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## ICU Volume 12 - Issue 2 - Summer 2012 - Nutrition

### Is Individualised Nutrition the Future?

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#### Introduction

Does the caloric intake of critically ill patients make a difference? Ever since initial measurements with indirect calorimetry were made, it has been obvious that predictions from body size end up with some + 30 percent uncertainty with regard to the actual energy expenditure of a patient. Following this realisation, a long line of modified equations has been suggested where, in addition to age, chronic and acute morbidity are considered. Still though, nothing much better than the original Harris-Benedict formula is at hand. An important confounder, and something which is not always sufficiently recognised, is timing in critical illness. In the acute phase, hypermetabolism, if defined as energy expenditure above basal metabolic rate, according to Harris and Benedict, is very rare, whilst it is common in a later more stable phase of critical illness, turning into a recovery phase. There is still more space for exploration of the variables associated with sufficient nutrition.

#### The Importance of Nutrition

The first step taken by Harris and Benedict in creating their formula was to recognise that massive overfeeding is not a good thing. Still, the study had a poor design where full parenteral nutrition was given in addition to adequate enteral nutrition (Veterans Affairs Total Parenteral Nutrition Cooperative Study Group 1991). Not to be forgotten, however, is that besides recognising the adverse effects of massive overfeeding, the study defined undernourished patients as a subgroup where adequate nutrition most probably made a difference. This finding was more recently reproduced in an observational study, where possible undernutrition was defined as a BMI < 20 (Alberta et al. 2009). However, the timeline of critical illness was not very well defined in this study.

In the acute phase of critical illness there are today a number of studies that indicate that caloric intake does not make a difference, or may even be dangerous. In well nourished patients this is well demonstrated in the recent EDEN study (Rice et al. 2012). Lacking though is a more controversial study that looks at patients who are possibly at nutritional risk. The EPaNIC study has also been critiqued since the majority of patients were not at nutritional risk (Casaer et al. 2011). In this large prospective study with a high inclusion rate, it was quite obviously indicated that in the acute phase of critical illness, full nutrition given as a combination of enteral and parenteral nutrition according to existing caloric recommendations related to body weight give a morbidity disadvantage. Also, in the subgroup where no enteral nutrition was possible to give, those patients randomised to no parenteral nutrition during the initial ICU week had more favorable outcomes. Although the EPaNIC study is criticised for not identifying patients who were at nutritional risk and for overfeeding patients who were not at risk, investigators pointed out that the choice of caloric intake and risk scoring were in accord with the current guidelines (Singer et al. 2009; McClave et al. 2009).

So, is nutritional nihilism the track to follow? Are the risks involved with nutrition outbalancing the possible advantageous effects? It is obvious that this issue has become very emotional and that we really need to settle what evidences there are.

#### Facts and Confounders

A primary ambiguity is that early enteral nutrition is advocated in critical illness as well as following major surgery (Doig et al. 2009), though most of the documentation behind this recommendation, which is present in all major guidelines, does not consider the nutritional status of the patients. A possible confounder of course, as demonstrated in the EDEN study, is that nutritional intake is not a critical factor in the outcome of the well fed majority of the patients studied. Another possible confounder is the fact that successful enteral nutrition is a favourable prognostic sign. It may be that studies which look at successful early enteral nutrition discriminate patients with good outcomes, rather than that the nutritional support in itself brings a better outcome. All statistical correlations are not causative!

Secondly, the level of caloric intake in itself does not logically cause excess morbidity. In all patients successfully enterally fed, a high caloric intake is associated with a favorable outcome, while the not so good outcomes seem to be confined to patients given parenteral nutrition in the early phase of critical illness. In the EPaNIC study there was a clear signal: waiting until day eight of ICU stay for supplementary parenteral nutrition was a better option when patients were randomised. The study dichotomised patients to parenteral supplementation on day two or on day eight. But what about day five? We still do not know whether providing parenteral supplementation on an alternative day may be a better choice.

A possible mechanistic explanation of why early parenteral supplementation may be a disadvantage is the hypothesis of an early autophagic phase in critical illness, in which mitochondrial stimulation by feeding may be harmful (Vanhorebeek et al. 2012). This hypothesis is founded on electron microscopy findings, where intracellular vacuoles and swollen mitochondria show up.

#### Application of Nutritional Support

The old concept that the caloric content of nutrition be dosed according to body weight may need to be reconsidered. The tight calorie control

study (TICACOS) investigators indicated in a pilot study that there might even be a survival advantage when caloric intake is given in close accordance with daily measurements of energy expenditure estimated by indirect calorimetry (Singer et al. 2011). In the preliminary results of the SPN study, it was reported that in the 60 percent of patients for whom the caloric intake was derived from measurements with indirect calorimetry, there was a 300 kcal/24 hours (15 percent) difference compared with patients to whom caloric intake was given according to body weight (Heidegger et al. 2011). If considering the EPaNIC study together with these data, one may conclude that overfeeding even marginally (10 - 20 percent) in relation to energy expenditure may be harmful. If so, the use of indirect calorimetry in the ICU should be encouraged.

Historically there have been technical difficulties associated with indirect calorimetry. Although modern instruments are easy to handle and to calibrate, there have been discrepancies in patients on stable mechanical ventilation (Sundstrom et al. 2011). In tertiary ICUs with a relatively high proportion of long-stay patients, and in centres with a high proportion of patients with a high BMI, it must be considered as controversial to abstain from indirect calorimetry to measure energy expenditure. Full indirect calorimetry is recommended since the sole measurement of CO<sub>2</sub> production is associated with placing a need of particularly high competence on evaluating readings in respiratorily unstable patients, in particular as the accuracy of the estimation of energy expenditure may be of greater importance than earlier anticipated.

In summary, adequate nutrition is lifesaving in the ICU as in any other segment of hospital care. Nutrition must be dosed properly, as both underfeeding and overfeeding may be dangerous for patients. Proper dosing is today not possible to define, but it is obvious that it varies between individuals and that it changes over the course of sickness in the individual patient. The best estimation is done by indirect calorimetry, and obtained readings should be interpreted as the maximum dosage. All sources of caloric intake must be considered in the intake calculation when caloric balance is established. During the early phase of acute illness, particular caution not to overfeed the patient should be applied. During this period, supplementary parenteral nutrition should not be practiced.

Published on : Sat, 14 Jul 2012