

### SPECIAL SUPPLEMENTS

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The Expanding Boundaries of ICU Nutrition

# Nutrition

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# New Trends in ICU Nutrition

The new trends in nutrition management included in the last guidelines are discussed, in particular the route and the dose of calories and proteins recommended.

differ from any other hospitalised patient (Singer et al. 2019).

## When and How?

The gut should be used if available by oral or enteral route. The oral route is commonly used (Bendavid et al. 2017). So, careful monitoring of the oral intake could permit to detect patients who will benefit from early (within 48h) enteral nutrition. Despite the absence of clear differences between short-term early enteral route and early parenteral route in recent RCTs (Harvey et al. 2014; Reignier et al. 2018), the former route is still recommended when there is no contraindication. The arguments are mainly

a parenteral nutrition (PN) should be implemented at a later stage, before the seventh day after admission. The importance of permissive underfeeding to avoid overfeeding during the acute phase (3-7 days) is emphasised (Reintam-Blaser and Berger 2017) and a full feeding (i.e. calculated to match energy expenditure (EE) and protein losses) was discouraged during the first days (Singer et al. 2019; Preiser and Wernerman 2017). A progressive increase of the intake is then recommended.

Historically, numerous observational studies showed that a low caloric and protein intake is associated with poor outcomes (Alberda et al. 2009; Villet et al. 2005). However interventional studies failed to demonstrate that increasing the caloric intake to the level of EE measured or predicted improved the outcome (Rice et al. 2011; Allingstrup et al. 2017; Arabi et al. 2015; Peake et al. 2014). As the enteral route could be insufficient to reach this target, the parenteral route (supplemental) was tested (Heidegger et al. 2013; Singer et al. 2011; Casaer et al. 2011; Harvey et al. 2014; Doig et al. 2013). However, the results did not show any consistent improvements in the mortality or the morbidity of the critically ill patients and even suggest that early full intake is deleterious (Zusman et al. 2016). The actual recommendation is to administer hypocaloric nutrition (not more than 70% of EE) during the early phase of acute illness and to increase the caloric delivery after day 3 up to 80-100% of measured EE if a reliable method of measurement is used (Singer et al. 2019). The indirect

## recent ESPEN guidelines take into account the latest RCT and updated expert opinion

the maintenance of the intestinal barrier integrity by the EN (trophic feeding) and its low cost. The list of contraindications to the enteral route decreased year by year and the ESICM (European Society of Intensive Care Medicine) clinical practice guidelines formulated 17 recommendations for specific conditions (Reintam-Blaser et al. 2017). They were endorsed by the ESPEN Guidelines and they more clearly defined the situation necessitating a careful usage of the enteral route (**Table 1**) (Singer et al. 2019).

When the enteral route is not available,



**Vincent Fraipont**  
Head of Intensive Care Unit  
CHR Liège  
Liège, Belgium.

vincent.fraipont@chrcitadelle.be



**Jean-Charles Preiser**  
Department of Intensive Care  
Erasme University Hospital  
Brussels, Belgium

jean-charles.preiser@erasme.ulb.ac.be

During the last decade, numerous paradigms and dogmas based on observational cohort studies were challenged by the publication of large multicentre prospective randomised controlled trials (RCT). Actually, until recently, the guidelines were supported by a very low evidence and were frequently expert opinions, implying controversial recommendations (Patel et al. 2017; McCarthy et al. 2016; Preiser et al. 2015). The very recent European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines (Singer et al. 2019) take into account the latest RCT and updated expert opinion. Its content is really useful for the bedside caregiver. Two other publications deserve also a mention as they could help to guide the practical bedside daily nutrition management (Berger et al. 2019; Reintam Blaser et al. 2017). We will briefly focus on the main new principles underlying the nutritional management of a critically ill patient.

## Who Should be Nourished?

All the patients admitted to the ICU (Intensive Care Unit) and staying more than 48h are at nutritional risk and deserve particular attention. The general assessment does not



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calorimetry is nowadays the sole reliable method available but is not widely accessible (Rattanachaiwong and Singer 2019). The alternative method, the predictive equations were clearly unreliable leading to individual unpredictable underfeeding or overfeeding. This justifies the preferred use of hypocaloric nutrition over isocaloric nutrition for the first week of ICU stay when these equations were used (Singer et al. 2019).

The gold standard indirect calorimeter was not sold since more than 20 years and the devices manufactured during the last decades were known to be unreliable (Fraipont and Preiser 2013). A group of experts sponsored by the ESICM and the ESPEN worked in collaboration with the industry to conceive a new tool without the inconvenience of the older ones (Oshima et al. 2017a). This apparatus was released last year and promises to be useful. It is light, easily mobilised, with easy calibration process, equipped with a friendly touch screen and interface, easy to use and seems to be reliable in in-vitro mass spectrometry validation studies (Oshima et al. 2017b).

The management of difficult EN achievement is not different from the past and call on prokinetics and lastly post-pyloric route. When the prescribed dose of EN is not reached after one week, a supplemental PN should be considered on a case by case basis (Singer et al. 2019).

Recent interests emerged and focused on the possible role of an increased protein intake (Preiser, 2018; Weijs 2018); however very few controlled data were available (Rugeles et al, 2013; Fetterplace et al. 2018; Allingstrup et al. 2017) and some warnings signs emerged from retrospective analysis (Casaer et al. 2013; Koekkoek et al. 2019). Therefore, the dose of protein recommended is 1.3 g/kg protein equivalents per day in opposite with the more generous guidelines of the Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition (McClave et al. 2016).

### Pharmaconutriments

Additional enteral doses of glutamine are limited to patients with burns > 20% body surface area or critically ill trauma. In case of unstable or complex ICU patients with hepatic or renal failure, intravenous supplements are also not recommended. The use of enteral omega-3 fatty acids is limited to nutritional doses. High doses of antioxidants is also not recommended but micronutriments (trace elements and vitamins) should be provided at the daily recommended dosage if the patient is under exclusive PN or if he did not receive sufficient EN (Singer et al. 2019). For the first time, following the result of a recent interventional study (Amrein et al. 2014), the guidelines pay attention to vitamin D recommending its dosage and supplementation with high doses in case of severe deficiency (Singer et al. 2019).

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**Table 1.** Category of specific patients that could be candidate to EN (grade of recommendation: B – strong consensus). Adapted from Singer et al. Clin. Nutr. 2019;38:48-79.

Low dose EN should be administered	
<input type="checkbox"/>	in patients receiving therapeutic hypothermia and increasing the dose after rewarming;
<input type="checkbox"/>	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
<input type="checkbox"/>	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.
Early EN can be performed	
<input type="checkbox"/>	in patients receiving ECMO
<input type="checkbox"/>	in patients with traumatic brain injury
<input type="checkbox"/>	in patients with stroke (ischaemic or haemorrhagic)
<input type="checkbox"/>	in patients with spinal cord injury
<input type="checkbox"/>	in patients with severe acute pancreatitis
<input type="checkbox"/>	in patients after GI surgery
<input type="checkbox"/>	in patients after abdominal aortic surgery
<input type="checkbox"/>	in patients with abdominal trauma when the continuity of the GI tract is confirmed/restored
<input type="checkbox"/>	in patients receiving neuromuscular blocking agents
<input type="checkbox"/>	in patients managed in prone position
<input type="checkbox"/>	in patients with open abdomen
<input type="checkbox"/>	regardless of the presence of bowel sounds unless bowel ischaemia or obstruction is suspected in patients with diarrhoea

### Specific Conditions

The importance of detecting dysphagia that could limit the oral intake is underlined as this dysfunction is very frequent in the critically ill patients (Zuercher et al. 2019). Following the publication of a large study on early EN versus early PN in ventilated adults with shock (Reignier et al. 2018) that showed possible harmful with the enteral route, the statement is that early and progressive EN should be used in septic patients after haemodynamic stabilisation (Singer et al. 2019). Early EN was also suggested in patients that were classically not good candidates for EN (Table 1) (Singer et al. 2019).

As the proportion of obese patients increases in most of the countries (Schetz et al. 2019), this setting is discussed in the ESPEN guidelines. The energy intake should be guided by indirect calorimetry and an iso-caloric high protein diet can be administered even if the grade of recommendation is low (Singer et al. 2019).

**indirect calorimetry is nowadays the sole reliable method available but is not widely accessible**

Close monitoring of the blood glucose and electrolytes is still the rule. A particular focus is made on the detection and management of the refeeding syndrome. Indeed, a large RCT showed that restricted energy supply during 48h followed by progressive increase in patient with refeeding hypophosphataemia ( $< 0.65 \mu\text{mol/l}$  or a drop of  $> 0.16 \mu\text{mol/l}$ ) saves life (Doig et al. 2015).

### Future

A great number of recommendations were not based on high evidence and a group of experts published (Arabi et al. 2017) a research agenda in nutrition and

metabolism to be done in the next 10 years. We hope that these future researches will provide clearer pragmatic attitudes for the practitioner involved in nutritional management. ■

### Conflicts of Interest

None

### Abbreviations

EE	energy expenditure
EN	enteral nutrition
ESICM	European Society of Intensive Care Medicine
ESPEN	European Society for Clinical Nutrition and Metabolism
ICU	intensive care unit
PN	parenteral nutrition
RCT	randomised controlled trials

### Key points

- Patients admitted to the ICU and staying more than 48h are at nutritional risk and deserve particular attention.
- Enteral route is still recommended when there is no contraindication.
- When the enteral route is not available, a parenteral nutrition should be implemented at a later stage.
- Hypocaloric nutrition is preferred over isocaloric nutrition for the first week of ICU stay.
- A new indirect calorimeter that is light, easily mobilised, with easy calibration process, equipped with a friendly touch screen and interface and that is reliable was recently released.

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For complete references, please email [editorial@icu-management.org](mailto:editorial@icu-management.org) or visit <https://iii.hm/x8b>

# Addressing Malnutrition in Critically Ill Patients

Baxter launches a new parenteral nutrition formulation designed to meet the need for higher protein provision in Europe and signs a global partnership with COSMED to commercialise Q-NRG+, a metabolic monitoring device that utilises indirect calorimetry technology.

## Malnutrition in the ICU

Around 20 to 50% of hospital patients, including those in the ICU (trauma, surgery) are malnourished.<sup>1</sup> Malnutrition is a clinical condition that affects multiple patient groups and can have a significant impact on both clinical outcomes and healthcare systems, as it is typically associated with higher infection rates, increased morbidity and mortality, longer hospital stays, increased healthcare costs and reduced quality of life.

Critical illness often results in rapid protein breakdown and muscle loss. Clinical evidence shows that nutrition that involves both moderate energy intake and high protein is associated with reduced mortality. Both the European Society of Nutrition and Metabolism (ESPEN) and the American Society for Parenteral and Enteral Nutrition (ASPEN) recommend a higher protein intake with reduced calorie for critically ill patients.<sup>2,3</sup>

## Clinical Nutrition Innovations

Clinical nutrition in the ICU has evolved over the years. Baxter International Inc., a global leader in clinical nutrition, has been a part of this journey, listening to clinicians and addressing the unmet needs in the critical care segment in line with nutritional guidelines that have moved towards acknowledging the importance of meeting protein targets in critically ill patients. Baxter have recently launched two innovations that will enable clinicians to identify and address malnutrition in the critically ill. Along with COSMED, a worldwide leader in the design of metabolic systems for clinical and human performance application, Baxter will be commercialising Q-NRG+; a metabolic monitoring device that utilises indirect calorimetry technology in 18 key countries around the world with potential for future expansion.

Indirect calorimetry (IC) is the gold standard<sup>4</sup> for measuring resting energy expenditure (REE) - a patient's calorie needs while at rest. The ESPEN guidelines recommend that in critically ill mechanically ventilated patients, energy expenditure should be determined using indirect calorimetry.<sup>2</sup> The ASPEN guidelines also suggest that IC be used to determine energy requirements, and in the absence of IC, a predictive equation or a weight-based equation be used.<sup>3</sup>

Q-NRG+, represents the next generation of IC technology and enables individualised monitoring measurements to help clinicians optimise nutrition therapy in critically ill patients. Q-NRG+ is designed to address barriers to rapidly and accurately measure a patient's REE. It is flexible, portable, and easy to use by all clinicians. The device requires minimal warm-up and calibration time and can deliver readings in as few as five minutes.

Q-NRG+ is a unique product that is a result of collaboration with world-class institutes in the field of nutrition support in ICUs. It is simple to use and can solve typical pitfalls of previous IC technology. Thus, with Q-NRG+, clinicians will now have access to an effective and practical tool.

Baxter have also launched in Europe, their latest addition to their olive oil-based parenteral nutrition (PN) triple chamber bag portfolio; Olimel N12. The new PN bag combines a high protein formulation with low glucose content, resulting in the lowest energy to protein ratio currently available in a standardised, triple-chamber bag. The new formulation contains 76g of amino acid per liter (designed to meet protein targets in lower fluid volumes) and only 73g of glucose per liter (helping to reduce the potential glycaemic load and subsequent risk of hyperglycaemia). The olive-oil based lipid emulsion may preserve immune func-

tion.<sup>5,6,7,8,9</sup> Olimel is indicated for parenteral nutrition for adults and children greater than 2 years of age when oral or enteral nutrition is impossible, insufficient or contraindicated.

## Future Outlook

As clinical nutrition continues to gain importance in the ICU setting, the need for advanced strategies and tools that could help clinicians ensure patients receive adequate nutrition for better long-term outcomes and improved quality of life will be fundamental. Baxter is committed in its role as a leader in clinical nutrition and continues to partner with institutions and clinicians to develop innovations that will improve outcomes for critically ill patients. ■

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