Feeding the Critically Ill Obese Patient

Carla Vartanian
Critically Ill Obese Patients

◆ **WHO**: Obesity is abnormal or excessive fat accumulation that may impair health, or as a BMI ≥ 30.

◆ **The American Medical Association**: As of June 2013, it recognizes obesity as a disease that requires medical treatment.

◆ There is evidence that rates of obesity are increasing worldwide.

◆ The prevalence of obese patients in intensive care largely mirrors that of the general population. There is concern, however, that this may also be rising:

> A recently published multi-center nutritional study of 894 critically ill patients (Nov 2009 - Sept 2014 at 7 tertiary care centers in Saudi Arabia and Canada) reported a mean BMI of 29 in their sample, suggesting that just under 50% of their intensive care population was obese. (*N Engl J Med*. 2015;372(25):2398-408).

It is inevitable, therefore, that the intensivist will care for the critically ill obese patient.
Latest ESPEN Guidelines

- ESPEN guidelines on nutrition in cancer patients (2016).
- ESPEN guidelines on chronic intestinal failure in adults (2016).
- ESPEN-ESPGHAN-ECFS guidelines on nutrition care for infants, children, and adults with cystic fibrosis (2016).
- ESPEN guideline on ethical aspects of artificial nutrition and hydration. (2016).
- ESPEN guidelines on nutrition in dementia (2015).
- ESPEN endorsed recommendations: Protein intake and exercise for optimal muscle function with aging: Recommendations from the ESPEN Expert Group (2014).

www.espen.org
Clinical Guidelines

Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.)

Stephen A. McClave, MD; Beth E. Taylor, RD, DCN; Robert G. Martindale, MD, PhD; Malissa M. Warren, RD; Debbie R. Johnson, RN, MS; Carol Braunschweig, RD, PhD; Mary S. McCarthy, RN, PhD; Evangelia Davanos, PharmD; Todd W. Rice, MD, MSc; Gail A. Cresci, RD, PhD; Jane M. Gervasio, PharmD; Gordon S. Sacks, PharmD; Pamela R. Roberts, MD; Charlene Compber, RD, PhD; and the Society of Critical Care Medicine and the American Society for Parenteral and Enteral Nutrition.
Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient

- **Target Patient Population:** The adult (≥ 18 years) critically ill patient expected to require a length of stay greater than 2 or 3 days in a medical ICU or surgical ICU.

Specific patient populations addressed by these expanded and updated guidelines include:

- *Organ Failure (pulmonary, renal, and liver).*
- *Acute Pancreatitis.*
- *Surgical Subsets (trauma, brain injury, open abdomen, burns).*
- *Sepsis.*
- *Postoperative Major Surgery.*
- *Chronic Critically Ill.*
- *Critically Ill Obese.*

- **Target Audience:** For all healthcare providers involved in nutrition therapy of the critically ill, primarily physicians, nurses, dietitians and pharmacists.
What population of patients in the ICU setting does not require nutrition support therapy over the first week of hospitalization?

- Patients who are at low nutrition risk with normal baseline nutrition status and low disease severity (NRS 2002 ≤ 3 or NUTRIC score ≤ 5) do NOT require specialized nutrition therapy over the first week of hospitalization in the ICU.

- These patients should be offered oral intake to try to maintain nutrition status, appropriate immune responses, and optimal organ function.
ESPEN Guidelines for Nutrition Screening
NRS 2002

<table>
<thead>
<tr>
<th>Final screening</th>
<th>Impaired nutritional status</th>
<th>Severity of disease (E increase in requirements)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent Score 0</td>
<td>Normal nutritional status</td>
<td>Absent Score 0 Normal nutritional requirements</td>
</tr>
<tr>
<td>Mild Score 1</td>
<td>Wt loss &gt;5% in 3 mths or Food intake below 50-75% of normal requirement in preceding week</td>
<td>Mild Score 1 Fracture* Chronic patients, in particular with acute complications: cirrhosis*, COPD*, Chronic hemodialysis, diabetes, oncology</td>
</tr>
<tr>
<td>Moderate Score 2</td>
<td>Wt loss &gt;5% in 2 mths or BMI 18.5-20.5 + impaired general condition or Food intake 25-65% of normal requirement in preceding week</td>
<td>Moderate Score 2 Major abdominal surgery* Stroke* Severe pneumonia, hematologic Malignancy</td>
</tr>
<tr>
<td>Severe Score 3</td>
<td>Wt loss &gt;5% in 1 mth (&gt;15% in 2 mths) or BMI &gt;13.5 + impaired general condition or Food intake 0-25% of normal requirement in preceding week in preceding week.</td>
<td>Severe Score 3 Head injury* Bone marrow transplantation* Intensive care patients (APACHE40)</td>
</tr>
</tbody>
</table>

### Impaired nutritional status

<table>
<thead>
<tr>
<th>Score</th>
<th>Normal nutritional status</th>
<th>Score</th>
<th>Normal nutritional requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent: 0</td>
<td>Normal nutritional status</td>
<td>Absent: 0</td>
<td>Normal nutritional requirements</td>
</tr>
<tr>
<td>Mild: 1</td>
<td>Wt loss &gt;5% in 3 mths or food intake below 50 - 75% of normal requirement in preceding week.</td>
<td>Mild: 1</td>
<td>Hip fracture, Chronic patients, in particular with acute complications cirrhosis, COPD*. Chronic haemodialysis, diabetes, oncology</td>
</tr>
<tr>
<td>Moderate: 2</td>
<td>Wt loss &gt;5% in 2 mths or BMI 18.5 - 20.5 + impaired general condition or food intake 25 - 60% of normal requirement in preceding week.</td>
<td>Moderate: 2</td>
<td>Major abdominal surgery, Stroke, Severe pneumonia, hepatologic malignancy</td>
</tr>
<tr>
<td>Severe: 3</td>
<td>Wt loss &gt;5% in 1 mths (&gt;15% in 3 mths) or BMI &lt;18.5 + impaired general condition or food intake 0 - 25% of normal requirement in preceding week.</td>
<td>Severe: 3</td>
<td>Head injury, Bone marrow transplantation, intensive care patients (APACHE &gt;10)</td>
</tr>
</tbody>
</table>

Score (nutritional status) + score (disease severity) = Total score:

Adjustment for age: if ≥ 70 years: add 1 to total score above

Age-adjusted total score
The NUTRIC Score is designed to quantify the risk of critically ill patients developing adverse events that may be modified by aggressive nutrition therapy. The score, 1-10, is based on 6 variables that are explained below in Table 1. The scoring system is shown in Tables 2 and 3.

### Table 1: NUTRIC Score variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>&lt;50</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>50-&lt;75</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>≥75</td>
<td>2</td>
</tr>
<tr>
<td>APACHE II</td>
<td>≤15</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>15-&lt;20</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>20-28</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>≥28</td>
<td>3</td>
</tr>
<tr>
<td>SOFA</td>
<td>≤6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6-&lt;10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>≥10</td>
<td>2</td>
</tr>
<tr>
<td>Number of Co-morbidities</td>
<td>≤1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>≥2</td>
<td>1</td>
</tr>
<tr>
<td>Days from hospital to ICU admission</td>
<td>≤1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt;1</td>
<td>1</td>
</tr>
<tr>
<td>IL-6</td>
<td>0-&lt;400</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>≥400</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 2: NUTRIC Score scoring system if IL-6 available

<table>
<thead>
<tr>
<th>Sum of points</th>
<th>Category</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-10</td>
<td>High Score</td>
<td>Associated with worse clinical outcomes (mortality, ventilation). Those patients are the most likely to benefit from aggressive nutrition therapy.</td>
</tr>
<tr>
<td>0-5</td>
<td>Low Score</td>
<td>Those patients have a low malnutrition risk.</td>
</tr>
</tbody>
</table>

### Table 3: NUTRIC Score scoring system: if no IL-6 is available*

<table>
<thead>
<tr>
<th>Sum of points</th>
<th>Category</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-9</td>
<td>High Score</td>
<td>Associated with worse clinical outcomes (mortality, ventilation). Those patients are the most likely to benefit from aggressive nutrition therapy.</td>
</tr>
<tr>
<td>0-4</td>
<td>Low Score</td>
<td>Those patients have a low malnutrition risk.</td>
</tr>
</tbody>
</table>

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*It is acceptable to not include IL-6 data when it is not routinely available; it was shown to contribute very little to the overall prediction of the NUTRIC score.

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December 16th 2011
Is the Clinical Evidence of Contractility (bowel sounds, flatus) Required Prior to Initiating EN in Critically Ill Adult Patients?

- In the majority of MICU and SICU patient populations, (while GI contractility factors should be evaluated when initiating EN), overt signs of contractility should not be required prior to initiation of EN.
- GI dysfunction in the ICU setting occurs in 30–70% of patients, depending on the diagnosis, premorbid condition, ventilation mode, medications, and metabolic state.
- The argument for initiating EN regardless of the extent of audible bowel sounds is based on studies (most of which in critically ill surgical patients) reporting the feasibility and safety of EN within the initial 36–48h of admission to the ICU.
- Reduced or absent bowel sounds may reflect greater disease severity and worsened prognosis.
- Patients with normal bowel sounds have been shown to have lower ICU mortality than those with hypoactive or absent bowel sounds (11.3% vs 22.6% vs 36.0%, respectively): *J Crit Care*. 2013;28(4):537
What is the benefit of early EN in critically ill adult patients compared to withholding or delaying this therapy?

- Nutrition support therapy in the form of early EN be initiated within 24–48 hours in the critically ill patient who is unable to maintain volitional intake.

- The specific reasons for providing EN are to maintain gut integrity, modulate stress and the systemic immune response, and attenuate disease severity
  
  - One meta-analysis of eight trials by Heyland et al, showed a trend toward reduced mortality. *(JPEN 2003;27(5):355-373).*

  - A second meta-analysis of 12 trials by Marik et al, showed significant reductions in infectious morbidity and hospital LOS when early EN was started on average within 36 hours of ICU admission. *(Crit Care Med. 2001;29(12):2264-2270).*

  - A third meta-analysis of six trials by Doig et al, showed a significant reduction in pneumonia and mortality. *(Intensive Care Med. 2009;35(12):2018-2027).*
Enteral or Parenteral Nutrition Support in Critically Ill Patients who Require Nutrition Support Therapy?

- In the majority of critically ill patients, it is practical and safe to use EN instead of PN.
- The beneficial effects of EN compared with PN are well documented in numerous RCTs involving a variety of patient populations in critical illness, including trauma, burns, head injury, major surgery, and acute pancreatitis.
- Non-infective complications and reduced hospital LOS were seen with use of EN compared with PN in one of the meta-analyses by Peter et al. (*Crit Care Med.* 2005;33(1):213-220).
- One meta-analysis by Simpson and Doig showed a significantly lower mortality despite a significantly higher incidence of infectious complications with use of PN compared with EN. (*Intensive Care Med.* 2005;31(1):12-23).
- In 12 studies representing 618 patients, 9 reported on infection, which was shown to be significantly less with EN than PN. The ICU, LOS also was shorter with EN by nearly 1 full day.

**SCCM/ASPEN:** PN should be initiated in the adult critically ill patient at low nutrition risk over the first 7 days of ICU admission if the patient cannot maintain volitional intake and if early EN is not feasible.

What population of patients in the ICU requires full EN beginning in the first week of hospitalization?

& How soon should target nutrition goals be reached in these patients?

- All hospitalized patients are required to undergo an initial nutrition screen within 48 hours of admission.

- Patients who are at high nutrition risk or severely malnourished should be advanced toward goal as quickly as tolerated over 24–48h while monitoring for refeeding syndrome.

- Trophic feeds (usually 10–20 mL/h, 10–20 kcal/h) may be sufficient to prevent mucosal atrophy and maintain gut integrity in low- to moderate-risk patients but may be insufficient to achieve the usual end points desired for EN therapy in high-risk patients.

- In a prospective nonrandomized study, Jie et al showed that high-risk surgery patients (NRS 2002 ≥5) who received sufficient preoperative nutrition therapy (>10 kcal/kg/d for 7 days) had significant reductions in nosocomial infections and over- all complications compared with patients who received insufficient therapy.

In a large observational study, Heyland et al showed that, for high-risk ICU patients with NUTRIC scores ≥6, increasing the percentage of goal energy delivered correlated significantly with reductions in mortality. *(Clin Nutr. 2011;30(2):148-155).*

Efforts to provide > 80% of estimated or calculated goal energy and protein within 48–72 hours should be made in order to achieve the clinical benefit of EN over the first week of hospitalization.

The lowest mortality was achieved with EN, which provided >80% goal energy. For low-risk patients, no correlation was seen between percentage goal energy delivered and mortality. *(Clin Nutr. 2011;30(2):148-155).*
Clinical Guidelines

A.S.P.E.N. Clinical Guidelines: Nutrition Support of Hospitalized Adult Patients With Obesity

Patricia Choban, MD1; Roland Dickerson, PharmD, BCNSP1; Ainsley Malone, MS, RD, CNSC2; Patricia Worthington, MSN, RN2; Charlene Compher, PhD, RD, CNSC, LDN, FADA, FASPEN3; and the American Society for Parenteral and Enteral Nutrition

Abstract

Background: Due to the high prevalence of obesity in adults, nutrition support clinicians are encountering greater numbers of obese patients who require nutrition support during hospitalization. The purpose of this clinical guideline is to serve as a framework for the nutrition support care of adult patients with obesity. Method: A systematic review of the best available evidence to answer a series of questions regarding management of nutrition support in patients with obesity was undertaken and evaluated using concepts adopted from the Grading of Recommendations, Assessment, Development and Evaluation working group. A consensus process, that includes consideration of the strength of the evidence together with the risks and benefits to the patient, was used to develop the clinical guideline recommendations prior to multiple levels of external and internal review and approval by the A.S.P.E.N. Board of Directors. Questions: (1) Do clinical outcomes vary across levels of obesity in critically ill or hospitalized non-intensive care unit (ICU) patients? (2) How should energy requirements be determined in obese critically ill or hospitalized non-ICU patients? (3) Are clinical outcomes improved with hypocaloric, high protein diets in hospitalized patients? (4) In obese patients who have had a malabsorptive or restrictive surgical procedure, what micronutrients should be evaluated? (JPEN. J Parenter Enteral Nutr. XXXX;XX:XX-XX)

Keywords: adult; body mass index; nutrition; assessment; outcomes; research/quality; support practice; obesity

Background

As of June 2013, the American Medical Association recognized obesity as a disease that requires medical treatment.1 Based on the National Health and Nutrition Examination Survey 2009-2010, the prevalence of obesity in the United States is 35.5% in adult men, 35.8% in adult women, including 4.4% and 4.2% respectively with body mass index (BMI) ≥ 40 kg/m².2 Thus, nutrition support clinicians are likely to care for obese patients, particularly during hospital admissions. While nutrition support clinicians care for patients across a broad range of clinical settings, the bulk of publications available for this clinical guideline have come from hospitalized patients. Furthermore, since the clinical acuity of patients admitted to intensive care units (ICUs) is much higher than those who are not critically ill, for this guideline most recommendations have been made separately for these 2 groups of obese hospitalized patients when data were available.

Bariatric surgery is a common treatment for patients who have severe obesity, with estimates of approximately 200,000 adults treated with bariatric surgery annually in the United States.3 Since these procedures are designed to limit the patient’s nutrient intake as a strategy to promote significant and durable weight loss, patients treated with these procedures may require nutrition care. Thus, the purpose of this clinical guideline is to guide clinicians on the nutrition support care of hospitalized adult patients who have obesity.

From 1Mbsd Hospital, Central Ohio Surgical Associates, Columbus, OH, USA; 2University of Tennessee Health Science Center, Memphis, TN, USA; 3Department of Pharmacy, M-Carnell West Hospital, Columbus, OH, USA; 4Thomas Jefferson University Hospital, Philadelphia, PA, USA; and 5University of Pennsylvania School of Nursing, Philadelphia, PA, USA.

The A.S.P.E.N. Clinical Guidelines Editorial Board guided the development of and review of these guidelines using the GRADE system. The A.S.P.E.N. Board of Directors approved the guidelines on June 26, 2013.

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JPEN, 2013;37:714-744
Body Composition and Metabolic Rate of Obese Patients

- Obese patients have increased resting energy expenditure secondary to increased BMI.

- Obese ICU patients are more likely than lean subjects to have problems with fuel utilization, greater insulin resistance and an increase in lipid metabolism which predisposes them to greater loss of lean body mass.

- Central adipose tissue is more metabolically active than peripheral adipose tissue.

- Adipose tissue is less metabolically active than fat free mass.
What Factors on Assessment Identify Obese Patients in the ICU to be at High Risk?

- Critically ill patients who are obese experience more complications than their lean counterparts with normal BMI.
- The factors that put the obese critically ill patient at the highest risk are the presence of metabolic syndrome, sarcopenia and abdominal adiposity.
- Nutrition assessment of the obese ICU patient should focus on evidence of central adiposity, metabolic syndrome, sarcopenia, BMI > 40, SIRS, or other comorbidities that correlate with higher obesity-related risk for cardiovascular disease and mortality.

- In a study by Paolini, the presence of central adiposity and metabolic syndrome was associated with an increased ICU mortality of 44%, compared to lean counterparts in the ICU, with a mortality of 25%. (Crit Care Med. 2010;38(5):1308-1314).
- In a trauma study involving 149 SICU patients, 47% of whom were overweight or obese, the presence of sarcopenia was shown to be associated with worsened outcome.
- Mortality increased from 14% to 32%, and there were fewer ICU-free days and ventilator-free days in the presence of sarcopenia compared to those cohort patients in the SICU without sarcopenia. (Crit Care. 2013;17(5):R206).
Do Obese ICU Patients Benefit Less from Early EN in the First Week of Hospitalization, due to their Nutrition Reserves, than their Lean Counterparts?

- Early EN start within 24–48 hours of admission to the ICU for obese patients who cannot sustain volitional intake.

- The importance of providing early EN and Non-nutritional benefits of early EN is no different for the obese critically ill patient than for their lean counterparts.

  - Malnutrition is much less apparent when the ICU patient is obese: 57% of hospitalized patients with a BMI > 25 show evidence of malnutrition. Patients with a BMI > 30 have an odds ratio of 1.5 for having malnutrition. (Obes Rev. 2012;13(9):753-765).

- The reason for the surprisingly high rate of malnutrition in obese patients is part from unintentional weight loss early after admission to the ICU and a lack of attention from clinicians who misinterpret the high BMI to represent additional nutritional reserves that protect the patient:

  “THE OBESITY PARADOX”
Dietary Assessment of Critically Ill Obese Patients

A-History:

✓ Dietary history.

✓ Any significant gain or loss of weight and whether this change was intentional.

✓ Risk factors for enteral failure (changes in GI function, prior abdominal or bariatric surgeries, and/or mechanical limitations to eating).
Dietary Assessment of Critically Ill Obese Patients

**B- Examination:**
- CVS, RESP, GI exam.
- Volume status.
- Muscle wasting (chronic protein-calorie malnutrition).
- Checking entire skin surface for integrity and presence of wounds:
  - Checking skin folds carefully.
  - May need additional staff / lifting equipment.

- Determining height and weight accurately -> calculate BMI:
  - Monitoring weight daily, preferably with calibrated bed scale.

- 24 hour fluid balance.

*JPEN, 2013;37:714-744*
What is the Best Method for Determining Energy Needs in the Critically Ill Adult Patient?

- Predictive equations for REE in the obese are highly unreliable.

- No final consensus as to which prediction equation is most accurate in obese patients.

- Indirect calorimetry is the preferred ‘gold standard’ method for measuring REE however, its use is limited by cost, availability of proper equipment and trained personnel, patient ventilatory status.

- When IC is unavailable or impractical, the Penn State equation and adjusted HBE have the strongest evidence to support their use.

**SCCM/ ASPEN Guidelines-2016:**

- For all classes of obesity, the goal of the EN regimen should not exceed 65–70% of target energy requirements as measured by IC.

- If IC is unavailable, the weight-based equation 11–14 kcal/kg *actual body weight*/day for patients with BMI in the range 30–50 and 22–25 kcal/kg *ideal body weight*/day for patients with BMI > 50 would be appropriate to use.
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Recommendation</th>
<th>Guideline Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENERGY</td>
<td>Use 25-30kcal/kg, or predictive equations, or indirect Calorimetry.</td>
<td>ASPEN 2009</td>
</tr>
<tr>
<td></td>
<td>Consider hypo caloric feeding in critically ill obese (BMI &gt;30kg/m2), e.g. 60-70% of target energy requirements, or 11-14kcal/kg actual body weight, or 22-25kcal/kg ideal body weight.</td>
<td>ASPEN 2009</td>
</tr>
<tr>
<td></td>
<td>20-25kcal/kg in acute phase of critical illness.</td>
<td>ESPEN 2006</td>
</tr>
<tr>
<td></td>
<td>25-30kcal/kg in recovery phase.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25kcal/kg</td>
<td>ESPEN 2009</td>
</tr>
</tbody>
</table>
Validation Study of Energy Requirements in Critically Ill, Obese Cancer Patients

◆ **Background:** Current (ASPEN/SCCM) guidelines regarding caloric requirements and the provision of nutrition support in critically ill, obese adults may not be suitable/accurately estimate the energy requirements for similar patients with cancer.

◆ **Materials and Methods:** A retrospective validation study of critically ill, obese cancer patients from March 1, 2007, to July 31, 2010. All patients ≥18 years of age with a BMI ≥30 kg/m\(^2\) who underwent IC were included. They compared the measured energy expenditure (MEE) against the upper limit of the recommended guideline (25 kcal/kg of IBW) and MEE between medical and surgical patients in the intensive care unit.

◆ **Results:** 33 patients were included in this study. Mean MEE (28.7 ± 5.2 kcal/kg IBW) was significantly higher than 25 kcal/kg IBW (P < .001), 78% of patients had nutrition requirements greater than the current guideline recommendations.

- No significant differences in MEE between medical and surgical patients in the ICU were observed.

◆ **Conclusions:** Critically ill, obese cancer patients require more calories than the current guidelines recommend, likely due to malignancy-associated metabolic variations. The results demonstrate the need for IC studies to determine the energy requirements in these patients and for reassessment of the current recommendations.

*JPEN. 2016;40:806-813*
Nutrition Strategy for Critically Ill Obese Patients: Rationale

◆ To Prevent complications of overfeeding, such as:
  ✓ Hyperglycemia.

✓ Fluid Retention.

✓ Increased Lipogenesis.

✓ Hepatic Steatosis.

✓ Increased CO2 production, which increases the work of breathing.

✓ Preserves Fat Free Mass.

✓ Promotes Steady Weight Loss.
Nutrition Strategy for Critically Ill Obese Patients: Protein Requirements

- Muscle protein catabolism is a hallmark feature of critical illness, regardless of BMI, with studies showing losses of up to 10–20% of skeletal muscle after 1 week in the ICU.
- Obese persons have increased amounts of FFM over their height-matched lean counterparts, but are more likely to use this muscle mass as fuel during critical illness when fasted, only accelerating the rate of protein losses.
- FFM catabolism typically persists despite the provision of nutrition support, though administration of either greater total calories or protein calories has been shown to mitigate its rate and improve nitrogen balance.
- Based on nitrogen balance data from studies, the ASPEN/SCCM guidelines recommend:
  - **Protein** (Often 50–60% total calories) at:
    - 2.0 g/kg IBW per day for class I and II obesity (BMI 30-35 and 35-40 respectively).
    - 2.5 g/kg IBW per day for class III obesity (BMI >40).

*High protein hypocaloric enteral nutrition (Table-2)*
A retrospective study by Choban et al, indicated that provision of protein at a dose of 2.0g/kg of IBW/day was insufficient for achieving neutral nitrogen balance when BMI>40. (JPEN;2013 (37):714)

Table 2 - Recommended protein provision level guidelines for critically ill patients, as reported by different societies

<table>
<thead>
<tr>
<th>Society</th>
<th>Protein provision (g ptn.kg ideal weight⁻¹.d⁻¹)</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESPEN[27,28]</td>
<td>1.3-1.5</td>
<td>+ 0.2 g ptn.kg ideal weight⁻¹.d⁻¹ if trauma, obesity or nephro-replacement therapy</td>
</tr>
<tr>
<td>ASPEN[29]</td>
<td>1.2-2.0</td>
<td>If BMI &lt;30</td>
</tr>
<tr>
<td></td>
<td>≥2</td>
<td>If BMI 30-40</td>
</tr>
<tr>
<td></td>
<td>≥2.5</td>
<td>If BMI &gt;40</td>
</tr>
<tr>
<td>DITEN[43]</td>
<td>1.0-2.0</td>
<td>-</td>
</tr>
</tbody>
</table>

BMI - body mass index.
## Hypocaloric Feeding: Studies

<table>
<thead>
<tr>
<th>STUDY</th>
<th>OUTCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dickerson et al:</strong> (Nutrition. 2003 Jul-Aug;19(7-8):700)</td>
<td>Hypocaloric enteral feeding in obese surgical patients was associated with improved nitrogen balance, shorter length of stay in the ICU, and decreased use of antibiotics.</td>
</tr>
<tr>
<td><strong>Krishnan et al:</strong> (Chest 2003;124:297–305)</td>
<td>Improved ICU outcomes, including mortality, return of spontaneous ventilation, and nosocomial sepsis rates among patients receiving approximately 9–18 kcal/kg/d.</td>
</tr>
<tr>
<td><strong>Villet et al:</strong> (J Thorac Dis. 2015 Jul; 7(7): 1086–1091)</td>
<td>A higher rate of infections and poor outcomes associated with increasing negative energy balance in a prospective study of 48 ICU patients.</td>
</tr>
</tbody>
</table>
Controversies in Hypocaloric Feeding

- There are relatively few contraindications to hypocaloric feeding, other than conditions precluding the use of high-protein nutrition:

  - Progressive renal failure or hepatic encephalopathy.

  - Conditions in which full caloric (dextrose) loads are preferred such as: history of hypoglycemia, diabetic ketoacidosis, or severe immuno-compromised state.

- Mild obesity may confer a survival advantage in critical illness, steady weight loss through hypocaloric feeding might negate this.
In Adult Obese ICU Patients, Does Use of High-Protein, Hypocaloric Feeding Improve Clinical Outcomes Compared with Use of High-Protein, Eucaloric Feeding?

- Use of high-protein hypocaloric feeding in hospitalized patients with obesity is associated with at least equivalent (and possible better) outcomes as use of high protein eucaloric feeding. *JPEN*, 2013;37(6):714-744.

- In a retrospective study of 40 obese critically ill surgical and trauma patients, use of high-protein hypocaloric EN was associated with shorter ICU stay, decreased duration of antibiotics, and fewer days of mechanical ventilation compared with use of a high-protein eucaloric diet. *Nutrition*. 2002;18(3): 241-246.

- Multiple observational trials have shown equivalent nutrition outcomes and nitrogen balance studies between the 2 types of diets (whether by EN or PN). *JPEN*, 2013;37(6):714-744.

- Low intake of protein in combination with a hypocaloric diet may worsen mortality in obese patients, as was shown in a prospective observational cohort study of adult ICU patients with class II obesity (BMI, 35–39.9). *Intensive Care Med*. 2009;35(10):1728-1737.
What are the Appropriate Monitors to Follow for the Obese Critically Ill Patient Receiving Early EN?
Metabolic Response to Critical Illness and Obesity

- Obesity is a pro-inflammatory state.
- Regardless of the inciting cause of injury or illness:

  Hypermetabolic, inflammatory response to physiologic stress, directed at promoting acute survival, which affects macronutrient utilization throughout the body.

- The usual response to critical illness is modified by:
  - Insulin resistance.
  - Obesity is a pro-inflammatory state.
  - Altered body composition.

- Monitoring to assess worsening of hyperglycemia, hyperlipidemia, hypercapnia, fluid overload, and hepatic fat accumulation in the obese critically ill patient receiving EN is a must.
Metabolic Derangement in Obese Patients: Glucose Tolerance

**Impaired Glucose Tolerance:**

- The higher incidence of diabetes seen in obesity is magnified by post-receptor insulin resistance and accelerated gluconeogenesis induced by critical illness.
- The challenges of glycemic control are further complicated by overly aggressive nutrition support and by medications administered in the ICU setting such as catecholamines, exogenous glucocorticoids, and adrenergic agents.
- Insulin infusion is the preferable method to achieve normoglycemia in the ICU setting, especially as insulin absorption may vary in obese patients with substantial amounts of subcutaneous adipose tissue.
- Alternatively, regular insulin can also be added directly to TPN solution once requirements are stable.
Increased Fatty Acid Mobilization:
- Obese persons have increased blood levels of hormones and substrates, including AAs and FFAs.
- Elevations in FFA usually signify insulin resistance, which causes increased lipolysis, impaired skeletal muscle FFA oxidation, and reduced suppression of plasma FFA by insulin.
- Despite having a relative abundance of serum FFAs and triglyceride-rich adipose stores, it appears the obese individuals are ineffective at mobilizing or using these energy sources during critical illness.

Accelerated Protein degradation:
- Depletion of lean body mass & High amino acid plasma levels.
- Hypocaloric, high-protein nutrition is a preferable approach in obese patients, as it can promote endogenous fat oxidation and shift obese patients away from utilization of FFM as the predominant fuel source, while simultaneously inducing favorable changes in body composition.
- Avoidance of overfeeding is also critical because excess caloric load is associated with increased protein turnover and fat storage.
What Additional Parameters should be Addressed with a Nutrition Assessment in Critical Illness when the Patient is Obese?

- Focusing on biomarkers of metabolic syndrome (serum glucose, triglycerides, and cholesterol concentrations), an evaluation of comorbidities, and a determination of level of inflammation, in addition to those parameters described for all ICU patients.

- Attention to blood pressure together with these markers should be used to establish whether the patient has evidence of metabolic syndrome.

- Identify pre-existing as well as emerging comorbidities, including diabetes, hyperlipidemia, obstructive sleep apnea, restrictive lung disease, cardiomyopathy with congestive heart failure, hypertension, thrombogenesis, and abnormal liver enzymes to suggest fatty liver disease.

- Assessing the level of inflammation should be done by looking at CRP, erythrocyte sedimentation rate, and evidence of SIRS.
What is the Preferred Level of Infusion of EN Within the GI Tract for Critically Ill Patients? How Does the Level of Infusion of EN Affect Patient Outcomes?

- The level of infusion should be diverted lower in the GI tract in those critically ill patients at high risk for aspiration or those who have shown intolerance to gastric EN.

- Based on expert consensus we suggest that, in most critically ill patients, it is acceptable to initiate EN in the stomach.
Does the obese ICU patient with a history of bariatric surgery or other malabsorptive condition require any additional supplementation of micronutrients when starting nutrition therapy?

- The obese ICU patients with a history of bariatric surgery have an increased risk of micronutrient deficiency:
  - They should receive supplemental thiamine prior to initiating dextrose-containing IV fluids or nutrition therapy.
  - An evaluation for and treatment of micronutrient deficiencies such as calcium, thiamin, vitamin B12, fat-soluble vitamins (A, D, E, K), and folate, along with the trace minerals iron, selenium, zinc, and copper should be considered.

- Currently, there is no consensus on the optimal regimen for micronutrient supplementation. (*JPEN, 2011;35(5):52S-59S*).

- Once normalized, serum micronutrient levels should be monitored annually.
What indications, if any, exist for use of specialty enteral formulations for adult obese ICU patients?

- If available, an enteral formula with low caloric density and a reduced NPC:N be used in the adult obese ICU patient because:
  - Most enteral formulas have a high NPC:N, which necessitates the routine addition of protein supplements in an ICU setting.
  - For obese critically ill patients, these formulas are entirely inadequate in design to provide a high-protein hypocaloric diet.
  - Fluid requirements may be higher in obesity, low–energy dense formulas (1 kcal/mL) may be more appropriate.

- Intuitively, obese ICU patients might then benefit from various pharmaconutrient immune-modulating agents provided in a formula or as a supplement. (*JPEN, 2011;35(5):60S-72S*). However, due to lack of outcome data, a recommendation for their use cannot be made at this time.
Special Considerations in Obese Patients

- Obtaining enteral access for feeding is performed using the same approach as in non-obese patients, but often becomes technically challenging in the obese.

- Feeding tube placement requiring imaging for guidance is difficult in patients weighing over 300–350 lbs (136–160 kg) due to limits of fluoroscopy or roentogram table.

- Percutaneous placement of feeding access either surgically or endoscopically is associated with much higher rates of complications in the obese, including hernia, wound infection, and ileus.

- Careful monitoring by the ICU team and consideration for consultation with an anesthesiologist prior to line placement is recommended.
Conclusion

◆ Obese patients present ICU clinicians with a unique set of challenges not encountered in less obese patients.
◆ Careful consideration must be given to energy and nutrient requirement calculations in this population, as prediction equations for REE may be highly unreliable.
◆ Indirect calorimetry should always be the preferred method for measuring REE, but when it is unavailable or impractical, the Penn State equation and adjusted HBE have the strongest evidence to support their use.
◆ Hypocaloric feeding containing at least 2.0 g/kg IBW per day protein (1.3–1.5 g/kg actual weight) is an approach to nutrition support that prevents complications of overfeeding, such as hyperglycemia and fluid retention, while preserving FFM and promoting steady weight loss.
◆ Further investigation, including randomized prospective controlled trials, is needed to determine a better approach to estimating energy needs in this population, in addition to validating hypocaloric feeding as the standard approach to nutrition support in the obese patients.
Thank you for listening to my presentation!