Meeting Protein Requirements in Critical Care Using an ENFit Compatible Modular Protein Supplement

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Meeting protein requirements in critically ill patients can be challenging. Their increased protein requirements are frequently not met due to under-delivery of enteral feed. This can be intentional to avoid overfeeding energy, or as a result of interruptions in continuous feeding. Modular protein supplements are key in improving protein provision within the critical care setting, however, there are difficulties associated with their administration. The Critical Care Unit at the Great Western Hospital, Swindon, recently made the switch to the ENFit compatible supplement ProSource TF® ENFit®. Here we discuss the rationale behind this change and the process of implementing it within our Critical Care Unit.

Protein requirements within critical care

Guidelines around provision of nutrition for critically ill patients universally recommend a higher protein intake when compared with the general population.[1,2] This is based on catabolism during critical illness causing high rates of muscle protein loss, which over a sustained period contributes to intensive care unit (ICU)-acquired weakness. A recent meta-analysis[3] showed that the average critically ill patient loses 2% of their muscle mass per day during their first week, with the prevalence of ICU-acquired weakness being 50% and associated with poorer outcomes. The degree to which critically ill patients are able to utilise high exogenous protein sources is, however, unclear.[4] Studies investigating clinical outcomes associated with varying protein intake are also heterogenous and have significant limitations.[5]

There is no consensus as to the specifics of protein recommendations, with inconsistent evidence around optimum dosing and timing of protein provision.[5] This is further complicated in patients with obesity, renal failure, and high protein-losing clinical conditions, such as burns. The recommendations for protein intake within the major guidelines encompassing critically ill patients[1,2] fall within a range of 1.2-2 g/kg of actual body weight in patients with a BMI <30 kg/m^2, and up to 2.5 g/kg of ideal body weight in patients with a BMI >30 kg/m^2.

Regardless of the specific protein target, studies consistently show that actual protein provision within critical care falls well below the minimum recommended range. An international study, in 2014,[6] demonstrated patients only receive 57.6% of protein prescribed, and the recent Evaluation of Nutritional Practices in the Critical Care (ENPIC) multi-centre observational study[7] population received a mean protein intake of 0.81 g/kg. The reasons for under-delivery of protein within critical care are multifactorial. Key contributing factors include: the requirement for hypocaloric feeding; sources of non-nutritional calories; and interruptions to enteral feeding.

Barriers to protein provision

The European Society for Clinical Nutrition and Metabolism (ESPEN)[1] recommends hypocaloric feeding during the acute phase of critical illness, as overfeeding is associated with increased complication rates and evidence of poorer outcomes. This reduces the target enteral feed volume needed to reach the patient's energy requirements, and a lower feed volume results in decreased protein provision. The energy:protein ratio of most enteral feeds means that target protein requirements are not met in the associated feed volume to achieve hypocaloric feeding. To address this, there have been recent developments within enteral feed ranges with new products that have energy:protein ratios more favourable for critically ill patients. Studies have shown that all non-nutritional calories combined can contribute up to one-third of an individual's total daily energy.[8] This is relevant due to the need to reduce target feed volumes accordingly to avoid overfeeding estimated energy requirements; although which sources of non-nutritional calories need to be taken into account is debated and practice varies between individual dietitians.

The provision of non-nutritional calories is common within critical care, with a 2016 study finding that only 2.7% of mechanically ventilated patients received no non-nutritional calories during their first week of admission.[8] The primary sources are propofol, dextrose and citrate anticoagulation for renal replacement therapy. However, the degree to which they contribute towards estimated daily calories can vary significantly. The sedative propofol is a lipid emulsion containing 1.1 kcal/ml and comes in 1% and 2% formulations, with a maximum recommended infusion rate of 4 mg/kg/hr.[9] The double-concentrated 2% propofol requires half the volume to achieve the same sedative effect, therefore reducing its contribution towards non-nutritional calories; however, not all critical care units are using this formulation. Dextrose contains 4 kcal/g, and the calories provided will vary depending on concentration and volume of the solution used. Dextrose delivery can come through numerous sources, including as a component of IV fluids, dilutions for medications and separate infusions. Tri-sodium citrate is one of the anticoagulation methods used during continuous renal replacement therapy and contains 0.59 kcal/mmol.[10] It has been shown to contribute an energy intake of around 200 kcal/day;[10, 11] although, in clinical practice this is challenging to calculate precisely as it varies significantly with each filter setting, and there is no agreed calculation to estimate actual calorie uptake from citrate in the filter. **Figure 1** demonstrates how non-nutritional calories can contribute to protein deficit within critical care.

Continuous feeding is the most commonly used method of administering enteral feed within critical care, and is recommended by ESPEN.[1] However, this increases the vulnerability to nutritional deficits due to the frequent interruptions to enteral feeding within critical care. A recent study[12] showed that each patient experienced on average just under 3 interruptions within their first week of admission, with medical interventions (radiological, surgical and airway procedures) accounting for nearly half of these. Malfunctions with the enteral feeding tube were found to be the interruption of greatest duration, and the total median duration of interruptions was 16 hours; this would equate to a 10% loss of feed delivery over a week with the equivalent underfeeding of protein. Volume-based feeding can be used to catch up missed feed, and there is growing evidence around the safety and potential benefits of intermittent feeding.[13] Intolerance to gastric feeding is an additional commonly reported interruption to continuous feeding.

A recent systematic review[14] indicated a relative risk of 0.55 [95% confidence interval = 0.45-0.68] of feeding intolerance being associated with not achieving enteral feeding targets. Raised gastric residual volume is a common marker of feeding intolerance and is used routinely within daily practice to establish and monitor enteral feeding tolerance, although its relevance and clinical application is debated.

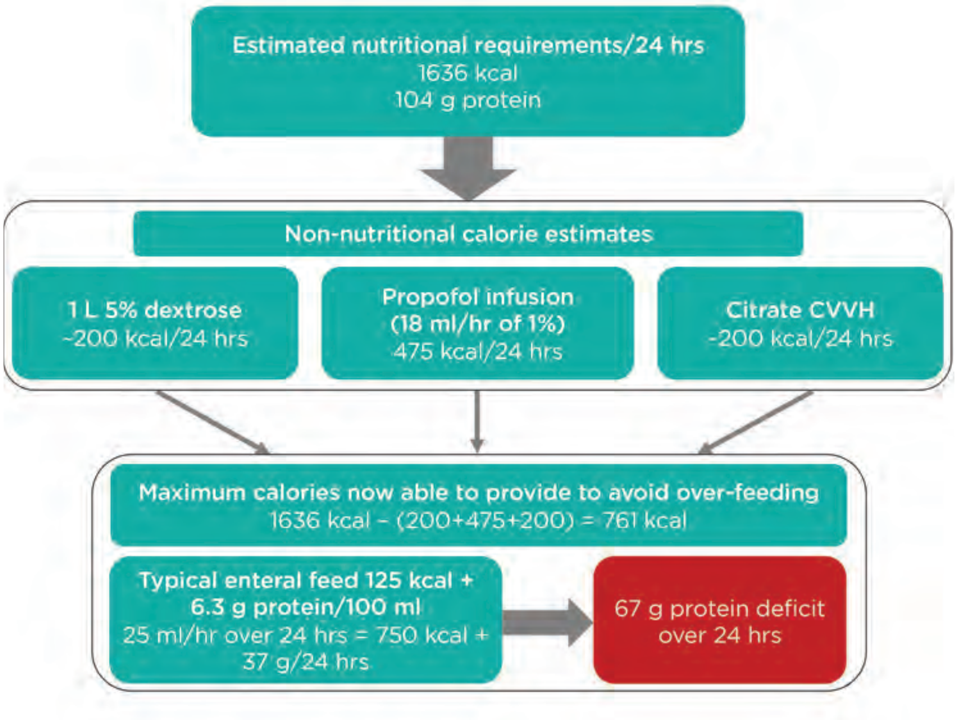
The development of modular protein supplements has enabled improvements in the provision of protein within critical care. Their low calorie, high protein content allows protein requirements to be met in the context of the reduced feed volumes necessary for hypocaloric feeding and to account for non-nutritional calories.[15] This is particularly valuable in patients with a higher than usual protein:energy requirement ratio, most notably in patients with obesity that require high protein intakes to maintain their lean body mass alongside controlled hypocaloric feeding.[16] The low volume bolus can be given at any time, therefore is much less impacted by a period of interruption to continuous enteral feeding administration. Protein boluses are also theorised to counteract the muscle-full effect associated with continuous feeding, however further studies are required to assess the impact on muscle wastage and clinical outcomes.[17]

Meeting protein needs at Great Western Hospital

The critical care unit at the Great Western Hospital consists of 12 beds of mixed Level 2 and Level 3. As a district general hospital, the unit has a heterogenous patient population, including medical and surgical patients for both acute care and rehabilitation.

Our standard feeding protocol uses a 125 kcal and 6.3 g protein per 100 ml non-fibre feed, and once the non-nutritional calories are accounted for this leaves most patients with a protein deficit at target caloric feed rate. We are therefore reliant on modular protein supplements to meet protein requirements and had used ProSource TF for several years. This dependence was particularly evident during the COVID-19 pandemic, with many patients remaining sedated for a prolonged period and a population with a higher than average body mass index (BMI). The high use of ProSource TF during this time highlighted the challenges with administering the product. In particular, the number of sachets that were required to meet protein needs and the need to decant into another container to draw it up into a syringe. This was time consuming for nursing staff and raised concerns about how much of the product may be wasted. It was also a high fluid burden, both from the product itself and water flushes required for each sachet, which contributed to difficulties managing fluid balance in our critically ill patients. The announcement of ProSource TF ENFit – a modular protein sachet with an ENFit compatible connector – in early 2022 presented an opportunity to solve the difficulties faced with our current ProSource TF sachets.

Figure 1: Example of how non-nutritional calories can contribute to protein deficit during the acute phase of critical illness



Product consideration

When considering changing products, it was firstly important to compare the nutritional composition of the two products, as well as any potential differences in cost.

Table 1 shows the comparison between ProSource TF and ProSource TF ENFit.

ProSource TF ENFit has a higher energy and protein content per millilitre, and a lower electrolyte content per gram of protein. This allows for the same protein provision in a smaller volume and lower kcal content, which has advantages for avoiding over-feeding calories and overloading fluid. There is no difference in cost when looking at protein content, therefore it was anticipated that the higher cost per sachet would balance out with reduced number of sachets used. Once this was discussed with our pharmacy procurement team, they were happy for us to proceed with changing products pending a trial on the ward.

The process of changing products

Nutrinovo provided samples to trial, which were distributed over several weeks between patients with a variety of size feeding tubes being nursed by different staff. We were particularly interested in the feedback from nursing staff, which was overwhelmingly positive. Staff reported a noticeable reduction in time taken to give the supplements per shift, due to less sachets being required and the ability to administer directly into the feeding tube, therefore freeing up time for other nursing duties. Feedback from nursing staff includes:

> ***"The easy administration makes it much less time consuming."***
> ***"It's helpful for giving less volume for fluid restricted patients."***
> ***"There's less wastage and saves plastic by not decanting into a container."***

From a dietetic perspective, it was beneficial to be able to meet protein requirements in a smaller volume and reduced associated energy and electrolyte provision. Cumulatively, this becomes clinically significant for those patients requiring a large proportion of their protein provision through modular supplementation.

Following evaluation of the nutritional, financial and practical implications, the decision was made to change from using ProSource TF to ProSource TF ENFit. We discontinued the ordering of ProSource TF and supplies of the ProSource TF ENFit were ordered in readiness. Once our existing stock of ProSource TF was approaching depletion, ProSource TF ENFit training literature provided by Nutrinovo (**Figure 2**) was distributed electronically to all critical care nurses by our Practice Development Team and printed copies were placed around the ward for reference. Following the official introduction, we continued to receive positive feedback from nursing staff with no issues raised around the adjustment to administration practice. There has also been no noticeable change to our spend on modular protein supplements.

The only identified downside to ProSource TF ENFit is that because it has 20 g protein/sachet, it reduces the flexibility to match protein requirements precisely compared to the 11 g protein/sachet product. For most patients this is not of concern in practice, however, it has made prescribing feeding regimens more challenging in patients for whom we are being careful not to exceed their estimated protein requirements due to their underlying clinical conditions. Although, it is acknowledged that protein requirements are estimates only and based on often inaccurate anthropometric measurements and, therefore, the clinical relevance of this reduced flexibility is debatable.

Modular protein supplements are invaluable for meeting the protein deficit commonly seen within critical care, but we would encourage dietitians in units using non-ENFit compatible supplements to speak to their nursing staff about the reality of administering these products. Consider whether ProSource TF ENFit would make a tangible difference to daily practice, both from a nursing and a dietetic perspective. We found the process of changing our modular protein supplements straightforward and we received excellent support from the Nutrinovo Team.

Table 1: Nutritional and cost comparison between ProSource TF and ProSource TF ENFit

	ProSource TF	ProSource TF ENFit
Volume per serving	45 ml	60 ml
Energy per serving	44 kcal	76 kcal
Energy per ml	0.97 kcal/ml	1.27 kcal/ml
Protein per serving	11 g	20 g
Protein per ml	0.24 g/ml	0.33 g/ml
Cost per serving	£1.36	£2.47
Cost per g protein	12p	12p

Based on list prices at time of review.

Figure 2: ProSource TF ENFit administration guidelines

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