] or consumed portions (0, ¼, ½; 1) during the last lunch or dinner, as indicated in The NutritionDay survey [29]. A patient eating 50% or less of the served food [29] (<7/10 on an analogue visual scale of food intake [28]) is considered eating insufficiently and at risk for malnutrition. Patients managing less than 70% of their usual intake indicates nutrition risk [28]. In the ICU setting, a protein-energy enriched diet should be recommended [30]. The objective of the oral diet is to reach the energy target by day 4 as this is generally recommended with EN. If oral intake is insufficient to cover energy or protein needs, oral nutritional supplements or supplemental EN are advised [31].

The ESPEN recommendation 10 states: "Gastric access should be used as the standard approach to initiate EN."

Our survey indicates that this recommendation is well implemented.

The ESPEN recommendation 7 states: “Early and progressive PN can be provided instead of no nutrition in case of contraindications for EN in severely malnourished patients.”

Our survey did not interview the centres regarding the nutrition therapy in malnourished patients. Clearly there is a lack of scientific evidence in this area. However, it is logical to advise to not delay nutritional support in severely malnourished patients (see also the paragraph ‘nutritional screening and assessment’). In the past two years, meta-analyses have been published regarding the use of SPN in ICU patients. They conclude that, when EN fails to reach the nutritional requirements, SPN is safe and may be beneficial as it helps in decreasing nosocomial infections [14,32] and ICU mortality [33].

Use of early or late nutrition support

The ESPEN recommendations 44, 12, 20 & 21 states:

“- Early and progressive EN should be used in septic patients after hemodynamic stabilization. If contraindicated, EN should be replaced by progressive PN.

- In patients deemed to be at high risk for aspiration, postpyloric, mainly jejunal feeding can be performed.

- In patients who do not tolerate full dose EN during the first week in the ICU, the safety and benefits of initiating PN should be weighed on a case-by-case basis.

- PN should not be started until all strategies to maximize EN tolerance have been attempted.”

These recommendations are in lines with the grade A and B recommendations cited above (see paragraphs ‘Feeding route decision making, including the use of supplemental parenteral

nutrition / Use of early or late nutrition support'). The survey suggests that waiting for hemodynamic stabilization before starting nutritional support is the current practice. Our survey did not include any specific question about the most common EN feeding route used in patients at high risk for aspiration. But this is a well-known practical point [1,7].

As usually recommended in the ICU [1,7], PN is indicated whenever EN is not possible or contraindicated, or in addition to EN where it is insufficient (supplemental PN). PN should be prescribed on a case-by-case basis. PN prescriptions should be determined with the aim of avoiding overfeeding and hyperglycemia over 10 mmol/l [1,34].

Use of prokinetics

The ESPEN recommendation 14 states: “Alternatively, intravenous metoclopramide or a combination of metoclopramide and erythromycin can be used as a prokinetic therapy.”

The survey indicates that the practice is in accordance with this recommendation (see paragraph ‘use of prokinetics’ in the chapter ‘The ESPEN recommendations that are advised to implement’).

Determination of energy target

The ESPEN recommendations 16 and 18 state:

“- If IC is used, isocaloric nutrition rather than hypocaloric nutrition can be progressively implemented after the early phase of acute illness.

- After day 3, caloric delivery can be increased up to 80-100% of measured EE.”

As already mentioned (see paragraph ‘Determination of energy target’ in the chapter ‘The ESPEN recommendations that are advised to implement’), IC is the reference method to evaluate EE in the ICU. Therefore, EE measured by IC should be used as the target to be

achieved by day 4-6 according to patient tolerance. Efforts should be made to ensure the widest use of IC among ICUs worldwide.

Determination of protein target

The ESPEN recommendation 22 states: “During critical illness, 1.3 g/kg protein equivalents per day can be delivered progressively.”

Despite a low level of scientific evidence, our survey indicates that the use of this predictive equation to determine the protein target of ICU patients is well implemented. There is currently no universal validated method to measure the protein needs of ICU patients.

Additionally, commercial EN and PN solutions do not frequently meet the protein and energy needs of ICU patients. Collaboration with manufacturers of commercial EN and PN solutions should be pursued to improve the possibility of matching both energy and protein targets.

Future research is warranted to develop accurate methods of assessment of protein needs of ICU patients.

Use of urinary urea excretion. See the paragraph ‘specific protocols in obese patients’ below.

Use of lipid emulsions, including the use of omega-3 or -9 fatty acids

The ESPEN recommendations 24 and 25 state:

**“- The administration of intravenous lipid emulsions should be generally a part of PN.
- Intravenous lipid (including non-nutritional lipid sources) should not exceed 1.5 g lipids/kg/day and should be adapted to individual tolerance.”**

All the interviewed centres use all-in-one PN solutions that integrates the lipid emulsion, as recommended. There is no clear evidence that one lipid emulsion should be preferred to another. The potential benefit of using pharmacological doses of omega 3 polyunsaturated

fatty acids remains controversial [35-37]. It may depend on the patient clinical situations, and is not recommended on a systematic basis [1].

The specific question of the maximal infusion rate of lipids has not been addressed in our survey. However, using commercial PN solutions administered according to the energy target recommended by ESPEN makes it unlikely that the maximal infusion rate of lipids of 1.5 g lipids/kg/day is reached.

The ESPEN recommendations 31 and 33 state:

“- EN enriched with omega-3 fatty acids within nutritional doses can be administered. - Parenteral lipid emulsions enriched with eicosapentaenoic acid (EPA)/ docosahexaenoic acid (DHA) (fish oil dose 0.1-0.2 g/kg/d) can be provided in patients receiving PN.”

Our survey indicates a variety of practices regarding parenteral lipid emulsions enriched with EPA/ DHA (see paragraph ‘survey analysis’). This could be due to different expert opinions or that product markets differ between countries. Scientific knowledge is currently insufficient to advise the use of one lipid emulsion over another. Supplementation of EPA/DHA in critically ill enteral feeding has shown inconsistent improvements in PaO₂/FiO₂ [38]. Intravenously, numerous studies and meta-analysis have shown an improvement in ICU and hospital length of stay as well as in length of ventilation but not in mortality [36].

Use of glutamine

The ESPEN recommendation 27 states: “In critically ill trauma, additional EN doses of glutamine (0.2-0.3 g/kg/day) can be administered for the first five days with EN. In case of complicated wound healing it can be administered for a longer period of ten to 15 days.”

This recommendation specifies the unique indication of enteral glutamine in critically ill trauma patients. The experts of our ICU nutrition SIG do not use glutamine in their daily practice. Enteral glutamine is not available in every country, and therefore this recommendation is not applicable in most ICUs.

Use of vitamins and trace elements

The ESPEN recommendations 36 and 37 state:

“- In critically ill patients with measured low plasma levels (25-hydroxy-vitamin D < 12.5 ng/ml, or 50 nmol/l) vitamin D3 can be supplemented.

- In critically ill patients with measured low plasma levels (25-hydroxy-vitamin D < 12.5 ng/ml, or 50 nmol/l) a high dose of vitamin D3 (500,000 UI) as a single dose can be administered within a week after admission.”

These recommendations suggest the use of vitamin D in the ICU in patients with measured low plasma levels due to its immune enhancing properties, despite one trial suggesting no benefit [39,40]. Our survey did not address this specific question. The application of this recommendation is optional but it should be applied according to local practices and availabilities of routine vitamin D dosage. It remains to determine whether lower doses but more frequently administered vitamin D doses should have better efficiency than higher vitamin D doses [41].

Monitoring of the achievement of nutritional goals and clinical and biological monitoring

The ESPEN recommendations 55 and 56 state:

“- Electrolytes (potassium, magnesium, phosphate) should be measured at least once daily for the first week.

- In patients with refeeding hypophosphatemia (< 0.65 mmol/ l or a drop of > 0.16 mmol/l), electrolytes should be measured 2-3 times a day and supplemented if needed.”

Prevention of RS is an important part of the care provided to critically ill patients [1,19,20,42]. Although, most centres undertake clinical and biological monitoring in patients with PN. It is clear that education regarding the importance of monitoring and supplementing electrolytes, including phosphate, to prevent complications associated with RS is warranted [42].

Existence of specific protocols

Our survey results indicate that standard nutritional protocols for nutrition support (EN, PN) procedures and monitoring are implemented, but this is not necessarily the case for specific protocols:

**Glucose control / Insulinotherapy*

The ESPEN recommendations 23 and 53 state:

“- The amount of glucose (PN) or carbohydrates (EN) administered to ICU patients should not exceed 5 mg/kg/min.

- Blood glucose should be measured initially (after ICU admission or after artificial nutrition initiation) and at least every 4 h, for the first two days in general.”

The specific question of the maximal infusion rate of glucose was not addressed in our survey. As already mentioned, using commercial PN or EN solutions administered according to the energy target recommended by ESPEN means that the maximal glucose oxidation rate will not be exceeded. Monitoring of blood glucose is a key part of the ICU management. In our survey, insulinotherapy and glucose control protocols are active in only three centres which is surprising. The interval of blood glucose measurement in the ICU is determined according to simple local protocols that need to be widely implemented. The ICU nurses play

a pivotal role to get the protocol daily and timely applied and the glucose control optimized. Indeed a protocol based on actions at the initiative of physicians would be associated with delay in insulin dose adjustments and suboptimal glucose control. The use of systems based on closed loop machines could improve the glucose control [43].

** Surgical, including transplanted, patients*

The ESPEN recommendations 45 to 49 state:

“- In patients after abdominal or esophageal surgery, early EN can be preferred over delayed EN.

- In critically ill patients with surgical complications after abdominal or esophageal surgery and unable to eat orally, EN (rather than PN) should be preferred unless discontinuity or obstruction of GI tract, or abdominal compartment syndrome is present.

- In the case of an unrepaired anastomotic leak, internal or external fistula, a feeding access distal to the defect should be aimed for to administer EN.

- In the case of an unrepaired anastomotic leak, internal or external fistula, or if distal feeding access is not achieved, EN should be withheld and PN may be commenced.

- In case of high output stoma or fistula, the appropriateness of chyme reinfusion or enteroclysis should be evaluated and performed if adequate.”

Our survey indicates that no centre has dedicated protocols for surgical patients, except two for transplanted patients (liver and kidney). The two first recommendations are in line with those previously commented about the feeding route decision-making / use of early or late nutrition support. The three other recommendations provide advice for indications for distal feeding in intestinal failure. These recommendations are line with already published

consensus by the ESPEN SIG on acute intestinal failure [44,45]. For patients for whom distal feeding could not be initiated or is insufficient to cover nutritional needs, PN is indicated.

**Obese patients*

The ESPEN recommendations 51 and 52 state:

“- An iso-caloric high protein diet can be administered to obese patients, preferentially guided by indirect calorimetry measurements and urinary nitrogen losses.

- In obese patients, energy intake should be guided by indirect calorimetry. Protein delivery should be guided by urinary nitrogen losses or lean body mass determination (using CT or other tools).

If indirect calorimetry is not available, energy intake can be based on “adjusted body weight”. If urinary nitrogen losses or lean body mass determination are not available, protein intake can be 1.3 g/kg “adjusted body weight”/day.”

In our survey, more than the half of the experts report using an adjusted body weight to estimate energy and protein targets of ICU obese patients. No SIG expert mentioned having a specific protocol dedicated to the nutrition support of obese ICU patients. Given the increased prevalence of obesity [46] and the increased protein catabolism as compared with non-obese patients [47], it may be useful to implement an individualized approach of energy and protein based on IC in order to avoid restrictive and hypocaloric nutrition [48,49] in obese patients obese patients, rather than a protocol which is more a ‘one size fits all’ interim approach.

**Non-intubated patients*

The ESPEN recommendations 41 to 43 state:

“- In non-intubated patients not reaching the energy target with an oral diet, oral nutritional supplements should be considered first and then EN.

- In non-intubated patients with dysphagia, texture-adapted food can be considered. If swallowing is proven unsafe, EN should be administered.

- In non-intubated patients with dysphagia and a very high aspiration risk, postpyloric EN or, if not possible, temporary PN during swallowing training with removed nasoenteral tube can be performed.”

This is an important issue as the risk of malnutrition is high in non-intubated patients, however, research traditionally focuses on intubated patients in the ICU. Even if these patients are able to eat, the risk that they do not reach their nutritional needs is high. As recommended for every hospitalized patient [1,31], nutritional support, oral nutritional supplements, or if insufficient, EN, as first lines, should be proposed in patients who are not eating sufficiently. In most patients, EN should be continued as patients are transitioned to oral to cover their protein-energy needs. After extubation, the nutritional support is promoting patient's recovery and rehabilitation, and should be continued until the patient resumes sufficient oral intake.

Only one expert of our ICU SIG reports having a protocol to address the provision of nutrition support after extubation. But, this does not mean that these patients are not reviewed by other centres as part of their daily workload. Post-extubation swallowing disorders are frequent and reported in 10 to 67% of patients [50]. This increases the risk of insufficient oral intake and therefore malnutrition. After extubation, approximately 24% of elderly patients require EN in addition to their oral food intake [1]. There is a need to implement specific protocols and strategies for feeding the non-intubated, ICU patient. ESPEN recommendations [1] and a recent publication from our group in the setting on Covid-19 [51] are proposing some strategies that could be applied to every ICU patient.

Use of physical activity

The ESPEN statement 3 states: “Physical activity may improve the beneficial effects of nutritional therapy.”

Our survey indicates that physical activity is far to be implemented in all ICUs. In addition to the lack of scientific evidence, the lack of manpower allocated to physical activity in the ICU, i.e. physiotherapists, physical activity educators..., is one of the most frequent reported limitations. Physical activity should be promoted in the ICU. Depending on the individual clinical condition, early mobilization at bedside will be encouraged as an approach to preserve muscle mass and function. Early goal-directed mobilization has been shown effective to improve patients' mobility level in the ICU, functional mobility at hospital discharge and length of stay in the ICU [52]. Further, there are indications that additional muscle activating measures, such as neuromuscular electrical stimulation, preserve muscle mass and prevent atrophy [53]. High protein delivery combined with early electrical muscle stimulation was associated with less muscle volume loss in critically ill patients [54]. Early advanced physiotherapy measures, by twice daily sessions of manual physiotherapy and 30-minutes passive/active cycling therapy, preserved muscle fiber cross sectional area in septic shock patients [55]. Muscular activation may stimulate exercise induced glucose uptake by GLUT4 [56] and reduce stress-induced hyperglycemia. However, a higher duration of muscle activation had no impact on insulin sensitivity in a recently published study [57]. Moreover, early mobilization has the potential to strengthen patients' autonomy. In elderly ICU survivors, out of bed mobilization during ICU stay was associated with a lower risk for decreased autonomy after 6 months [58]. In addition, early mobilization may show direct clinical benefits on comorbidities, for example, the reduction of anxiety, mood disorders, deep venous thrombosis, pressure ulcer or atelectasis [59]. However, clear evidence on outcome improvement by early mobilization remains rare. On the other hand, all these benefits pertain to a small number of trials that use different early mobilization protocols as well as outcome

parameters, which limits the comparability and explains recent efforts to define core outcome sets. Especially, time of initiation and dosage seems to be an important parameter when it comes to beneficial effects of early mobilization and there appears to be a great heterogeneity between trials and needs to be defined and reported better in the future [52,53].

Early mobilization protocols should be adapted to the patient's capacity for autonomy.

Protocols with information on feasible procedures and stepwise intensification according to the patients' condition can support physiotherapists to establish standardized approaches.

Protocols should include a daily mobilization target, to be defined in the morning ward rounds (level 0=no mobilization, level 1=passive range of motion exercise, level 2=sitting, level 3=standing, level 4=ambulation) and include safety criteria to advance mobilization. A facilitated inter-professional communication structure is essential to address barriers and implement the goal across shifts. Bed-side signs with mobility targets may be supportive [52].

How to improve implementation of the guidelines?

Several points may be improved to ensure the widest implementation of the ESPEN guidelines on ICU clinical nutrition [1]:- As the ESPEN guidelines are little followed by selected expert professionals, the situation might be worse on a large scale. Therefore, communication and dissemination should be improved through social media, dedicated apps targeted to ICU professionals; they could be made through selected information, illustrated by practical clinical cases, on a weekly or monthly basis. This information should be translated into different languages to make them available to a wider range of clinicians.

- Methods to assess the nutritional status (e.g. muscle mass assessment by bioimpedance analysis, CT-scan, ultrasound) or energy expenditure (indirect calorimetry), should be better known and handled by the ICU professionals on the field; the industrial companies should be

involved in the diffusion of the different techniques to make them the easiest to do and the cheapest in the daily practice.

- More research on ICU clinical nutrition and metabolism is needed, especially prospective randomized controlled trials, to increase the levels of evidence of the guideline. There are still a lack of high level studies, so that the number of grade A (n=4/57, 7%) and B (n=19/57, 33%) recommendations is poor (23/57, 40%). New emerging areas, such as protein target, nutritional strategy in non-intubated patients, monitoring, and physical activity, deserve dedicated studies. Also, the origin of the high variability in clinical nutrition practice that may be related to either strong beliefs or confusing messages from key opinion leader and scientific societies when strong evidence for many aspects is not available should be scientifically investigated.

- Each ICU should make available dedicated nutritional protocols to better sensitize their personal to the importance of nutritional therapy at the same levels that they are doing for hemodynamics, renal or respiratory fields. The use of dedicated EN, PN, or combined EN+PN protocols based on the nurse appreciation and intervention should be more efficient than protocols based on physician prescriptions. Indeed, the latter are more frequently associated with delay in nutrition therapy optimization. To implement this strategy of nutrition therapy protocolization from the bottom to the top, there is a need of specifically trained ICU nurses in all our ICUs. Also, ideally, the protocols should be adapted for specific situations, such as for glucose control and insulinotherapy, surgical, including transplanted, obese, non-intubated, or trauma patients. Educational interventions such as the Long Life Learning program of ESPEN may consider using core elements of guidelines as discussed in this paper to promote simplified core nutrition protocols.

- The better applications of clinical nutrition guidelines should go through the improvement of nutrition teaching at the university level in European medicine schools, and then selectively intensified at the specialty level for residents and graduated physicians.

Conclusion

Optimized nutrition care of the ICU patients is important to maintain GI tract function, sustain immune defences, prevent malnutrition and its worsening, and avoid severe loss of muscle mass and function. The latter is crucial to promote short and long-term recovery. Therefore, the implementation of guideline A and B recommendations on ICU clinical nutrition should be considered mandatory. Randomized controlled trials in the area of ICU nutrition remain strongly needed. The improvement of ICU nurse training on nutrition is pivotal to ensure adherence to nutrition protocols. The ESPEN community should contribute to these; these are the main goals of the new created ESPEN SIG on ICU nutrition. This is the only way to enrich our knowledge about metabolism and nutrition of the ICU patient, to adapt the nutrition support strategy to the patient, and to improve the scientific evidence and the grade of the recommendations.

Declarations

Ethical Approval and Consent to participate

Not applicable

Consent for publication

Not applicable

Availability of supporting data

Not applicable

Competing interests

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Authors ' contributions

Ronan Thibault, Elisabeth de Waele, and Pierre Singer set up the survey. Ronan Thibault, Danielle E. Bear, Arabella Fischer, Juan Carlos Montejo Gonzalez, Péter Tamási, Mehmet Uyar, Elisabeth de Waele, and Pierre Singer answered the survey. Ronan Thibault analysed the survey. Ronan Thibault, Danielle E. Bear, Arabella Fischer, Michael Hiesmayr, Steffen Weber-Carstens and Pierre Singer drafted the article. All the authors revised the article and approved the final version.

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Authors' information

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1 **Table 1 – The recommendations (R) of the ESPEN guideline on clinical nutrition in the intensive care unit [1], grouped by topics, that**
 2 **are needed to be implemented, advised, or optional, and proposals for improving their implementation.** BIA, bioimpedance analysis; CT,
 3 computed tomography; EMF, electronic medical file; EN, enteral nutrition; GLIM, Global Leadership Initiative on Malnutrition; NRS,
 4 Nutritional Risk Screening; PRCT, prospective randomized controlled trials; SGA, Subjective Global Assessment.

5

| Topics | Needed to be implemented (grade A recommendations) | Advised (grade B recommendations) | Optional according to local practices and availabilities (other grade recommendations) | How to improve/promote the implementation | Who should make it? |
|--------------------------------------|--|-----------------------------------|--|--|----------------------------------|
| Nutritional screening and assessment | - | - | R 1 & 2 | <ul style="list-style-type: none"> - Increased awareness towards the useable tools (GLIM procedure; nutritional screening tools: NRS-2002 / SGA, muscle mass/fat-free mass assessed by BIA (+phase angle), muscle echography, CT scan, muscle function assessment according to the centre protocols - Implement the systematic use of); implement relatives' interview about usual weight and food intake before admission; - Promotion of PRCT - Attribute financial resources for buying the nutritional tools | Intensivists, dietitians, nurses |

| | | | | | |
|--|-------|--------------|----------------------------|--|--------------------------------------|
| | | | | | Intensivists Administrative staff |
| Feeding route decision making / Use of early or late nutrition support | R 5,8 | R 38-40 | R 3, 7, 10, 12, 20, 21, 44 | Multi-professional team meetings for protocol writing for early enteral feeding | Intensivists, dietitians, nurses |
| Continuous or intermittent enteral nutrition | - | R 9 | - | Multi-professional team meetings for protocol writing | Intensivists, dietitians, nurses |
| Use of prokinetics | - | R 11,13 | R 14 | Multi-professional team meetings for protocol writing; in case of gastrointestinal intolerance; systematic measure of gastric residual volumes is optional | Intensivists, dietitians, nurses |
| Use of supplemental parenteral nutrition | - | R 6 | - | Multi-professional team meetings for protocol writing: through a central venous route, between days 4 to 7, when target is not reached on day 4 by enteral route | Intensivists, dietitians, nurses |
| Determination of energy target | - | R 15, 17, 19 | R 16, 18 | <ul style="list-style-type: none"> - Increase the intensivist, dietitian, and ICU teams awareness towards indirect calorimetry and predictive equations - Systematic calculation of predictive equations in the EMF - Multi-professional team meetings for protocol writing - Promote PRCT Financial plan for indirect calorimeter | Intensivists, dietitians, nurses |

| | | | | | |
|--|------|----------|------------------|---|---|
| | | | | | Intensivists Administrative staff |
| Determination of protein target | - | - | R 22 | <ul style="list-style-type: none"> - Increase the intensivist, dietitian, and ICU teams awareness towards predictive equations - Systematic calculation of the predictive equation (1.3 g/kg/day) in the EMF - Multi-professional team meetings for protocol writing - Promote PRCT | Intensivists, dietitians, nurses |
| Use of urinary urea excretion | - | - | R 51, 52 | <ul style="list-style-type: none"> Increase the intensivist and ICU teams awareness - Protocols for obese patients or long stayers | Intensivists for prescription, dietitians for calculation |
| Use of lipid emulsions, including omega-3 or 9 fatty acids | - | R 30, 32 | R 24, 25, 31, 33 | ICU team selection of the available hospital products | Intensivists, pharmacists |
| Use of glutamine | R 29 | R 26, 28 | R 27 | To improve knowledge regarding the indications and contraindications | Intensivists, pharmacists |
| Use of vitamins and trace elements | - | R 34, 35 | R 36, 37 | <ul style="list-style-type: none"> - To improve knowledge regarding the indications (should be (systematic if PN and when EN is <1500 kcal/day) - Team meetings for protocol writing | Intensivists, dietitians, nurses |
| Monitoring of the achievement of the nutritional goals | - | - | - | <ul style="list-style-type: none"> - Systematic calculation by EMF based on the collected information, including the intentional and non-intentional (propofol, glucose,...) calories – Increase the awareness of intensivists towards the nutrition support adaptation - Attribute financial resources for hiring physiotherapists | Intensivists, nurses, dietitians |

| | | | | | |
|--|---|-----------------------|---|---|--|
| | | | | | Administrative staff, hospital directors |
| Clinical and biological monitoring | - | R 57 | R 55, 56 | - Increase the awareness of intensivists about the risk of refeeding syndrome - Multi-professional team meetings for protocol writing | Intensivists, dietitians, nurses |
| Existence of specific protocols (e.g. for glucose control and insulinotherapy, surgical, including transplanted, obese, non-intubated, or trauma patients) | Glucose control and insulinotherapy: R 54 | Trauma patients: R 50 | - Glucose control and insulinotherapy: R 23, 53 - Surgical, including transplanted patients: R 45, 49 - Obese patients: R 51, 52 - Non-intubated patients: R 41-43 | - Multi-professional team meetings for protocol writing according to the ICU specificity. - A dedicated protocol to adapt the nutrition therapy for obese ICU patients is advised. | Intensivists, dietitians, nurses |
| Use of physical activity | - | - | R 3 | - Increase the intensivist awareness - - Protocols for active and passive mobilization whenever possible - Promotion of PRCT - Attribute financial resources for hiring physiotherapists | Intensivists, physiotherapists Intensivists Administrative staff, hospital directors |
| <p>In addition to a dedicated ICU dietitian, all ICU team should work with at least one physician with an expertise in the field of clinical nutrition , in order to ensure the best application of the recommendations into daily practice, promote teaching of clinical nutrition in the ICU and of ICU nutrition among nutrition and medicine schools.</p> <p>The physician could be an intensivist, working in collaboration with the hospital nutrition support team (NST).</p> | | | | | |

7 **Supplementary Tables**

8

9 **Supplementary Table 1 – Sheet of the survey sent to all the core members of the**
 10 **European Society for Clinical nutrition and metabolism (ESPEN) specific interest group**
 11 **on intensive care unit (ICU) clinical nutrition.** The members were asked to give their input
 12 regarding their own daily practices in the different topics addressed by the ESPEN guideline
 13 on clinical nutrition published in 2019 [1].

| What | How | When | By who | Where noted | Comments |
|--|-----|------|--------|-------------|----------|
| Nutritional screening | | | | | |
| Nutritional assessment | | | | | |
| Feeding route decision making | | | | | |
| Use of early or late nutrition support | | | | | |
| Continuous or intermittent enteral nutrition | | | | | |
| Use of prokinetics | | | | | |
| Use of supplemental parenteral nutrition | | | | | |
| Determination of energy target | | | | | |
| Determination of protein target | | | | | |
| Use of urinary urea excretion | | | | | |
| Use of lipid emulsions, including omega-3 or -9 fatty acids | | | | | |
| Use of glutamine | | | | | |
| Use of vitamins and trace elements | | | | | |
| Monitoring of the achievement of the nutritional goals, and clinical and biological monitoring | | | | | |
| Existence of specific protocols (e.g. for glucose control and insulinotherapy, surgical, including transplanted, obese, non-intubated, or trauma patients) | | | | | |
| Use of physical activity | | | | | |

14

15 **Supplementary Table 2 – Survey answers of the core members of the European Society for Clinical nutrition and metabolism (ESPEN)**
 16 **specific interest group on intensive care unit (ICU) clinical nutrition.** The members were asked to give their input regarding their own daily
 17 practices in the different topics addressed by the ESPEN guideline on clinical nutrition published in 2019 [1].

| What | How | When | By who | Where noted | Comments |
|------------------------------|---|---|---|---------------------|--|
| Nutritional screening | NRS2002 (EW) | At admission | ICU dietitians | EMF | Special tool in electronic medical file which makes filling in easier (eg body weight loss is calculated automatically when you report BW 12, 6 months and 3 and actual) |
| | No screening tool used, but all mechanically ventilated patients reviewed by dietitian within 48-72 hours of admission (DB) | Within 48-72 hours of admission | ICU dietitians | EMF | - |
| | No use of NRS-2002, or any screening tool (RT) | Empirical based on physical examination | Absence of ICU dietitian full time making the assessment non protocolized | EMF since only 2021 | Body weight is collected every day but more with the objective of fluid hydration status assessment |
| | None (JCMG) | - | - | - | - |
| | NRS2002 (MU) | At admission | Physician, dietitian unavailable in ICU | EMF | NRS-2002 calculation integrated into EMF |

| | | | | | |
|-------------------------------|--|----------------------------|--|-----|---|
| | Computerized for MUST (PS) | Within 48 hours | Dietitians | EMF | - |
| | SGA (PT) | Not regularly at admission | ICU physicians | EMF | - |
| | NRS2002 (AF) | Not done | - | - | - |
| Nutritional assessment | Anamnesis (body weight and physical function) (EW) | First 3 days | Treating MD to relatives Dietitians | EMF | - |
| | GLIM (EW) | At admission | ICU dietitians | EMF | - |
| | GLIM not implemented (RT, AF, MU) | - | - | - | - |
| | Anamnesis (body weight and physical function) (RT) | Not implemented | - | - | Body weight is collected every day but more with the objective of fluid hydration status assessment than the nutritional assessment |
| | Anamnesis (body weight and physical function) (JCMG) | First 3 days | ICU MDs | EMF | - |
| | Anamnesis (body weight and physical function) (PT) | First day | Treating MD | EMF | - |

| | | | | |
|--|--|-------------------------------|-----|--|
| Anamnesis (body weight and physical function) (AF) | Preoperative | Treating MD | EMF | - |
| Body weight (DB) | Usually estimated on admission, but aim for weekly weight thereafter | Nursing staff/physiotherapist | EMF | Some beds have scales, but not always 'zeroed' prior to patient being admitted. Obvious confounder of fluid. |
| Physical examination (EW) | First 3 days | Treating MD | EMF | MD's get training how to recognize muscle loss etc |
| Physical examination (DB) | 48-72 hours after ICU admission and then weekly | Dietitians | EMF | Physical examination similar to SGA used, but without the scoring. Ulna length/MUAC may be used if appropriate |
| Physical examination (RT) | First 3 days | Treating MD | EMF | MDs are not trained how to recognize muscle loss: to be done! |
| Physical examination (JCMG) | First 3 days | ICU MDs | EMF | - |
| Physical examination (PT) | First day | Treating MD | EMF | - |
| Physical examination (AF) | At admission | Treating MD | EMF | - |

| | | | | |
|---|--|----------------|--------------------------------------|--|
| Predictive equations (DB) | 48-72 hours after ICU admission and then minimum weekly if Penn state used or if new weight acquired | Dietitians | EMF | Modified Penn State used in most mechanically ventilated patients. Weight based equation used in ECMO patients |
| Energy expenditure predictive equations (RT) | ESPEN guidelines: 25 kcal/kg/day at D4 | Treating MD | Not noted; to be done in the new EMF | - |
| Muscle Echography to measure Rectus femoris cross-sectional area (DB) | Research purposes only | Dietitian | Study file | - |
| Body composition (EW) | On day 3 (max 3+2 if day 3 = weekend) | ICU dietitians | EMF | Not in case of restricted therapy |
| Body composition (PT) | Not performed | - | Body composition | To be implemented |
| Body composition (AF) | In study context | Treating MD | - | - |

| | | | | |
|--|---|---|------------------|-------------------|
| Muscle mass (EW) | In study context | - | - | - |
| Muscle mass (PT) | - | Treating MD | EMF | Only estimation |
| Muscle mass (AF) | In study context | Treating MD | - | - |
| Bioimpedance analysis (DB) | About to start a trial of using this on step down to the ward to implement GLIM | Dietitian/Dietetic assistant | EMF | - |
| Body composition (RT) | On days 1 to 3 including BIA phase angle | Absence of ICU dietitian full time making the assessment non protocolized | - | To be implemented |
| Medical history including body weight (MU) | At admission | Physician | EMF | - |
| Measurement of patient height to estimate ideal body weight (MU) | At admission | Nurse | EMF | - |
| Physical exam (MU) | At admission | Physician | EMF | - |
| GLIM (PS) | Within 48 h | Dietitian | EMF problem list | - |

| | | | | | |
|--------------------------------------|---|---|---|-----|---|
| Feeding route decision making | By protocol NGT at admission when LOS >2 days (not cardiac or brain surgery) (EW) | Every day after lookback on last 24hours: if GE not enough SPN is started | ICU dietitians + treating or supervising MD's | - | Every day ICU dietitians go bedside to give feedback on last 24h intake adequacy and talk to treating MD and nurses |
| | By protocol NGT at admission for all patients expected to be ventilated more than 48 hours (DB) | Dietitians screen patients daily for any tolerance concerns | Dietitian/Medical team | EMF | Dietitian screens patients daily and raises any concerns to medical team. Energy and protein balances calculated minimum weekly to aid decision making. |
| | By protocol NGT at admission when length of stay >2 days (RT) | Every day after lookback on last 24hours: if EN<60% of target, SPN is started between day 4 & 7 | Treating or supervising MD's | EMF | Every day, ICU dietitians go bedside to give feedback on last 24h intake adequacy and talk to treating MD and nurses |
| | By protocol NGT at admission in intubated patients (JCMG) | Every day in clinical round. SPN is started if caloric intake by EN is below 70% of prescribed | ICU MDs | EMF | - |

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|---|--|---|--|-----|---|
| | Routine NGT for ventilated and unconscious patients (MU) | At admission | Physician | EMF | - |
| | Enteral first NGT by protocol (PS) | Within 24 h | Physician | EMF | EN preferred |
| | NGT at admission (PT) | Every day after lookback on last 24hours: if EN<60% of target, SPN is started | Treating or supervising MDs | | Every day ICU physicians go bedside to give feedback on last 24h intake using notes of nurses |
| | By protocol: start minimal enteral nutrition (AF) | When ICU LOS >24h | Treating MD | EMF | - |
| Use of early or late nutrition support | By protocol: start in first 48h (EW) | Decision making on day 1. | ICU dietitians + treating or supervising MDs | EMF | The objective is to be on target by day 4, so late nutrition support does rarely exist |
| | Early - enteral feeding to start within 48 hours (DB) | Decision making on day 1 | Medical team | EMF | Aim for target feeding by day 3 (first point of dietetic assessment) |
| | By protocol: start in first 48h (RT) | Decision making on day 1 | Treating or supervising MDs | EMF | The objective is to be on target by day 4, so late nutrition support does rarely exist |

| | | | | | | |
|---|--|--------------------------|-----------------------------|-----|--|---|
| | By protocol: start in first 48h (JCMG) | Decision making on day 1 | ICU MDs | EMF | The objective is to be on target by day 3 | |
| | Within 48h After hemodynamic stabilization (MU) | Daily clinical round | Physician | EMF | Usually start with 20 mL/h and increase to reach the target on day4 | |
| | Early preferred (PS) | Within 24-48 h | Physician | EMF | - | |
| | Start on 2nd day (PT) | decision making on day 2 | Treating or supervising MDs | EMF | The objective is to be on target by day 4, so late nutrition support does rarely exist | |
| | By protocol: start after first 24h (AF) | | Treating MD | EMF | | |
| Continuous or intermittent enteral nutrition | Continuous (EW) | | ICU nurses | - | - | |
| | Continuous (DB) | - | | - | - | |
| | Continuous (RT) | - | | - | - | |
| | Continuous (JCMG) | - | | - | - | |
| | Continuous (MU) | - | | - | - | |
| | Continuous always (PS) | From the start | | | EMF | - |
| | Continuous feeding (gastric and postpyloric), with regular measurement of GRV, | - | | | - | - |

| | | | | | |
|---------------------------|---|--------------------------------------|--|-----|---|
| | and adjusting the volume accordingly (PT) | | | | |
| | Continuous for 20h per day. Pause for 2 hours in the morning and for 2 hours in the evening to check for GRV (AF) | - | | - | |
| Use of prokinetics | By protocol: when GI intolerance we start, combining erythromycin and metoclopramide (EW) | GE intolerance | ICU dietitians + treating or supervising MDs | EMF | - |
| | By protocol: metoclopramide 1 st line, erythromycin second line (DB) | GI intolerance (GRV >300ml/ 4 hours) | Dietitians/medical team | EMF | By protocol: metoclopramide 1 st line, erythromycin second line. Post-pyloric feeding if high GRV persists for 3 days. |
| | By protocol: when GI intolerance we start, combining erythromycin and metoclopramide (RT) | GI intolerance | Treating or supervising MDs | EMF | - |
| | By protocol: when GI intolerance we start metoclopramide. In case of persistence we combine erythromycin | GI intolerance | ICU MDs | EMF | - |

| | | | | | |
|---|--|---|---------------------------------|-----|-------------------------|
| | and metoclopramide (JCMG) | | | | |
| | Metoclopramide by protocol (erythromycin unavailable) (MU) | According to gastric residual volumes | Nurse | EMF | GRV measured every 8 hr |
| | If GRV > 500 ml (PS) | Any time | Physician | EMF | Erythromycine preferred |
| | When GE intolerance we start metoclopramide + erythromycin sometimes (PT) | GE intolerance | Treating or supervising MDs | EMF | - |
| | By protocol: if > 400 ml GRV/24h: start of erythromycine and metoclopramide (AF) | GE intolerance | Treating or supervising MD | EMF | - |
| Use of supplemental parenteral nutrition | Central line (EW) | When target is not reached on day 4 by EN | ICU dietitians + MDs and nurses | - | - |

| | | | | | |
|--|--------------------------|---|----------------|-----|--|
| | Central venous line (DB) | When weaning from PN to EN | Dietitians | EMF | We do not typically use SPN in the true sense. When starting PN would we always try to keep some trophic feeding going. SPN usually occurs by default when weaning off PN back to EN |
| | Central venous line (RT) | When target is not reached on day 4 by EN | MDs and nurses | EMF | - |
| | Central line (JCMG) | When target is not reached on day 4 by EN | ICU MDs | EMF | |

| | | | | |
|---------------------------|---|-----------------------------------|-----|---|
| Usually central line (MU) | When enteral target is below 60% on day 4 | Physician and nurse | EMF | - |
| Ready to use bag (PS) | Not reaching target with enteral feeding | Physician pharmacist dietician | EMF | - |
| Central line (PT) | When target is not reached on day 4 by EN | Treating MD's | - | - |

| | | | | | |
|---------------------------------------|---|---|---|--------------------------------|--|
| | | Central line (AF) | - When targets cannot be reached with EN: we start PN it from day 2 onwards if goals are not met by EN (first ICU day is counted as day 0) -when an awake patient has problems with swallowing and does not tolerate a gastric feeding tube: we also apply PN | Treating or supervising MD | |
| Determination of energy target | Indirect calorimetry or 25 kcal/kg/day adjusted BW (EW) | Day 1 of ICU stay: plan is developed with targets defined on day 3 (max 3+2 if D3= week-end) repeated on day 7 or in changed clinical context | Dietitians ICU or some MD's | EMF | We start with 25kcal/g/day and perform IC at latest day 3 because we want to be on target by day 4 |
| | Penn state for ventilated non-ECMO, 20-25 | 48-72 hours after ICU | Dietitians | Penn state for ventilated non- | 48-72 hours after ICU admission and then minimum |

| | | | | |
|---|--|--------------|---|--|
| kcal/kg for ECMO (Adjusted body weight if overweight/obese) (DB) | admission and then minimum weekly if Penn state used or if new weight acquired | | ECMO, 20-25 kcal/kg for ECMO (Adjusted body weight if overweight/obese) | weekly if Penn state used or if new weight acquired |
| Energy expenditure predictive equations: ESPEN 20-25 kcal/kg usual or adjusted BW /day - indirect calorimetry device not available (RT) | Day 2 of ICU stay | Some MDs | Not noted; to be done in the future ICU-dedicated EMF | We start with 8, 15 at day 2, 20 at day 3 to reach 25kcal/kg/day at day 4 |
| Indirect calorimetry or 20 kcal/kg/day usual BW (non obese) or adjusted BW (obese) (JCMG) | After patient stabilisation | Some ICU MDs | | |
| Predictive equations (DB) | 48-72 hours after ICU admission and then minimum weekly if Penn state used or if new weight acquired | Dietitians | EMF | Modified Penn State used in most mechanically ventilated patients. Weight based equation used in ECMO patients |

| | | | | |
|---|---|-------------------------------|-----|---|
| Indirect calorimetry (DB) | Around day 3 in eligible patients, and then weekly | Dietitian | EMF | - |
| Indirect calorimetry for ventilated patients or 25 kcal/kg/day for non-ventilated (MU) | First 3 days and repeated weekly | Physician | EMF | After hemodynamic and metabolic stabilization |
| Occasionally indirect calorimetry or Occasionally CO ₂ production (VCO ₂ (ml/min)) on ventilator: according to modified Weir equation [#] Or 20-25 kcal/kg/d or 1 kcal/kg/h (AF) | Occasionally or in study context | Treating MD | EMF | - |
| Indirect calorimetry as possible If not, Faisy predictive equations: 30% day 1, 50% day 2, 70% day 3 and increase to 100% (PS) | Within 48 h and redone if patient changing condition or every week if patient stable | Physician, nurse or dietician | EMF | Respecting limitations and preventing overfeeding |

| | | | | | |
|--|---|---|---------------------------|--|---|
| | 25 kcal/kg/day adjusted BW – indirect calorimetry device not available (PT) | Day 2 of ICU stay plan is developed with targets defined | Treating MDs | - | We start with 15kcal/kg/day, and aim to reach the target 25 kcal/kg/day on day 4 |
| Determination of protein target | 1.3 g/kg BW/day adjusted BW (EW) | Day 1 of ICU stay plan is developed with targets defined | ICU dietitians and/or MDs | - | Rotating MDs get training in ICU nutrition and how to use the tool. once they know, they are tested on the plans they develop |
| | Minimum 1.2 g/kg BW/day (IBW if overweight or obese) (DB) | 48-72 hours after ICU admission | Dietitians | Minimum 1.2 g/kg BW/day (IBW if overweight or obese) | 48-72 hours after ICU admission |
| | 1.3 g/kg BW/day adjusted BW (RT) | Day 2 of ICU stay | Some MDs | - | - |
| | 1.3 g/kg BW/day usual BW (non obese) or adjusted BW (obese) (JCMG) | After patient stabilisation and start of nutrition protocol | ICU MDs | - | - |
| | 1.3 g/kg/day (MU) | Within 48h | Physician | EMF | Modular protein supplement if protein intake inadequate |
| | 1.3 g/kg/day (PS) | Within 72 h | Physician-dietician | EMF | Use of supplemental amino acid powder if needed |

| | | | | | |
|--------------------------------------|--|--|----------------------------|----------|---|
| | 1.3 g/kg BW/day adjusted BW (PT) | day 2 of ICU stay plan is developed with targets defined | Treating MDs | - | Rotating MD's get training in ICU nutrition |
| | 1.3 g/kg/day (adjusted body weight) (AF) | Plan developed within 48h | Treating or supervising MD | - | We often observed that more protein leads to more urinary nitrogen losses in patients with CKD staying in the ICU longer than 14 days. If a patient has increasing urinary nitrogen losses and increasing BUN over several days, some physicians decrease protein target in these patients. |
| Use of urinary urea excretion | 24h collection (EW) | In study context or on indication (long stayers, ...) | ICU dietitians and/or MD's | - | - |
| | Not done (DB) | - | - | Not done | - |
| | 24h collection (RT) | In study context or on indication (long stayers, ...) | MDs | - | - |

| | | | | | |
|--|--|------------------------------------|---|----------|---|
| | Not done (JCMG) | - | - | Not done | |
| | 24h collection (MU) | In study context or on indication | Physician and nurse | EMF | - |
| | Total urine collection (PS) | Unfrequent, for research purposes | Nurse | EMF | - |
| | Urinary N2 excretion (PT) | Not performed | | | |
| | 24h collection occasionally protein loss is calculated: protein loss (g/24h)=urinary urea in g/L / 2,14 x (24h urine volume) x 6,25 alternatively, Bistran's Equation for metabolic protein requirement (g/day): 24-h urinary urea (mmol/day) × 0.028 × 100/16 + 25 (AF) | Daily | Treating or supervising MD | EMF | |
| Use of lipid emulsions, including omega-3 or -9 fatty acids | In ready to use bags (EW) | On indication protocol is deviated | Supervising MD (myself as nutrition expert) | EMF | |

| | | | | |
|--|---|---|-----|---|
| In ready to use bags (triple chamber bags) (DB) | When PN required | Dietitians | EMF | Dietitians determine requirements, pharmacist checks stability, medical team prescribe, nurses administer |
| In ready to use bags (all-in-one tricompartmentalized solutions) (Baxter Olimel, olive oil) (RT) | Rare use of omega3 emulsions (Omegaven) | If so supervision by myself as nutrition expert | EMF | - |
| In ready to use bags or in Hospital Pharmacy compounded bags (JCMG) | In all PN prescribed | Some ICU MD's | EMF | |
| All-in-one bags (MU) | When PN indicated | Supervising physician | EMF | Supplemental omega-3 in surgical patients |
| Ready to use bags (PS) | As needed when PN is used. No n-6 | Physician pharmacist dietician | EMF | |
| All in one bags (PT) | On indication (almost always) | Supervising MD | EMF | |
| Omegaven and all-in-one PN (for example: Nutriflex omega special, Smofkaviben N-plus central) (AF) | When PN indicated | Supervising physician | EMF | Supplemental omega-3 in surgical patients |

| | | | | | |
|---|---|---|---|---------------------|--|
| Use of glutamine | Intravenous (EW) | Almost never ; only complicated wounds (we have no burn patients) | - | - | We used to provide glutamine off label to patients in first 5 days of EN |
| | Not used (DB) | - | - | - | - |
| | almost never used (RT) | almost never (we have no burn patients) | If so supervision by myself as nutrition expert | - | - |
| | In hospital Pharmacy compounded bags (JCMG) | During acute phase in pts with indication for PN | Some ICU MD's | EMF | - |
| | Enteral or parenteral (MU) | Trauma patients and patients having wounds | Supervising physician | EMF | - |
| | No more use (PS) | - | - | - | Stopped prescribing |
| | Never (AF) | - | - | - | - |
| Use of vitamins and trace elements | Added to PN (EW) | Every PN bag that leaves the pharmacy | Standing order by protocol of nutrition team | On the bag - in EMF | Not with EN |

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| | Included in PN and also given IV to patients on CRRT > 35ml/kg (DB) | Every PN bag and when patients on high dose CRRT | Dietitians/medical team | Electronic medical record | Not routinely given with EN unless on high dose CRRT or unless felt necessary by the dietitian |
| | Added to PN by nurses at patient bedside (RT) | Every PN bag | | On the bag - in EMF | Not with EN |
| | Added to PN (JCMG) | Every PN bag Pharmacy compounded | ICU MD's | On the bag - in EMF | - |
| | Added to PN at the bedside (MU) | Daily | Physician order | EMF | - |
| | In the EN formulas or added to PN at bedside (PS) | Each time EN or PN is used | Physician Dietician Pharmacist | EMF | In the EN formulas or added to PN |
| | Added to PN (PT) | Every PN bag (industrial) | By nurses | On the bag - in EMF | Not with EN |
| | Added to PN and also given IV to patients on CRRT (AF) | Every PN bag | By nurses | EMF, on the bag | - |
| Monitoring of the achievement | Every day a ratio between intake of intentional and non- | Every morning | ICU dietitians | EMF | We designed ourselves an excel file which was incorporated in the electronic |

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| of the nutritional goals | intentional calories and proteins and targets is made (EW) | | | | medical system of the hospital so it takes around 5 min per patient per day (by users with experience) |
| | Reviewed weekly via excel spreadsheet (prescription vs delivery, non-nutritional kcal included) (DB) | Weekly | Dietitians | EMF | |
| | Not on a systematic daily basis (RT) | - | MD's | - | New EMF is on implementation |
| | Every day a ratio between intake of intentional and non-intentional calories and proteins and targets is made (JCMG) | Every morning | ICU MD's ICU nurses | EMF | A tool to automatically calculate ratio is incorporated in EMF |
| | Difference between target and actual intake is calculated (MU) | Daily clinical round | Physician | EMF | - |
| | Visible of the screen of the EMR (PS) | Every day | Physician, dietician | EMF | - |
| | Every day a ratio between intake of intentional and non-intentional calories and proteins and targets is made (PT) | Every morning | Treating MD, clinical pharmacist | EMF | - |
| | Applied intentional and non-intentional calories | Every morning | Treating or supervising MD | EMF | - |

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| | can be checked daily in the EMF (AF) | | | | |
| Clinical and biological monitoring | Clinical + lab (EW) | Extra attention with PN use | Treating MDs, clinical pharmacist, ICU dietitians | EMF | We have 'PN lab profiles' but in ICU Triglycerides, phosphate etc are in most ICU profiles available |
| | Clinical + lab (DB) | Each review (minimum weekly) | Dietitian | EMF | This is relating to nutrition assessment purposes only. Bloods are taken daily |
| | Clinical + lab (RT) | Extra attention with PN use | Treating MDs | EMF | - |
| | Clinical + lab (JCMG) | Extra attention with PN use | ICU MDs | EMF | We have 'nutrition lab profiles' |
| | Clinical + lab (MU) | Daily | Physician | EMF | Full blood chemistry twice a week including prealbumin |
| | Lab (PS) | Every day | Physician | EMF | Phosphate several times a day when needed |
| | Clinical + lab (PT) | Extra attention with PN use | Treating MDs, clinical pharmacist | EMF | Triglycerides, phosphate etc are in most ICU profiles available |
| | Clinical + lab (AF) | Extra attention with PN use | Treating and supervising MD, clinical pharmacist, sometimes dietician | EMF | For special questions or problems during nutritional therapy, we contact mostly our |

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| | | | | | clinical pharmacist and sometimes dieticians. |
| Existence of specific protocols | Rarely (JCMG) | On indication | - | - | - |
| Glucose control and insulin therapy (DB) | Computerized protocol | - | - | EMF | Sliding scale insulin regimen |
| Glucose control (PS) | Computerized protocol | Each time glucose is taken | Nurse | EMF | - |
| | Not in use (PT) | - | - | - | - |
| Insulin therapy (MU, AF) | Mostly continuous infusion when EN and PN infused (MU) | Starts when glucose > 150 mg/dl and stops when < 110 mg/dl | Nurse | EMF | Bolus insulin if continuous nutrition is not given |
| | Mostly continuous infusion when EN and PN infused (AF) | Insulin is started with 0,5-2 IE/h when glucose > 125 mg/dl or 2-3 IE/h when glucose > 200 mg/dl and stopped when | Nurse | EMF | 10-30 ml glucose 33% solution is given as iv bolus if glucose < 100 mg/dl |

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| | | glucose < 125 mg/dl | | | |
| Transplantation (EW, RT) | Kidney transplantation (EW) | on indication | - | - | - |
| | Liver transplantation (RT) | Daily, on indication | - | - | - |
| Obese patients | None | - | - | - | - |
| Nutritional therapy after extubation (MU) | NGT is being kept until oral intake > 50% of target | ONS if hospital food intake is poor | - | - | - |
| Post extubation (PS) | According to the speech therapist evaluation, progressive oral feeding is started or not | Day after extubation | Physician Speech therapist | EMF | - |
| Trauma patients | None | - | - | - | - |
| Use of physical activity | Active and passive mobilisation (EW) | Every day | Physiotherapists | EMF | - |
| | Active and passive mobilisation (DB) | Aim daily, but dependent on staffing | Physiotherapists | EMF | - |
| | Active and passive mobilisation (RT) | Not every day because | Physiotherapists | EMF | - |

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| | | of practical issues | | | |
| | Active and passive mobilisation (JCMG) | Every day | Physiotherapists | EMF | - |
| | Active and passive (MU) | Once a day | Physiotherapists | - | - |
| | Cycle ergometry Electrical muscle stimulation (PS) | When possible and no contra indication | Physiotherapists | EMF | Electrical muscle stimulation for heavily sedated patients (ECMO...) |
| | Active and passive mobilisation (PT) | every day | Physiotherapists | EMF | - |
| | Active and passive mobilisation (AF) | every day | Physiotherapists | - | - |

18 In the first column, the initials between brackets are the ones of the group members who have answered the survey regarding their daily practices
19 of ICU nutrition: Elisabeth de Waele (EW) (24-bed medical and surgical ICU, Brussels, Belgium); Danielle Bear (DB) (57 ICU beds, 30 high-
20 dependency unit beds. Mixed medical surgical, commissioned for severe respiratory failure, London, UK); Ronan Thibault (RT) (16-bed medical
21 and 16-bed surgical ICUs, Rennes, France); Juan Carlos Montejo Gonzalez (JCMG) (17-bed Medical-surgical, 13-bed cardiac and 12-bed trauma
22 ICUs. Madrid. Spain); Mehmet Uyar (MU) (27-bed medical/surgical general ICU, Izmir, Turkey); Pierre Singer (PS) (18-bed Medical-Surgical
23 and 5-bed intermediate surgical ICU, Tel Aviv, Israel); Peter Tamasi (PT) (12 bed mixed profile ICU, Budapest, Hungary); Arabella Fischer
24 (AF) (16-bed cardiac surgery ICU, Vienna, Austria).

25 BIA, bioimpedance analysis; BW, body weight; CRRT, continuous renal replacement therapy; EMF, electronic medical file; EN, enteral
26 nutrition; ESPEN, European Society for Clinical Nutrition and Metabolism; GI, gastrointestinal; GLIM, Global leadership initiative on
27 Malnutrition; GRV, gastric residual volume; MD, medical doctor; MUST, Malnutrition Universal Screening Tool; NGT, nasogastric tube; NRS,
28 Nutritional Risk Screening; ONS, oral nutritional supplements; PN, parenteral nutrition; SGA, Subjective Global Assessment.
29 # modified Weir equation of resting energy expenditure (REE) = VCO_2 (ml/min) x 8.19 or $REE = (3,941 \times VCO_2$ (l/min) /Respiratory quotient
30 (RQ)) + (1,11 x VCO_2 (l/min)) with RQ=0,86 [see reference 60].

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