Nutrition in the Critically-Ill Obese Patient

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Providing nutrition to the morbidly obese critically-ill has come to be a frequent challenge.

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Abstract

People are fatter than they used to be. Although the upward trend has slowed in recent years, more than one third of all adults in the US are obese, and one in six children are overweight or obese.[1,2] Reflecting this reality, there are a large number of obese patients in the intensive care unit. Some 30-35% of adult ICU patients are obese, and 5% or more are morbidly obese.[3] Patients who are both critically-ill and morbidly obese present unique challenges to care. These range from basic care, such as prevention of bedsores and ambulation, to sophisticated issues, such as medication dosing and ventilator management. It takes a team of caregivers, for example, to help a 400-pound patient in and out of bed. One of the most difficult aspects of the care of such patients is nutrition support, which is the subject of the present review.

Introduction

So why is nutrition a problem? After all, obese patients have large amounts of stored calories. Can't they live off their fat? Unfortunately, the answer to that is no, they cannot, at least not entirely. The problem is that those stored fat calories aren't the right kind. Everyone needs fat and carbohydrates for energy, amino acids to support protein synthesis and prevent muscle wasting, and a whole array of vitamins and trace elements. Stored fat can and should be relied on to provide a portion of the energy required. As will be seen later, hypocaloric feeding is currently recommended.[4] But patients still need carbohydrates to provide glucose for the central nervous system, the hematopoietic system, the immune system, and wound healing. Moreover, obese patients need protein. Much research over the years has clearly shown that critically-ill patients need more protein than healthy patients, and that patients fed fewer calories than required need still more protein. In short, a generous amount of protein and a relatively modest amount of carbohydrates are required to adequately feed obese patients.[3] And this is true whether the feeding method is enteral, parenteral, or even old-fashioned oral intake. It is the intent of this review to present the methods by which this can be safely accomplished in the critically-ill patient.

Diagnosis and assessment

A careful history and physical examination should always be performed during the initial

Table 1
Classification for Obesity by Body Mass Index

- Underweight — BMI <18. 5 kg/m^2
- Normal weight — BMI ≥18.5 to 24.9 kg/m^2
- Overweight — BMI ≥25.0 to 29.9 kg/m^2
- Obesity — BMI ≥30 kg/m^2
- Severe Obesity — BMI ≥ 40 kg/m^2
- Super Obesity — BMI ≥ 50 kg/m^2
- Obesity Class I — BMI of 30.0 to 34.9 kg/m^2
- Obesity Class II — BMI of 35.0 to 39.9 kg/m^2
- Obesity Class III — BMI ≥40 kg/m^2

The recommended classifications for BMI as adopted by the WHO, NIH, and numerous professional societies. Class III obesity is often referred to as severe, extreme, or morbid obesity.

nutritional assessment. The history should determine on recent weight loss or gain, previous history of weight loss surgery, medical conditions affecting absorption of nutrients, quality of oral intake, and such concurrent metabolic conditions as diabetes mellitus. Physical findings such as acanthosis nigricans and increased central adiposity can point towards long-standing insulin resistance.

Extreme obesity is obvious, even though lesser degrees of obesity frequently goes unrecognized by physicians and nurses.[5] But, what constitutes "extreme?" A common nomenclature has been accepted by the National Institute of Health (NIH) and World Health Organization (WHO). The WHO and INH use BMI for classification of patients.[6] The BMI, it should be noted, is far from an ideal method of classification. The BMI ignores body habitus, and tends to over-estimate the prevalence of obesity in men relative to women. In any case, the recommended classifications are: underweight BMI ≤ 18.49 kg/m,^{2} normal weight BMI ≥ 18.5 to 24.9 kg/m,^{2} overweight BMI ≥ 25.0 to 29.9 kg/m,^{2} obesity class I, BMI ≥ 30 to 34.9 kg/m,^{2} obesity class II, BMI ≥ 35 to 39.9 kg/m,^{2} and obesity class III, BMI ≥ 40 kg/m.^{2} Class III obesity has been referred to as morbid, severe, extreme, and super obesity (See Table 1). It is very obvious that these categories are highly arbitrary, based as they are on simple multiples of five. Nonetheless, they provide a crude but workable method of classifying obesity.

Many Class II and Class III obese patients are in fact sarcopenic – that is, they have too little muscle mass for their size, and they should be considered as having muscle wasting. Evidence of malnutrition in patients with obesity may be difficult to demonstrate. So-called sarcopenic obesity can be measured by specialized studies, such as computed tomography or magnetic resonance imaging. However, it is not obvious on physical examination. Patients should be viewed with suspicion if they have recent weight loss, marked loss of appetite, generalized muscle weakness, or peripheral edema.

Laboratory studies are of relatively little value. One should always screen for low serum albumin, especially on admission, since it tends to correlate with chronic malnutrition. But once a patient is in the ICU, the serum albumin is of little value in determining nutritional status. The same can be said for other visceral proteins.

Transferrin, thyroxin-binding pre-albumin, and retinol-binding protein may be of value in a stable patient but can be misleading in a critical illness.

Despite the difficulty in making the diagnosis, malnutrition in the obese patient is nonetheless real, and the response of such patients to the stress of critical illness is much less robust than that of well-nourished patients. Identification of this sub-group of the obese is important to prevent the adverse consequences of nutritional stress combined with pre-existing malnutrition.

Determination of Nutritional Requirements

There are currently no Level 1 recommendations on calculating the metabolic needs of obese patients, for reasons that will become apparent. A number of approximations are available. The commonly used Harris-Benedict equations were derived nearly 100 years ago, from normal people weighing up to 250 pounds. They have not been validated in the critically-ill or the morbidly obese.[7] Using actual body weight in these equations can result in significant overestimation of caloric needs. The consequent overfeeding may in turn cause hepatic steatosis, increased lipogenesis, and increased respiratory effort.[8] Other formulas have been published: Mifflin formula, Penn State 1998 equation, Ireton-Jones equation, and others.[7, 9] None of these is especially satisfactory, although the Penn State and Ireton-Jones equations are probably the least inaccurate.

Calculations using the ideal body weight are often used, although their substitution into standard equations may produce underfeeding.[9, 10] The ideal body weight formula (Broca's index, DeVine formula) was originally derived from little or no data by a French physician, P. Broca, in 1871.[10] It completely lacks scientific validity. Therapeutic plans based on its use should include great flexibility to increase the recommended amounts of caloric administration, if appropriate.

The best determination of the caloric needs of the morbidly obese is through indirect calorimetry (IC). Unfortunately, this is not available in most hospitals. Even if available, it may be cumbersome to use. It is unreliable in patients requiring greater than 60-70% FiO_2. Nonetheless, it remains the gold standard, and is the only way of being relatively certain about a patient's energy needs.

In the absence of indirect calorimetry, current practice recommends a weight-based formula, either one of those listed above, or else the simple formula recommended by the American Society for Parenteral and Enteral Nutrition (ASPEN) and the Society for Critical Care Medicine (SCCM).[11] Normal weight or overweight patients can be fed at 20 to 25 calories per kilogram per day. For Class I through Class III obesity, where BMI is >30 kg/m^2, the goal of any nutrition regimen, enteral or parenteral, should be 11–14 kcal/kg actual body weight per day. Using the ideal body weight, that would be 22–25 kcal/kg IBW/d.[11,12] This represents fairly extreme hypocaloric feeding, at least as compared with the amount that would be calculated for a non-obese patient. But as noted earlier, hypocaloric feeding is probably best in such patients.

High protein feeding is the current recommendation for obese patients.[8,11,13,14] Protein requirements should be increased from the usual level of 1 to 1.5 gm/kg actual body weight/day, up to 2.0 gm/kg IBW/day for Class I and II obesity, and 2.5 gm/kg IBW/day for Class III obesity.[11] This recommendation is based on the long-standing observation that there is a trade-off between calories and protein. That is, the lower the caloric intake, the more protein is required to maintain the patient in positive nitrogen balance. Using a relatively high protein intake has been shown to provide the best maintenance of lean muscle mass and maintain positive nitrogen balance. Patients on this regimen have demonstrated decreased insulin requirements, fewer total ICU days, fewer days requiring antibiotics, and decreased length of ventilator dependence. Adequacy of provision of protein can be monitored by frequent collection of 24-hour urine specimens for urinary urea nitrogen (UUN), and calculation of nitrogen balance. When calculating nitrogen balance, a useful formula is:

$$N\_balance = N\_intake - 1.25(UUN)$$

Glucose control in the critically-ill has been another topic of intense discussion in the last ten years. On the basis of van den Berghe's study from Belgium, very strict glucose control (less than 110 mg/dL) was initially thought to be best.[15] However, this level of tight glucose control has since been found to be associated with increased adverse events related to hypoglycemia.[16] Recent evidence indicates that moderate glucose control (less than 180 mg/dL) to be associated with less overall morbidity, and this is the current reccomendation.[11,16]

Vitamins, Trace Elements, and Electrolytes

A nutrition regimen for obese patients should include vitamins and trace elements in amounts appropriate for any other adult patient. There are no particular requirements for the obese patient.[11] Most enteral formulas contain a sufficient mix of vitamins to meet the daily requirements, and the same can mostly be said for trace elements.

Electrolytes may be a somewhat different problem. Obese patients have requirements little different from normal patients. Paradoxically, this can be a problem. Fluid overload is fairly common in critically-ill patients, but it seems to be a more difficult issue in obese patients. For one thing, the much larger body mass can hide a relatively large amount of edema before it becomes clinically obvious. For another, there is a tendency to give intravenous fluids and sodium to match the patients total body weight. Obese patients should receive no more than 100 to 150 mEq of sodium and 50 to 80 mEq of potassium, per day, with no more fluid than necessary to maintain fluid balance. That includes the electrolytes given in the enteral or parenteral nutrition formula. Unless there are ongoing gastrointestinal or other losses, large amounts of sodium-containing fluid should not be given.

Immune-Enhancing Nutrition

There are a number of nutritional components that have been advocated as providing enhancements to the immune system. These include the amino acids arginine, glutamine, and alanine-glutamine dipeptide (available in Europe); omega-3 fatty acids; the trace element selenium; ribonucleic acids, and others. A review of these can be found elsewhere in this issue.

Access to the Central Veins and GI Tract

Access for feeding is frequently an additional challenge in treating the critically-ill obese. Obtaining central venous access is challenging due to obscured landmarks, being able to appropriately position the patient, and even the length of the access devices, including needles, available to the practitioner. However, the newer technique of placing central lines through the jugular route using ultrasound guidance has made it considerably easier to access the difficult patient. Use of a peripherally placed central catheter ("PICC" line) has greatly facilitated short term access for intravenous feeding.

Placing enteral access may also be more difficult in the obese patient. Access can be complicated by the patient's own co-morbidities, such as gastroparesis due to diabetes mellitus, and increased intra-abdominal pressure. Obese patients are at risk for increased gastroesophageal reflux and aspiration. Fluoroscopically guided enteral tube placement is often limited by the patient's inability to lay flat and by poor visualization of the tube through excessive adipose tissue. The newer technique of magnetically-assisted enteral tube placement is limited in obese patients because of the ability of magnet to obtain appropriate attraction through the adipose tissue.

Surgical or endoscopic gastrostomy tube placements, via percutaneous endoscopic gastrostomy (PEG), are significantly higher risk procedures in the morbidly obese. An increased rate of wound infections, post-operative ileus, and even 30-day mortality has been reported in the morbidly obese undergoing these procedures.[17,18] These types of enteral access are also technically difficult in the morbidly obese, due to inability to trans-illuminate through the abdominal wall. Maintaining the tube in position may be difficult, due to excessive movement of the abdominal wall with tube displacement due to the weight of the pannus. Often, laparoscopic gastrostomy tube placement is required.

Summary

Providing nutrition to the morbidly obese critically-ill has come to be a frequent challenge. Early enteral nutrition remains the ideal. Further accumulation of data from randomized controlled trials should further clarify the exact metabolic needs of these patients. Utilization of recent guidelines from ASPEN can provide a starting point for initiation of enteral and parenteral nutrition. Macro and micronutrient deficiencies must be contemplated and addressed. Use of urinary urea nitrogen and indirect calorimetry throughout the hospital course provides ongoing guidance for titration of feedings to optimize outcomes. Obtaining enteral and parental access for nutrition can be challenging, but the use of multidisciplinary resources in experienced surgical and gastroenterology teams can facilitate initiation of appropriate nutrition early in the hospital course.

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Disclosure

None reported.

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