Parenteral/enteral nutrition in the critically ill and obese

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Disclosure

The author of this presentation does not have any financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

Abbreviations

- ABW: actual body weight
- A.S.P.E.N: American Society for Parenteral and Enteral Nutrition
- BEE: basal energy expenditure
- BMI: body mass index
- EN: enteral nutrition
- GI: gastrointestinal tract
- IBW: ideal body weight
- ICU: intensive care unit
- IC: indirect calorimetry
- LOS: length of stay
- MAP: Mean Arterial Pressure
- OBS: observational study
- PN: parenteral nutrition
- PPN: peripheral parenteral nutrition
- REE: resting energy expenditure
- SCCM: Society of Critical Care Medicine
- TPN: total parenteral nutrition

Pharmacist Objectives

- Compare and contrast between different clinical practice recommendations for parenteral and enteral nutritional support
- Recognize different methodologies to determine nutritional requirements, and evaluate criteria associated with indicators for nutrition
- Estimate the most appropriate nutritional support for critically ill and obese patients
Pharmacy Technician Objectives

- Define and categorize obese patients through nutritional assessment
- Differentiate between enteral and parenteral nutrition support
- Describe and discuss the clinical challenges associated with providing nutritional support to the critically ill and obese patients

Obesity

- Chronic condition characterized by the presence of excess body fat
- In adults obesity is defined based on BMI

\[
\text{BMI} = \frac{\text{Weight in pounds}}{(\text{height in inches})^2} \times 703
\]

Introduction to Obesity

Health Risk and BMI

<table>
<thead>
<tr>
<th>Weight Class</th>
<th>BMI (kg/m²)</th>
<th>Health Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>30–34.9</td>
<td>Mild</td>
</tr>
<tr>
<td>Class II</td>
<td>35–39.9</td>
<td>Moderate</td>
</tr>
<tr>
<td>Class III</td>
<td>&gt; 40</td>
<td>Severe/Morbid</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>Weight Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 18.5</td>
<td>Underweight</td>
</tr>
<tr>
<td>18.5–24.9</td>
<td>Normal</td>
</tr>
<tr>
<td>25.0–29.9</td>
<td>Overweight</td>
</tr>
<tr>
<td>≥ 30</td>
<td>Obese</td>
</tr>
</tbody>
</table>

Obesity in the United States

• Epidemiology
  – 34.9% or 78.6 million of adults are obese
    • Non-Hispanic Blacks
    • Hispanics
    • Non-Hispanic Whites
    • Non-Hispanic Asians

• Etiology
  – Behavior
  – Genetics

Pathophysiology of Obesity

Prevalence of Self-Reported Obesity Among U.S. BRFSS, 2014

Clinical Outcomes in the Intensive Care Unit

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Outcome</th>
<th>Type of Evidence</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obese vs. Optimal BMI</td>
<td>Mortality</td>
<td>18 OBS</td>
<td>9 Increased, 5 Decreased, 4 No difference</td>
</tr>
<tr>
<td></td>
<td>Hospital LOS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI &gt; 40 kg/m² vs. Optimal BMI</td>
<td>Mortality</td>
<td>8 OBS</td>
<td>2 Increased, 3 Decreased, 3 No difference</td>
</tr>
<tr>
<td></td>
<td>Hospital LOS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Clinical Challenge

• Achieve net protein anabolism
• Avoid worsening of complications of obesity
  – Especially hyperglycemia
  – Recommended glucose range of 140 or 150-180mg/dl
• Avoid development of new complications of overfeeding
• Avoid further fat weight gain

Nutritional Therapy

• Intended to
  – Help attenuate metabolic response to stress
  – Prevent oxidative cellular injury
  – Favorably modulate immune responses
• For patients expected to be admitted in the critical care for 2-3 days or longer
• EN is the preferred mode of delivery
  – Overt signs of GI contractility are not required prior to initiation

Nutrition Support Clinical Guidelines Recommendations in Adult Patients With Obesity

Nutrition Assessment

• Determination of nutrition risk in all patients admitted to the ICU for whom volitional intake is anticipated to be insufficient
  – Nutritional risk screening
  – NUTRIC score
  – Evaluation of comorbid conditions
  – Function of the gastrointestinal tract
  – Risk of aspiration
  – Avoid using traditional nutrition indicators or surrogate markers
    • Prealbumin is not a good nutritional indicator
Acute Phase Response

• Defined as a group of physiologic processes occurring soon after the onset of:
  – Infection
  – Trauma
  – Inflammatory processes
  – Some malignant condition

• Fever and metabolic changes may also occur

Acute Phase Proteins

Positive Phase

• Complement System
• Coagulation and fibrinolytic system
• Transport gradients
• C-Reactive protein

Negative Phase

• Albumin
• Prealbumin
• Transferrin
• Retinol binding protein

Acute Phase Proteins

• Acute phase proteins are proteins which are classified as either positive or negative phase

• Positive phase proteins:
  – Proteins whose plasma concentrations *increase* in response to inflammation

• Negative phase proteins:
  – Proteins whose plasma concentrations *decrease* in response to inflammation

Prealbumin

• First thought of as a maker for malnutrition

• Half-life of 2 days

• Serum concentrations affected by liver/renal function, hydration, and inflammation

• New research indicates:
  – Prealbumin relates to *severity of illness*
NUTRIC Score

- Designed to quantify the risk of critically ill patients developing adverse events that may be modified by aggressive nutritional therapy.
- Scored 1-10 and is based on the following variables:
  - Age
  - APACHE II score
  - SOFA score
  - # of comorbidities
  - Days from hospital to ICU admission
  - IL-6 level

NUTRIC Score

- NUTRIC Score scoring system if IL-6 is available:
  - 0-5: Patients have a low malnutrition risk
  - 6-10: Associated with worse clinical outcomes; most likely to benefit from aggressive nutrition therapy

- NUTRIC Score scoring system if IL-6 is unavailable*:
  - 0-4: Patients have low malnutrition risk
  - 5-9: Associated with worse clinical outcomes; most likely to benefit from aggressive nutrition therapy
  - *IL-6 has been shown to contribute very little to overall NUTRIC score"
Explanation of APACHE II Score

• APACHE II is an ICU scoring system to determine severity of disease
• Applied within 24 hours of admission to ICU
• Score 0-71
• The higher the score, the more severe the disease and the higher risk of death associated
• The score is not recalculated during stay and is essentially an admission score

Explanation of SOFA score

• SOFA: Sequential Organ Failure Assessment (formally Sepsis-related Organ Failure Assessment)
• Used to determine the extent of a person’s organ function or rate of failure
• An increase of SOFA score in first 24-48 hours in the ICU predicts mortality rate
  • i.e. scores less than 9 is 33% mortality rate whereas scores more than 11 relate to a 95% mortality rate
**Explanation of SOFA score**

- SOFA score is based on the sum of six different scores, one score for each of the following systems:
  - Respiratory (PaO₂/FiO₂)
  - Coagulation (platelet count)
  - Liver (total Bilirubin)
  - Cardiovascular (MAP or pressor usage)
  - CNS (Glasgow Coma Scale)
  - Renal (Creatinine)

  *Urine output is taken into consideration when SCr > 3.5 mg/dL.*

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**Nutritionally-at-Risk Adults**

- Involuntary loss of 10% or more of usual body weight within 6 months
- Involuntary loss of ≥ 5% of usual body weight in 1 month
- Involuntary loss/gain of 10 pounds within 6 months
- Body mass index < 18.5 kg/m² or > 25 kg/m²
- Chronic disease
- Increased metabolic requirements
- Altered diets or diet schedules
- Inadequate nutrition intake, including not receiving food or nutrition products for > 7 days

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**Nutrition Assessment for Obese Patients**

**SCCM and A.S.P.E.N. 2016 guidelines**

- Determine ABW & IBW
- Calculate BMI
- Identify class of obesity
- Waist circumference measure (if possible)
- Avoid using adjusted body weight
- Evaluate markers for metabolic syndrome
- Assess comorbidities that correlate with higher obesity-related risk for cardiovascular disease and mortality
Parenteral or Enteral Nutrition?

Enteral Nutrition

- Any method of feeding that uses the gastrointestinal (GI) tract to deliver caloric requirements
  - Normal oral diet
  - Liquid supplements
  - Tube feeding
- Requires functional GI tract
- Preferred
- Different routes for administration

Routes of Enteral Nutrition

Enteral Nutrition Categories

- **Polymeric**
  - Standard
  - High nitrogen
  - Caloric dense
  - Fiber containing
- **Monomeric**
  - Partially hydrolyzed
  - Elemental
  - Peptide based
- **Disease Specific**
  - Renal
  - Hepatic
  - Pulmonary
  - Diabetic
  - Immune enhancing
- **Obese**
  - Low caloric density
  - Reduced non protein calorie to nitrogen ratio
Parenteral Nutrition

- Intravenous administration of nutrients
  - Central
  - Peripheral
- May include
  - Protein
  - Carbohydrate
  - Lipids
  - Minerals and electrolytes
  - Vitamins and other trace elements

Enteral vs. Parenteral Nutrition

<table>
<thead>
<tr>
<th>Enteral</th>
<th>Parenteral</th>
</tr>
</thead>
</table>
| - Tube Feeding
- GI Tract
- More Physiologic
- More Convenient
- Lower Risks of Complications
- Less Expensive |
| - TPN or PPN
- Central or Peripheral vein
- Less Physiologic
- Invasive
- Higher Risks of Complications
- More Expensive |

Indications for PN

- Tube feeding contraindicated
- Failed tube feeding
- Ischemic bowel
- Small bowel obstruction
- Post-Op ileus
- High output fistula
Determining Energy Requirements

Indirect Calorimetry (IC)

- \( Kcal/day = [(VO_2 \times 3.941) + VCO_2 \times 1.11)] \times 1440 \)

- Measures volume of oxygen consumption and volume of carbon dioxide
- Energy expenditure (EE) and Respiratory Quotient (RQ)
- Measure of relative fat vs. carbohydrate oxidation

Penn State equation

- Obese patients: \( 30 \leq BMI < 40 \)
- \( REE = BEE(1.1) + VE(32) + T_m(140) - 5340 \)
- \( REE \text{ (men)} = 10 (\text{wt in kg}) + 6.25 (\text{ht in cm}) - 5 (\text{age in yrs}) + 5 \)
- \( REE \text{ (women)} = 10 (\text{wt in kg}) + 6.25 (\text{ht in cm}) - 5 (\text{age in yrs}) - 161 \)
- Use actual body weight

If IC is Unavailable . . .

SCCM and A.S.P.E.N. 2016 guidelines suggest:

- Use weight-based equation
  - 11-14 Kcal/kg/d with BMI of 30-50 \( \text{kg/m}^2 \) (ABW)
  - 22-25 Kcal/kg/d with BMI > 50 \( \text{kg/m}^2 \) (IBW)

- Protein
  - 2 gm/kg/d with BMI of 30-40 kg/m² (IBW)
  - Up to 2.5 gm/kg/d with BMI > 40 kg/m² (IBW)
**Initiating Nutrition Therapy**

- EN should start within 24-48 hours of admission
  - High nutrition risk
  - When EN is not feasible, initiate PN as soon as possible following ICU admission
- Low nutrition risk
  - PN should be withheld over the first 7 days following ICU admission in the patient who cannot maintain volitional intake and early EN is not feasible

**Proceeding to Nutrition Goal**

- High nutrition risk
  - Advanced towards goal as quickly as tolerated over 24-48 hours
- 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

**Goal of Nutrition**

- Goal of the regimen should not exceed 65-70% of target energy requirements

- High protein hypo caloric feeding
  - Preserve lean body mass
  - Mobilize adipose stores
  - Minimize the metabolic complications of overfeeding

**Monitoring Parameters**

- Monitor for worsening:
  - Hyperglycemia
  - Hyperlipidemia
  - Hypercapnia
  - Fluid overload
  - Hepatic fat accumulation
History of Bariatric Surgery

- Must provide supplemental thiamine prior to initiating dextrose-containing IV fluids or nutrition therapy.
- Evaluation for micronutrient deficiencies
  - Calcium
  - Thiamin
  - Vitamin B12
  - Fat-soluble vitamins (A,D,E,K)
  - Folate
  - Trace minerals iron, selenium, zinc, and copper

Micronutrients Evaluation

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Nutrient Deficiency</th>
<th>Type of Evidence</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative to postoperative Roux-en-Y gastric bypass</td>
<td>Copper</td>
<td>3 OBS</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Zinc</td>
<td>3 OBS</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Iron</td>
<td>3 OBS</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Selenium</td>
<td>1 OBS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thiamine</td>
<td>1 OBS</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Folic acid</td>
<td>1 OBS</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Vitamin B12</td>
<td>2 OBS</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Vitamin D</td>
<td>5 OBS, 2 RCT</td>
<td>Increased with supplements</td>
</tr>
</tbody>
</table>

Requirements for Water and Electrolytes

<table>
<thead>
<tr>
<th>Component</th>
<th>Daily Cost Requirements (Dietary Reference Intakes for adults)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>2.7 to 3.7 L (ages 19 to 30) 3.1 L (ages 31 and older)</td>
</tr>
<tr>
<td>Sodium</td>
<td>1.5 g (ages 19 to 30) 1.2 g (ages 31 and older)</td>
</tr>
<tr>
<td>Chloride</td>
<td>2.5 g (ages 19 to 30) 2.0 g (ages 31 to 70) 1.5 g (age 71 and older)</td>
</tr>
<tr>
<td>Potassium</td>
<td>4.7 g (lactation)</td>
</tr>
<tr>
<td>Magnesium</td>
<td>310 mg (women) 400 mg (men)</td>
</tr>
<tr>
<td>Calcium</td>
<td>10 to 15 mg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>700 mg</td>
</tr>
</tbody>
</table>

Conclusion

- Obesity is a chronic condition with high incidence in the United States
- There are many obstacles that limit provision of nutrition support in the obese ICU
- Careful consideration must be given to energy and nutrient requirement calculations for critically ill and obese patients
- Prealbumin indicates severity of disease
- Indirect calorimetry is the preferred method for measuring REE, but when it is unavailable weight based equation should be used
- Hypo caloric/high protein feeding is the most viable approach
Patient Case: MM

MM is a 63 y/o WF who presents to the ED with complaint of abdominal pain s/p colonoscopy for the past 8 days which has limited her nutritional intake but has not caused any significant weight loss. Upon further investigation, it is found that MM has a perforated colon due to colon obstruction secondary to ovarian cancer. The patient was treated for ovarian cancer with surgery back in 2012 but metastases have moved to the colon. The patient was admitted and was scheduled for resection & re-anastomosis of the colon. Post-op, MM presented with ileus. MM’s weight is 104kg (229lbs) and her height is 5’1” (62 inches). Past medical history is positive for ovarian cancer with colon metastasis, hypertension (HTN), and diabetes.

Is this patient nutritionally-at-risk?

Nutritional assessment of obese patients according to A.S.P.E.N 2016 guidelines:

- ABW: 104kg
- IBW: 50.1kg
- BMI: 41.9 kg/m^2
- Class of obesity?
- Markers of metabolic disorder?:
- Comorbidities?:

Patient Case

References

• According to the A.S.P.E.N 2016 guidelines, what are the caloric and protein requirements?
  • Caloric requirement
  • Protein requirement

Patient Case: MM

• Is MM a candidate for EN or PN?
  • How soon should we start EN or PN in MM?