Clinical Nutrition xxx (2017) 1–18

Contents lists available at ScienceDirect

Clinical Nutrition

journal homepage: http://www.elsevier.com/locate/clnu

Review

Lipids in the intensive care unit: Recommendations from the ESPEN Expert Group☆

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ARTICLE INFO

Article history:
Received 5 July 2017
Accepted 31 August 2017

Keywords:
Lipid emulsion
Enteral nutrition
Parenteral nutrition
Sepsis
Critical illness
Surgery

SUMMARY

This article summarizes the presentations given at an ESPEN Workshop on "Lipids in the ICU" held in Tel Aviv, Israel in November 2014 and subsequent discussions and updates. Lipids are an important component of enteral and parenteral nutrition support and provide essential fatty acids, a concentrated source of calories and building blocks for cell membranes. Whilst linoleic acid-rich vegetable oil-based enteral and parenteral nutrition is still widely used, newer lipid components such as medium-chain triglycerides and olive oil are safe and well tolerated. Fish oil (FO)-enriched enteral and parenteral nutrition appears to be well tolerated and confers additional clinical benefits, particularly in surgical patients, due to its anti-inflammatory and immune-modulating effects. Whilst the evidence base is not conclusive, there appears to be a potential for FO-enriched nutrition, particularly administered perioperatively, to reduce the rate of complications and intensive care unit (ICU) and hospital stay in surgical ICU patients. The evidence for FO-enriched nutrition in non-surgical ICU patients is less clear regarding its clinical benefits and additional, well-designed large-scale clinical trials need to be conducted in this area. The ESPEN Expert Group supports the use of olive oil and FO in nutrition support in surgical and non-surgical ICU patients but considers that further research is required to provide a more robust evidence base.

1. Nutrition support of the critically ill patient

Patients in an intensive care unit (ICU) are heterogeneous and include surgical and medical patients, mechanically-ventilated or non-ventilated, obese or undernourished, preterm infants to older adults, requiring either short-term or long-term intensive care [1]. Nutrition support is critical in maintaining homeostasis in the ICU

☆ Based upon the ESPEN Workshop "Lipids in the ICU" held in Tel Aviv, Israel on 23 and 24 November 2014.

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http://dx.doi.org/10.1016/j.clnu.2017.08.032

patient and to provide nutrients for the maintenance of lean body mass as well as repair and maintenance of organ function and support of defense and healing processes.

Enteral nutrition (EN) comprises specialized liquid nutrition delivered through a nasogastric or post-pyloric feeding tube into the stomach or small intestine (duodenum/jejunum), respectively [2]. The European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines recommend that EN should be given to all ICU patients who are not expected to be taking a full oral diet within three days [3].

Whilst ESPEN acknowledges that there are no definitive data supporting the early use of EN in terms of clinical outcomes, its guidelines recommend that hemodynamically stable critically ill patients who have a functioning gastrointestinal tract should be fed early (<24 h) using an appropriate amount of feed [3]. Early initiation of EN is also recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN) and the Canadian Society of Critical Care Medicine (SCCM) [4], as well as the European Society of Intensive Care Medicine (ESICM) [5]. Administration of early EN in critically ill patients appears to also have a positive economic impact, with analysis suggesting that it is associated with significantly reduced costs relating to reduction in ICU stay and duration of mechanical ventilation compared with standard care [6].

There are a number of nutritional and non-nutritional benefits associated with early EN feeding. These include the maintenance of lean body mass, gut integrity, mucosal associated lymphoid tissue and muscle function, together with attenuation of oxidative stress [7]. Studies performed after the publishing of ESPEN guidelines have demonstrated positive clinical outcomes with early EN administration, such as reduction in duration of mechanical ventilation, reduction in length of ICU stay and higher survival rates in critically ill mechanically-ventilated patients, compared with delayed EN administration [8,9]. Furthermore, two meta-analyses investigating early EN (<24 h) in critically ill and trauma patients reported a significant mortality reduction versus standard care and a significant reduction in incidence of pneumonia [10,11].

The macronutrient content of several EN formulas used in clinical practice or in experimental studies is detailed in Table 1; it is evident that these differ greatly in content of macronutrients and in individual bioactive nutrients including glutamine, arginine and omega-3 fatty acids. Hence the metabolic, physiologic and clinical impact of different EN formulas will differ.

Parenteral nutrition (PN) is nutrition support provided through intravenous administration of nutrients such as amino acids, glucose, lipids (as emulsions), electrolytes, vitamins and trace elements. PN can be provided through a central venous line or through a peripheral intravenous line [12]. The ESPEN Guidelines for Parenteral Nutrition in Intensive Care recommend that all patients who are not expected to be on normal nutrition within 3 days should receive PN within 24–48 h, if EN is contraindicated or if they cannot tolerate EN [13]. Furthermore, supplementary PN may also be initiated alongside EN in critically ill patients to help achieve energy and protein targets.

In terms of the safety of PN compared with EN in critically ill patients, whilst PN is associated with a lower mortality risk, particularly when compared to late EN, it has an increased risk of infectious complications [14,15]. Compared to standard care (oral diet when tolerated plus iv dextrose) in malnourished patients, EN appears to be associated with a lower risk of infection, whilst PN confers a lower risk of mortality as well as infection [16]. Supplemental PN may have clinical benefits in addition to reaching nutritional targets earlier, such as reduced risk of nosocomial infections when initiated on days 4–8 alongside EN compared to EN alone [17]. However, a recent large scale multi-center randomized controlled study compared EN to PN and found no significant difference in mortality and infectious complications [18].

2. Lipids in enteral and parenteral nutrition

Lipids are used in enteral and parenteral nutrition primarily due to their high caloric content and are thus a good concentrated source of energy. As such, they lower the amount of carbohydrate that needs to be provided as part of the nutrition support. Lipids also provide the building blocks for cell membranes and provide essential fatty acids, thereby preventing essential fatty acid deficiency. The two essential fatty acids are the omega-6 (n-6) polyunsaturated fatty acid (PUFA) linoleic acid (LA) and the omega-3 (n-3) PUFA α-linolenic acid (ALA). In the body these may be converted to longer chain, more unsaturated derivatives that have important biological functions [19]. LA is the metabolic precursor of arachidonic acid (ARA) while ALA is the metabolic precursor of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The absence of lipids in artificial nutrition support regimens can result in the onset of essential fatty acid deficiency, especially in preterm infants, where there is insufficient synthesis of the omega-3 fatty acid DHA and the omega-6 fatty acid ARA from their essential precursors [20]. Lipids also allow for delivery of fat soluble vitamins.

Lipids used in nutrition support contain fats primarily in the form of triglycerides, with either medium-chain fatty acids (caprylic, capric, lauric and myristic acids), long-chain fatty acids (palmitic, oleic, linoleic and α-linolenic acids) or very long chain fatty acids (EPA and DHA) [19]. Table 2 details the nomenclature and sources of fatty acids commonly used as a component of nutrition support. Triglycerides rich in medium-chain fatty acids have been

Table 1
Macronutrient composition of EN formulas commonly used in research studies.

	Oxepa[1]	Pulmocare[1]	Ensure Plus HN[2]	Impact[3]	Reconvan[4]
Protein (g/l)	63	63	63	56	55
Carbohydrate (g/l)	105	105	204	132	120
Fat (g/l)	93 (MCT, canola oil, fish oil, borage oil)	93 (MCT, canola oil, corn oil, high oleic safflower oil)	49 (MCT, canola oil, corn oil)	28 (Palm kernel oil, high oleic sunflower oil, high oleic safflower oil, fish oil)	33 (MCT, safflower oil, flaxseed oil, fish oil)
Omega-6 PUFAs (g/l)	18.4	18.4	7.7	5.8	6.9
Of which GLA (g/l)	4.3	0	0	0	0
Omega-3 PUFAs (g/l)	10	4.8	1.5	3.3	3.4
Of which EPA + DHA (g/l)	6.5	0	0	1.7	2.5
Also contains	Taurine, carnitine, vitamin C, α-tocopherol, β-carotene	Taurine, carnitine, vitamin C, α-tocopherol, β-carotene	Vitamin C, α-tocopherol	Arginine, nucleotides, vitamin C, α-tocopherol, β-carotene	Arginine, glutamine, vitamin C, α-tocopherol, β-carotene

Source: [1]Abbott Nutrition company website; [2]Taken from [68]; [3]Taken from [202] and Nestlé Health Science company website; [4]Fresenius Kabi company website.

Please cite this article in press as: Calder PC, et al., Lipids in the intensive care unit: Recommendations from the ESPEN Expert Group, Clinical Nutrition (2017), http://dx.doi.org/10.1016/j.clnu.2017.08.032