FEEDING CRITICALLY ILL OBESE PATIENTS

Despite ongoing nutritional research in this area, there is a paucity of high quality research to guide the feeding of obese patients on the Intensive Care Unit (ICU). In a nutritionally complex population, this paper will review the available evidence and summarise key points to consider when assessing the nutritional requirements in the critical ill obese.

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Obesity remains on the increase; in England, 61.9% of the adult population are overweight or obese.[1] The cost to the health service for overweight and obese patients is greater than £6 Billion a year[1,2] and contributes to 30,000 excess deaths in the UK.[3]

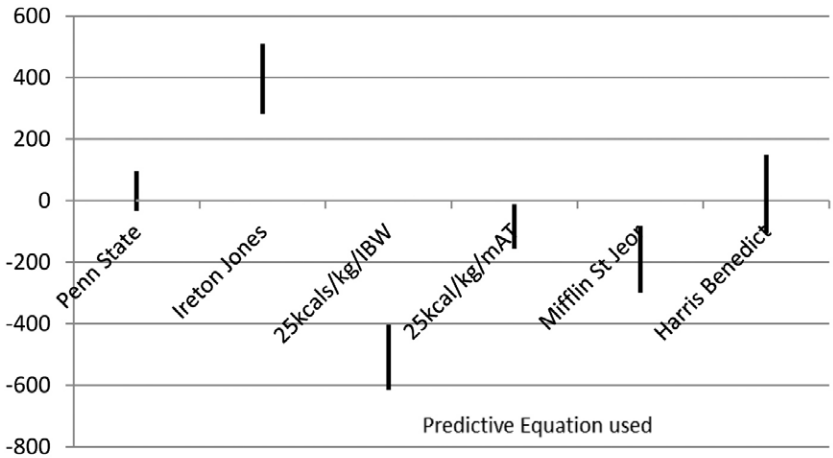
The ICU 'obesity paradox' has been used to describe this observed phenomenon of improved survival of the obese patients, despite increased lengths of stay,[4] the opposite to what many might expect. Audits[4] and multicentre observational studies[5] evaluating the outcome of obesity in critical illness, found that patients with a BMI of between 30-39 and >40 had a lower mortality when compared to a normal BMI (<25). Theories try to explain why the obesity paradox exists, one suggestion is altered metabolism of the adipose tissue, an increase in Leptin levels and beneficial functions of adipose tissue in response to sepsis.[5,4] Despite a large sample size of the studies, the morbidly obese patients (BMI >40) represented only 3.5% of the study population.[4] A recent systematic review has also cast doubt over the existence of this paradox.[6]

Even if the ICU obese paradox exists, complexities arise with the medical and nutritional management of the obese critically ill patients that impact on morbidity. There is a strong link between obesity and insulin resistance and a prevalence of fatty liver and respiratory compromise. The risk of hypothalamic and pituitary dysfunction can result in increasing levels of the stress hormone cortisol. Poor mobility due to the critical illness heightens patient risk of pulmonary embolisms or deep vein thrombosis due to the patient's hyper-coagulable state.[2,7] Locally, over the last year, our ICU admitted 1,775 patients; of these, nearly a quarter (23%) were obese (BMI >30) and 4.0% morbidly obese (BMI >40).There is a need to have a consensus amongst our profession to ensure that the nutritional management of the obese patient is appropriate and evidenced based. Establishing a definitive nutritional pathway for obese patients on ICU remains an ongoing issue for dietitians due to complexities with assessing the nutritional need of the patient, alongside prescribing feeding regimens with adequate macro and micronutrients.[8]

NUTRITIONAL REQUIREMENTS

Without the use of indirect calorimetry, predictive equations must be used when assessing nutritional needs of a patient.[9] Predictive equations can be inaccurate and lead to over or under estimations of calorie and protein needs.[9] The Parenteral and Enteral Nutrition Group (PENG)[10] recommends calculating estimated energy requirements (EER) based on disease-related stress for BMI >30, protein/g/kg/d is adjusted to 75% and 65% requirements for obesity and morbid obesity respectively (Table 1). The supporting evidence behind this recommendation is somewhat sparse.

Figure 1: Graph to show the bias in predictive equations in morbidly obese patients



Source: adapted from Frankenfield 2013 et al with permission.[9] IBW: ideal body weight, MAT: metabolically active tissue. Penn state: (equation 1, for all patients irrespective of age).

Frankenfield et al[9] evaluated the available predictive equations for 55 mechanically ventilated obese patients with a BMI >45. Predictive equations were compared to measured energy expenditure (MEE) to determine accuracy (Figure 1). The equation with the highest accuracy (±5.0% of measured EE) was the Penn State equation (2011); however, this was accurate in only 51% of the patients, so caution should be taken when using this equation in those with a BMI >45. The Ireton-Jones equation (1992), which was developed specifically to include obese hospitalised patients, had an accuracy of 16% (to ±5.0% of MEE) and fixed kcal equations (25kcal/kg) has an accuracy of 0% to +/-10% if MEE.[9]

See Figure 1 for the predictive equations. Those recommended are highly inaccurate.[9]

Choban et al (2013) recommend the Penn State University equation (2009) should be used and the adjusted Penn State calculation used in patients over 60 years old. Recommendations for hypocaloric, high protein feeding suggest using 50-70% estimated energy requirements or 14kcals/kg actual weight. Protein ranges are increased in the obese group (BMI >30), but supported with low grade evidence, see Table 1.[11]

Current guidelines offer suggestion to dietitians when calculating nutritional requirements in obese patients.

ASPEN's D grade recommendations for feeding the obese ICU patients accounts for underfeeding calories, but feeding high protein allows for neutral nitrogen balance and wound healing.[11, 12]

Calculating protein requirements is just as problematic as estimating calorie requirements in the obese ICU patient. Table 1 gives a variety of protein ranges based on actual or ideal body weight. Obese patients have an increased level of total body fat as well as an increase of lean body mass (LBM) and IBW does not correlate to this change in body habitus. Accurately obtaining LBM is costly and often not feasible at the bedside, so using an equation to calculate LBM has been recommended.[15, 16]

HYPOCALORIC VS PERMISSIVE UNDERFEEDING

Where indirect calorimetry and predictive equations accounting for obesity are not available, then clinical guidelines may assist and direct nutritional prescriptions in ICU obese patients. As Table 1 presents, giving a percentage or lower amount of calories to the obese patient (hypocaloric feeding) may be helpful in preventing negative side effects of overfeeding ICU patients, such as hyperglycaemia.[7]

Determining how much to feed the ICU obese patient will vary depending on clinical condition and individual aim. Within the literature, terminology varies and it is important to distinguish the significant difference of the two

Table 1: Current nutritional recommendations

Guidance	Energy	Protein
American Society for Parenteral and Enteral Nutrition ASPEN[11,12,13]	BMI >30-50 60-70% energy requirements or 11-14kcal/kg/actual body weight or BMI >50: 22-25kcal/kg ideal body weight	BMI >30-40 >2.0g/kg Ideal body weight BMI > 40 >2.5g/kg ideal body weight
Parenteral and Enteral Nutrition Group (PENG)[10]	BMR - Henry (2005) or in ventilated patients use Ireton-Jones equation (2002) BMI>30 Not stressed: subtract 400-1000kcals. Mildly stressed: feed to BMR (calculated using actual body weight) Moderate stress: feed to BMI +/_ activity or stress factor Severely stressed: add a stress factor OR use 19-21kcal/kg actual body weight	BMI >30 75% protein requirement BMI >50 65% protein requirement
American College of Chest Physicians (ACCP)[14]	21-25kcal/kg/actual body weight	Do not give recommendations for protein requirements
Kreymann et al 2015[15]	Use Standard Body weight (SBW - adapted from Lemmens et al, based on BMI 22) x 25kcal 25kg x kg SBW	Based on LBM (adapted from Fernandez) and decide on range of protein required depending on clinical picture

terms: hypocaloric and permissive underfeeding. Hypocaloric feeding suggests low calories (mainly as carbohydrate) whilst maintaining adequate protein. Permissive underfeeding is a conscious decision to underfeed calories alongside protein.[7]

Hypocaloric feeding (low calorie, less than predicted energy expenditure) with adequate protein provision >1.2g/kg/d Ideal Body Weight (IBW) aims to maintain lean body mass (LBM) whilst simultaneously losing fat mass. Underfeeding calories aims at avoiding the metabolic complications associated with overfeeding in ICU patients, such as hyperglycaemia, increased infections and increased ventilator days.[7]

A small retrospective study of 40 obese ICU patients receiving enteral nutrition were fed either <20kcals/kg adjusted body weight/d (hypocaloric feeding) or >20kcals/kg adjusted body weight/d (eucaloric feeding). The findings suggested that the hypocaloric group had shorter ICU stay (P <0.03) and reduced number of ventilator days (P <0.09). Both groups were fed equal amounts of protein (2.0g/kg/d IBW).[17]

There is a lack of quality randomised control trials reviewing nutritional prescriptions for this patient group. However, the American guidelines suggest that hypocaloric, high protein feeding is at least equivalent as permissive underfeeding, if not improved when adequate protein is provided.[8]

HYPOCALORIC, HIGH PROTEIN FEEDING

Using the hypocaloric high protein feeding strategy to optimise outcomes in the critically ill obese can present practical complications for dietitians prescribing enteral feeding regimes. Using commercial available enteral feeds can be a challenge to meet both requirements for protein and obligatory glucose without overfeeding, especially when also factoring in the delivery of non-nutrient calories such as propofol or IV fluid solutions. Failure to meeting obligatory glucose levels can lead to gluconeogenesis and exacerbate further loss of muscle mass.[8]

Protein supplements alongside commercially available tube feeds with a lower non-protein energy:nitrogen ratio <1:80) can improve protein intake without overfeeding energy.[8] Adjustment of feeding regimens goes beyond that of using a pure protein supplement. Careful adjustment in feed prescription is essential when accounting for the non-nutritional energy provided in the form of intravenous fluids, sedation preparations and renal replacement solutions. Failure to adjust will lead to excess energy from non-nutritional sources, or displacement and reduction of protein intake. The provision of a protein and carbohydrate mixed supplements can help close the protein gap while meeting obligatory glucose requirement. Micronutrient provision will also need to be considered when making adjustments for macronutrients.[8]

SUMMARY

Despite a suggestion of lower mortality from critical illness, obese critically ill patients present a lot of nutritional challenges to dietitians working on the ICU. We lack definitive answers to guide prescriptions for the ICU obese patient, but emerging evidence suggests that the trend towards hypocaloric feeding alongside adequate protein and glucose provision improves outcomes and prevents substrate intolerance. Estimating energy requirements should include using evidenced based and validated predictive equations, mindful that the accuracy of these equations falls as BMI increases >45.[9] Consideration for non-nutrient energy sources, adequate micronutrient provision and the use of protein and carbohydrate supplements help bridge the protein gap to ensure this patient group are adequately fed to optimise outcomes.

KEY POINTS

- Use indirect calorimetry or validated predictive equations for the ICU obese patients.
- If predictive equations aren't available, follow international guidelines ensuring adequate protein is provided.
- Feeding regimens need to be adjusted to allow for non-nutritional energy from sedation preparations, intravenous fluids and renal replacement solutions.
- Consider a protein supplement to improve the protein adequacy, without over-feeding. Commercially available feeds may not provide enough protein for patients with increased protein requirements.
- Pre-admission nutritional status: consider micronutrient deficiencies and adjust depending on clinical conditions.