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Nutrition Challenges of the Obese in the ICU

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Obese patients are a large and growing group in the ICU. Obese patients face a number of problems in the ICU: Length of stay is usually longer, the risk of infections and of pressure sores is higher, respiratory problems more frequent but mortality is usually similar to patients with lower BMI after risk adjustment. There is most likely a U-shaped association between outcome and BMI with a slightly higher risk of death in the very low BMI (e.g. < 18.5) and the extremely obese III (BMI>40) whereas the risk is slightly lower in overweight and obese patients. Such a U-shaped association appears also to exist for risk of critical illness necessitating ICU admission. Patients with low and high BMI are over represented in hospitalised patients and even more in ICU patients as found in the nutrition Day project for wards and ICUs, as well as in a recent Canadian project.

Little attention has been given to nutrition of the obese in the ICU until recently. Many different concepts have been applied in obese critically ill patients. Partial starvation of these patients is one accepted nutritional strategy while another is to consider standard nutrition mandatory until recovery from critical illness is achieved. Special consideration should be given to the fact that many complications associated with obesity in the ICU, such as pneumonia, poor wound healing, pressure sores, and difficult weaning are typical complications of under- or overnutrition. The U-shaped association of complications indicates that optimal energy supply may be a critical factor for improved outcome.

Energy Consumption in the ICU

Energy consumption and thus energy needs are commonly determined with the use of a formula, only few ICUs routinely use indirect calorimetry to measure energy consumption. The Harris- Benedict equation, determined in 1918 by study of 239 healthy adults and 94 newborns, is the standard formula used in many institutions (Harris and Benedict, 1918). The range of weights covered was from 25 to 125 kg and the age from 21 to 70 years. Thus the formula is certainly representative for a mean population but not for patients with “disease related malnutrition” or the morbidly obese. The mean energy consumption of 25.7 Kcal.kg-1 in men and 24.5 Kcal.kg-1 in women is very near to the simple recommendation of 20-25 Kcal.kg-1 in the acute state and 25-30 Kcal.kg-1 during recovery (Kreymann et al. 2006). Measurements in many groups of critically ill patients have challenged the use of the Harris-Benedict equation with the two formulae depending on gender. The deviation between measurement and calculation could be as large as 300-500 Kcal around the mean value (Faisy et al. 2003). Adding minute ventilation and body temperature to weight and height and excluding age and gender have improved the individual prediction slightly. - Thus most recommendations have included the simple formula 25 Kcal.kg-1.day-1 to determine energy needs. Weight is usually actual weight but some authors have advocated the use of ideal or adjusted body weight for patients with an increased BMI.

Age should always be considered as energy consumption decreases by 15-20% between the age of 40 and 80 years (Poehlman 1992). Another factor that may have a dynamic effect on energy consumption is disease activity and shock. Energy consumption decreases in general when disease is associated with a compromised cardio-circulatory function such as in severe sepsis or septic shock (Kreymann et al. 1993).

Energy Deficit in the ICU

A substantial energy deficit has been found in many ICU patients that have been followed prospectively with either indirect calorimetry or assessed in comparison with accepted standards. The largest energy deficit accumulates during the first week of ICU stay (Dvir, et al. 2006; Krishnan, et al. 2003; Villet et al. 2005). An energy deficit above 5000 Kcal was not uncommon during the first week and has been associated with an increased risk of complications such as infections, renal failure and pressure sores. The development of an energy deficit has never been followed specifically in obese patients.

A surprising relation between BMI and energy supply has been found in a large multi-centric trial. Patients with a BMI < 20 received 990 Kcal in 24 hours and this amount was not much larger in those with a BMI > 40 with 1050 Kcal in 24 hours. All other BMI groups were between these two values suggesting that all patients received the same amount of nutrition regardless of BMI (Alberda, et al., 2009). The amount of nutrients given was slightly higher in the nutritionDay ICU project (www.nutritionday. org) where more than 50% of patients in all BMI categories received more than 20Kcal.kg-1.day-1 based on ideal body weight. The variability in the amount of energy given was high and similar for all groups, indicating again that there is great uncertainty about the optimal amount of nutrients.

Overnutrition in the ICU

Overnutrition is probably actually much less frequent nowadays because the deleterious effects of hyperalimentation such as fatty liver, respiratory failure and difficult to control hyperglycemia are well known. It has been shown that any increase in energy intake above measured resting energy expenditure induces an increase in weight in parallel with fat accumulation and without any beneficial effect on protein loss. Clinical signs of overnutrition should be appreciated when calorimetry is not available to tailor nutrition care.

Nutrition and Metabolic Abnormalities in Obese Patients

Obesity is often associated with the metabolic syndrome with increased insulin levels and a proinflammatory state. Traumatised obese patients have a decreased efficiency in protein synthesis, a larger protein breakdown and a reduced fat oxidation compared with normals. Lipolysis was reduced and free fatty acids levels high indicating a block in the utilisation of fat as fuel. Thus endogenous protein may serve as fuel despite the large fat stores.

Morbidly obese patients have frequently decreased levels of vitamin B6, C and D (Aasheim et al. 2008). Moreover, many of these patients have used special diets or have repeatedly tried a massive reduction in nutrient intake leading to additional deficits of vitamins, electrolytes and essential nutrients. These patients, especially if weight loss in the last month is also reported, should be considered as malnourished and have probably a decreased lean body mass despite a high BMI.

Refeeding syndrome should always be considered when artificial nutrition is started in patients with specific risk profile, such as several days of low nutrient intake, weight loss within the last 3-6 months, electrolyte abnormalities, history of alcohol misuse or chronic medication with insulin, antacids or diuretics (NICE 2006).

Artificial Nutrition in Obese Critically Ill

We suggest that patients at the extremes of BMI should receive safe and proper nutrition care based a simple concept as illustrated in figure 3. For obese patients the three major elements are an early start of nutrition care, careful tailoring of the amount of energy and a substantially increased amino acid supply.

Nutrition care should start early e.g. within 24 hours of admission to avoid large energy deficits in these patients with a high probability of nutrition deficits and abnormalities before admission to the ICU. Energy intake should be gradually increased to reduce the risk of re-feeding syndrome and to be able to assess tolerance. Measured or estimated energy needs should be met by day three after adequate stabilisation. Estimation of energy needs in the very low BMI group should be based on actual body weight and increased carefully to ideal body weight if well tolerated whereas the energy estimates for the obese patients should be based on ideal body weight. Because large inter-individual differences in energy needs are well known, clinical signs of overnutrition should be searched. The problem of the accumulation of a large energy deficit can be prevented by the early start of nutrition support and an effort to reach soon a reasonable target. In very old patients the amount of energy should be reduced compared with recommendations by 10-20 percent.

Specific attention should be given to a sufficient provision of protein. The amount of protein should be increased to about 2g.kg-1.day-1 to compensate for the metabolic abnormality of increased and preferential protein breakdown in injured obese patients. I would suggest again ideal body weight as the reference for calculations. Unfortunately, there are actually not sufficient choices of enteral and parenteral industrial nutrition solutions that satisfy the two conditions of moderate energy supply with a high protein content.

Conclusion

In summary, nutritional care of the obese ICU patient will be a challenge for the future as this group is vulnerable and will further increase in the next years. Recommendations are based on the synthesis of a puzzle of elements and the proposed strategy should be prospectively evaluated in different settings.

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