Hypocaloric, High Protein Nutrition Support for the Obese Patient:
New 2016 A.S.P.E.N. Guidelines for the Critically Ill Patient

Ainsley Malone, MS, RDN, LD, CNSC, FAND, FASPEN

will begin shortly.

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Ainsley Malone, MS, RDN, LD, CNSC, FAND, FASPEN

Mt. Carmel West Hospital
Columbus, OH
March 3rd, 2016
Objective

1. Describe the prevalence of obesity and the challenges with the obese patient in the ICU setting

2. Outline hypocaloric, high protein nutrition support for the obese critically ill patient

Obesity Prevalence

• 2011-12—34.9% of adults (20+ years)\(^1\)
  – Not significantly increased since 2003-04

• Intensive care unit

<table>
<thead>
<tr>
<th>BMI</th>
<th>US(^2)</th>
<th>Europe(^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-29.9</td>
<td>27%</td>
<td>36%</td>
</tr>
<tr>
<td>30-39.9</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td>≥40</td>
<td>7%</td>
<td>3%</td>
</tr>
</tbody>
</table>

• Canadian ICU Nutrition Survey 07-09\(^4\)
  – BMI 25 – 39.9: 46%
  – BMI 40 – 49.9: 4%
  – BMI 50 – 59.9: 1.3%
  – BMI ≥ 60: 0.06%

Cardiopulmonary Changes in Obesity

- Decreased compliance of the respiratory system
- Reduced lung volumes
- Oxygen consumption and carbon dioxide production are increased
- Severe gas exchange impairment in post op and supine patients
- Increased susceptibility to depressant effects of sedatives and anesthetic agents
### Management Challenges in the ICU Patient

<table>
<thead>
<tr>
<th><strong>Airway management</strong></th>
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</thead>
<tbody>
<tr>
<td>More difficult tracheal intubation</td>
</tr>
<tr>
<td>Post extubation stridor</td>
</tr>
<tr>
<td>Weaning difficulty – hypoventilation, sleep apnea</td>
</tr>
<tr>
<td>Have reduced lung volumes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Positioning</strong></th>
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<tbody>
<tr>
<td>Supine and Trendelenberg restrict cardiac reserve</td>
</tr>
<tr>
<td>Prone positioning can be difficult</td>
</tr>
</tbody>
</table>

**Difficulty with central venous and arterial catheters**

**Difficult to assess volume status**
Metabolism in Critically Ill Obese

- Greater loss of lean body mass proportionate to non-obese
- Similar to catabolic response injury
- Higher diabetes prevalence
- Greater insulin resistance
- Related to hyperglycemia
- Triglyceride levels
- Greater loss of lean body mass proportionate to non-obese
Obesity and Inflammation

- Excess lipid deposition causes lipotoxicity
- Induces cell inflammation
- May lead to organ dysfunction

Figure 1. Ectopic fat deposition and pathophysiological dysfunctions in vital organs associated with obesity.

Energy Assessment Methods

Controversial

Indirect calorimetry obvious choice if available

Predictive equations most frequent choice

How to account for altered body composition in the obese

- FFM increased and ranges from 20 – 40% of excess weight
- Not a linear relationship – greater obesity, less % of LBM

Predictive equations from non-obese individuals
Poll Question

- How do you assess energy and protein needs?
  A. Indirect calorimetry
  B. Predictive equations
  C. A & B
  D. Other
**Rationale for Underfeeding in Obesity**

Stems from early work of using protein sparing diets

Obese associated with metabolic changes

- Insulin resistance
  - Hyperglycemia
- Obstructive sleep apnea
- Fatty infiltration

Provide nutrients without exacerbating metabolic issues

Protect lean body mass
Relationship Between Protein and Energy Intake on Nitrogen Balance

![Graph showing the relationship between protein intake, energy intake, and nitrogen balance.](https://via.placeholder.com/150)

- Energy Intake/Total Energy Expenditure
- Protein Intake (g/kg/d)
- Nitrogen Balance (mg/kg/d)

JPEN J Parenter Enteral Nutr 2011;35:36S-43S
What is the Evidence?
• Pilot study (n=13)
• Prospective evaluation with PN
  – 7 – gastric bypass
  – 6 – other surgical procedures
• Wt: 120 kg ± 60
• Received average of 881 Kcals (51% MREE) as non-protein kcals
  – 2.1 g/protein/kg IBW
• Duration: 48 ± 31.4 (12-190) days
Dickerson 1986

- Weight loss occurred
  - Decrease to 109 kg ± 32.5
- Nitrogen balance +2.4±1.9 g/day
  - Equal or positive balance occurred after 24 ± 9.7 days
- Wounds and fistulas healed
- In mild to mod stressed obese, hypercaloric feedings are not necessary
Prospective trial in acutely ill patients receiving PN (n=16)
- Excluded those with DM
- Primarily surgical population

Randomized to receive 50% or 100% MREE non-protein kcals
- 2 g protein/kg/IBW
- Higher dextrose and lipid intake in control group

Duration 2 weeks or transitioned to EN or PO
- 9.6 ± 3 days (5-15)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Hypocaloric</th>
<th>Control</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>90 ± 12.5</td>
<td>102± 19.9</td>
<td>NS</td>
</tr>
<tr>
<td>BMI</td>
<td>33 ± 5.5</td>
<td>35 ± 4.2</td>
<td>NS</td>
</tr>
<tr>
<td>Non-protein Kcals/d</td>
<td>585</td>
<td>1972</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total Kcals/d</td>
<td>1285</td>
<td>2492</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total Kcals/kg/IBW</td>
<td>22 ± 6.9</td>
<td>42 ± 7.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Protein g/kg IBW</td>
<td>2 ± 0.6</td>
<td>2.18 ± 0.4</td>
<td>NS</td>
</tr>
</tbody>
</table>

• Nitrogen balance
  – +1.3 ± 3.62 hypocaloric group (NS)
  – +2.8 ± 6.9 control group (NS)

• Weight loss
  – 4.1 ± 6.7 kg - hypocaloric group (NS)
  – 7.4 ± 8.4 kg - control group (NS)

• Conclusion – hypocaloric PN can result in a comparable nitrogen balance
  – Moderately stressed
Choban - 1997

- Prospective evaluation in acute/critically ill patients (n=30) requiring PN
  - Excluded those with renal or hepatic disease
- Stratified by critical or non-critical care
  - n = 13 and n = 17
- Randomized to receive PN formula
  - Hypocalorie
  - Control
  - Both received 2 g protein/kg/IBW/day
- Duration of PN
  - 10 ± 3 d in hypocalorie vs 11 ± 2 d in control
- Glucose controlled - 100-180 mg/dl

Am J Clin Nutr 1997;66:546
### Choban-1997

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<tr>
<th>Parameter</th>
<th>Hypocaloric</th>
<th>Control</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>97 ± 19</td>
<td>90 ± 17</td>
<td>NS</td>
</tr>
<tr>
<td>BMI</td>
<td>36 ± 5</td>
<td>34 ± 6</td>
<td>NS</td>
</tr>
<tr>
<td>Non-protein Kcals/d</td>
<td>814 ± 225</td>
<td>1507 ± 164</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total Kcals/d</td>
<td>1294 ± 299</td>
<td>1937 ± 198</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total Kcals/kg/IBW</td>
<td>22 ± 2.9</td>
<td>36 ± 4.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Protein g/kg IBW</td>
<td>2 ± 0.1</td>
<td>2 ± 0.1</td>
<td>NS</td>
</tr>
</tbody>
</table>

Am J Clin Nutr 1997;66:546
Nitrogen balance (NS)
- 4 ± 4.2 – hypocaloric
- 3.6 ± 4.1 - control

Weight change – no difference
- ICU patients with no difference

Trend toward lower glucose levels in hypocaloric group
- Less days requiring insulin (3.2 vs 8.0 d) p<0.05

Concluded that hypocaloric high protein PN can be provided and achieve nitrogen balance

Am J Clin Nutr 1997;66:546
Dickerson - 2002

- Retrospective evaluation in critically ill obese patients (n=40)
  - Hypocaloric = < 20 kcals/kg adj BW
  - Eucaloric = 20 – 25 kcals/kg adj BW
  - Protein intake = 2 g/kg/day IBW for both groups

- Demographic data
  - BMI = 41.3 ± 13.7 – hypocaloric group
  - BMI = 36 ± 12.4 – eucaloric group
  - Weight
    - 118 ± 41 – hypocaloric group
    - 102 ± 36 – eucaloric group

Nutrition 2002;18:241
Dickerson - 2002

• Average calorie intakes
  – 16.2 – 22.2 kg/d over 4 weeks – hypocaloric group
  – 21.5 – 29.9 kg/d over 4 weeks – eucaloric group

• Average protein intakes
  – 1.14 – 1.53 g/kg/IBW/d – hypocaloric group
  – 0.82 – 1.19 g/kg/CBW/d – eucaloric group

• Duration of therapy = maximum of 14 days

• Nitrogen Balance
  – Both groups were near nitrogen equilibrium
Dickerson 2002 – Nitrogen Balance

P = NS

Nutrition 2002;18:241
Clinical outcomes

- Decreased ICU stay (p=0.03)
- Decreased antibiotic therapy (p=0.03)
- Trend toward decreased ventilator days (P < 0.09)
- No difference in glucose levels
  - May be related to EN versus PN

• Conclusion
  - Hypocaloric EN feeding approach at least AS favorable is eucaloric feeding
  - May provide a clinical benefit

Nutrition 2002;18:241
Choban and Dickerson - 2005

- Combined data sets
- Evaluated morbidly obese (Class III = BMI ≥ 40) N = 70
  - 44 provided hypocaloric regimen
  - 26 provided eucaloric regimen
  - Via regression determined higher protein intake is needed
    - 1.9 - 2.5 g/kg/IBW in critically ill patients
  - Trend toward worsening hyperglycemia in Class III compared to less obese
Protein Intake and Nitrogen Balance

Protein Requirements

Choban, Dickerson (NCP 2005;20:480)
Dickerson - 2013

- Prospective evaluation in critically ill older trauma patients requiring EN or PN
  - Question: differences in nutrition response and clinical outcomes in older vs younger patients
- Stratified by age
  - 18-59 yrs (n=41); ≥60 yrs (n=31)

<table>
<thead>
<tr>
<th>Variable</th>
<th>18-59 years</th>
<th>≥ 60 years</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kcal/kg IBW/day</td>
<td>18±4</td>
<td>21±5</td>
<td>0.002</td>
</tr>
<tr>
<td>Protein, g/kg IBW/day</td>
<td>2.1± 0.4</td>
<td>1.9±0.3</td>
<td>0.016</td>
</tr>
<tr>
<td>Serum urea nitrogen (SUN)</td>
<td>30±14</td>
<td>20±9</td>
<td>0.001</td>
</tr>
<tr>
<td>SUN Max</td>
<td>43±19</td>
<td>28±12</td>
<td>0.001</td>
</tr>
</tbody>
</table>

J Parent Ent Nutr 2013;37:342
- No significant clinical outcome differences between older and younger groups
- Those who achieved a positive N Balance more likely to survive

Nitrogen Balance (mean) - NS
- 2.3 ± 0.3 g/kg IBW/day (older group)
- 2.3 ± 0.2 g/kg IBW/day (younger group)

p = .363
A trial of hypocaloric high protein feeding is suggested in patients who do not have severe renal or hepatic dysfunction (weak).

Hypocaloric feeding may be started with 50%-70% of estimated energy requirements or < 14 kcal/kg actual weight.

High protein feeding may be started with 1.2 g/kg actual weight or 2-2.5 g/kg ideal body weight, with adjustment of goal protein intake by the results of nitrogen balance studies.
“Suggest that high-protein hypocaloric feeding be implemented in the care of obese ICU patients” (EC)

Goals of EN regiment should not exceed 65-70% of target energy requirements from IC. If IC unavailable:
- BMI 30 – 50: Suggest 11-14 kcals/kg actual body
- BMI > 50: 22-25 kcal/kg/IBW

Suggest protein should be provided in a range:
- BMI 30 – 40: 2 g/kg/IBW/day
- BMI > 40: 2.5 g/kg/IBW/day
Guidelines – What Do They Tell Us?

Hypocaloric low protein feedings are associated with unfavorable outcomes. Clinical vigilance for adequate protein provision is suggested.

- Observational cohort study of ICU patients
- 2722 patients – 333 with Class II or III obesity
- Average calorie intake – 1009 kcals
- Average protein intake – 46 g/day
  - 0.9 - 1 g/kg/day
- Mortality higher in the Class II obesity group (0.039)

Intens Care Med 2009;35:1728.
Poll Question

- Do you currently follow the 2016 A.S.P.E.N. hypocaloric high protein recommendations for your obese patients?
  - Yes
  - No
Hypocaloric Regimens in Obese Patients

- ??’s

What are the patient populations studied?
- Does my patient fit within that population?

Renal function
- Severe azotemia without RRT?
- Marked renal dysfunction with RRT?

Liver function
- Encephalopathic or failing liver?

Duration of hypocaloric intake?
## Duration of Hypocaloric Feeding

<table>
<thead>
<tr>
<th>Author-Year</th>
<th>Population</th>
<th>Duration of Regimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dickerson - 1986</td>
<td>Non-ICU surgical</td>
<td>48 (20-190 days)</td>
</tr>
<tr>
<td>Burge - 1994</td>
<td>Non-ICU surgical</td>
<td>9.6 (5-15) days</td>
</tr>
<tr>
<td>Choban - 1997</td>
<td>ICU and non-ICU</td>
<td>9 days</td>
</tr>
<tr>
<td>Dickerson - 2002</td>
<td>ICU</td>
<td>Maximum of 14 days</td>
</tr>
</tbody>
</table>

- **Mirtallo 2010 (NCP 25:38S)**
  - Long term hypocaloric PN (BMI ≥ 40 with ECF in 67%)
  - Therapy duration: 130 ± 60 days
  - Transition to enteral nutrition: 67%

- **Hamilton 2011 (NCP 26:577)**
  - HPN in bariatric surgical patients (BMI ≥ 35)
  - Median duration of therapy: 1.5 months
  - 83% weaned to oral diet
How To Achieve High Protein Intakes

**TPN formulas**
- Requires high amino acid base formulation
  - 15%
  - Lower base AA formulations result in increased fluid intakes
  - Difficulty with standardized (pre-mix) formulas

**Enteral formulas**
- Improved options with introduction of very high protein EN formulas
  - Protein content = 35% - 37% (87.3 - 92.5 g/liter)
- Additional formulas to consider (25% protein)
- Modular protein supplementation
## Practicalities in Achieving Protein Requirements

<table>
<thead>
<tr>
<th>BMI</th>
<th>Protein Requirements (75 kg IBW)</th>
<th>EN Formula 18% protein</th>
<th>EN Formula 25% protein</th>
<th>EN Formula 37% protein</th>
<th>Protein supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Per Guideline Energy Recommendations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-40</td>
<td>150 g/day</td>
<td>55 g</td>
<td>83 g</td>
<td>115 g</td>
<td>35 g – 55 g/day</td>
</tr>
<tr>
<td>40+</td>
<td>188 g/day</td>
<td>55 g</td>
<td>83 g</td>
<td>115 g</td>
<td>73 g – 133 g/day</td>
</tr>
<tr>
<td>50+</td>
<td>188 g/day</td>
<td>76-87 g</td>
<td>103-117 g</td>
<td>144-164 g</td>
<td>24 g – 112 g/day</td>
</tr>
</tbody>
</table>

- 14 kcals/kg actual weight (200#/90.9kg) – 1270 kcals
- 22-25 kcals/kg IBW (70”/166#/75kg) – 1650 – 1875 kcals
Poll Question

• Do you use modular protein to meet the protein needs of your obese patients?
  – Yes
  – No
What If Hypocaloric Regimen Is Contraindicated?

- In the critically ill obese patient, if indirect calorimetry is unavailable, energy requirements should be based on the Penn State University 2003b predictive equation or the modified Penn State University equation if the patient is over the age of 60 years (strong).
- If the Penn State University equations cannot be used, energy requirements may be based on the Mifflin–St Jeor equation using actual body weight.

J Parent Ent Nutr 2013;37:342
Patient Case

• 45 yr male admitted for planned roux-en-y gastric bypass

• Developed post-op respiratory failure requiring intubation
  – AKI – requiring continuous renal replacement therapy
  – Severe ileus (per radiology)

• Started on PN on 5th PO day

• On 12th PO day, trach placed and G-tube placed in gastric remnant
Patient Case

- Height: 64#
- Admission weight: 467# (212 kg)
- Ideal weight: 160# (72.7 kg)
- BMI: 69

<table>
<thead>
<tr>
<th></th>
<th>Energy</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 Guidelines</td>
<td>1600-1815 kcal/day</td>
<td>145 g/day</td>
</tr>
<tr>
<td>2016 Guidelines</td>
<td>1600 – 1815 kcal/day</td>
<td>182 g/day</td>
</tr>
</tbody>
</table>

- EN initiated – very high protein formula
  - 35% protein; 87.5 g/L
Patient Case

- Enteral feeding goal rate for calories = 75 mL/hr
- Provides 157 g protein/day
- Additional 25 g protein needed for supplementation
- TPN weaned off on post op day #14th
  - Initiated protein supplementation once TPN d/c’d.
- Review of enteral infusion next 5 days
  - 79% of goal volume
  - 1422 kcals/148 g protein (with supplement)
- Increased rate to 80 mL/hr (22 hr basis)
Patient Case

- Transferred out of the ICU on post op day 20
- EN volume intake next 5 days
  - 96% of goal volume
  - 1728 kcals/183 g protein (with supplement)
- PO diet initiated after swallowing study
- EN continued throughout hospitalization
  - Transitioned to cycle infusion
  - 100 mL/h X 12 hrs
  - 66% of goal requirements – w/protein supplement
- Transferred to LTACH with cycled EN and PO
<table>
<thead>
<tr>
<th><strong>Putting It All Together</strong></th>
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<tbody>
<tr>
<td>Obesity in the ICU continues to increase</td>
</tr>
<tr>
<td>Altered body composition and metabolic response significant in the obese</td>
</tr>
<tr>
<td>Hypocaloric high protein feeding can achieve nutrition goals</td>
</tr>
<tr>
<td>- Supporting lean body mass without metabolic exacerbation</td>
</tr>
<tr>
<td>Guideline recommendations supportive</td>
</tr>
<tr>
<td>Application with PN and EN regimens achievable</td>
</tr>
</tbody>
</table>


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