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<th>Activity Tools</th>
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<th>Webinar Audience</th>
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<tr>
<td>Polling questions</td>
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<td>Submit your responses when prompted on the screen</td>
</tr>
<tr>
<td>Questions for faculty</td>
<td>Turn in question card to staff or use microphone</td>
<td>Expand control panel (click on orange arrow) and type in your question</td>
</tr>
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<td>Evaluation</td>
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<td>Complete evaluation when you process CE online</td>
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  - Fresenius Kabi USA, LLC: consultant, speakers bureau

- Phil Ayers, Pharm.D., BCNSP, FASHP
  - Fresenius Kabi USA, LLC: speakers bureau
Learning Objectives

• Examine the current state of malnutrition in hospitalized patients.
• Identify best practices for the appropriate use and safe delivery of parenteral nutrition.
• Using a clinical case study, illustrate safe and appropriate use of parenteral nutrition in an acutely ill patient.
• Using a clinical case study, illustrate considerations for the safe and appropriate use of long-term parenteral nutrition therapy.
Assessing the Nutrition Status of Patients in the Hospital Setting

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Jackson, Mississippi
Which of the following is the most accurate nutritional marker?

a. Prealbumin
b. Albumin
c. Transferrin
d. None of the above
HCUP Malnutrition Facts

• In 2013, the all-cause 30-day readmission rate for patients with malnutrition 23/100, compared with 14.9/100 for patients without malnutrition.

• For all types of malnutrition combined, the rate of readmission was highest among
  – Ages 18-64 years
  – Medicaid patients
  – Patients in metropolitan areas

HCUP Malnutrition Facts, 2013

• Average cost/readmission was $16,900 for patients with protein-calorie malnutrition and $17,900 for patients with post-surgical non-absorption versus $13,400 readmission cost for patients without malnutrition.

HCUP Malnutrition Facts, 2013

• Septicemia was the leading diagnosis at readmission involving all types of malnutrition, except post-surgical non-absorption for which complication of device (implant or graft) was the leading reason for readmission

Types of Malnutrition among Hospital Stays with Malnutrition, 2013

- Weight loss, failure to thrive: 421,335 (21.6%)
- Underweight: 85,275 (4.4%)
- Postsurgical nonabsorption: 33,485 (1.7%)
- Nutritional neglect: 2,830 (0.1%)
- Cachexia: 161,955 (8.3%)
- Protein-calorie malnutrition: 1,249,559 (63.9%)

In-hospital Death by Malnutrition Type, 2013

Nutrition Disorders and Nutrition-Related Conditions

- Malnutrition/undernutrition
- Sarcopenia and frailty
- Overweight and obesity
- Micronutrient abnormalities
- Re-feeding syndrome

Etiology-based Malnutrition Definitions

AND/ASPEN Clinical Characteristics to Support Diagnosis of Malnutrition

- Energy intake
- Interpretation of weight loss
- Body fat
- Muscle mass
- Fluid accumulation
- Reduced grip strength

AND = Academy of Nutrition and Dietetics

Body Composition and Lab Studies

- Anthropometrics
- Bioelectrical impedance (BIA)
- Dual energy X-ray absorptiometry (DEXA)
- Imaging with CT or MRI
- Ultrasound
- Laboratory studies
  - Visceral proteins: albumin, prealbumin, transferrin, retinol binding protein, C-reactive protein
  - Nitrogen balance
  - Urine 3-methylhistidine
### Obesity Classification and Risk

<table>
<thead>
<tr>
<th>Obesity Class</th>
<th>BMI, kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25-29.9</td>
</tr>
<tr>
<td>Obesity class I</td>
<td>30-34.9</td>
</tr>
<tr>
<td>Obesity class II</td>
<td>35-39.9</td>
</tr>
<tr>
<td>Obesity class III</td>
<td>≥40</td>
</tr>
<tr>
<td>High risk</td>
<td>Waist circumference, cm</td>
</tr>
<tr>
<td></td>
<td>Men &gt; 102, Women &gt; 88</td>
</tr>
</tbody>
</table>

BMI = body mass index

NIH publication no. 98-4083, September 1998.
Visceral Protein Compartment

- RBP
- Prealbumin
- Transferrin
- Albumin

Half life (days)
Nutritionally-at-Risk Adults

- Involuntary loss of 10% or more of usual body weight within 6 months or involuntary loss of ≥ 5% or more of usual body weight in 1 month
- Involuntary loss or gain of 10 lb within 6 months

Nutritionally-at-Risk Adults

- BMI < 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 greater than 7 days

ASPEN. Definitions of terms – 2015.
Nutritionally-at-Risk Children

• A weight for length or weight for height < 10^{th} percentile or > 95^{th} percentile
• BMI for age or sex < 5^{th} percentile or > 85^{th} percentile
• Increased metabolic requirements

Nutritionally-at-Risk Children

- Impaired ability to ingest or tolerate oral feedings
- Documented inadequate provision or tolerance of nutrients
- Inadequate weight gain or a significant decrease in usual growth percentile

Nutritionally-at-Risk Neonates

• Low birth weight (<2500 g) even in the absence of gastrointestinal, pulmonary, or cardiac disorders
• Birth weight > 2 standard deviations below the mean for gestational age on fetal weight curves
• Acute weight loss of 10% or more

## Nutrition Assessment Tools

<table>
<thead>
<tr>
<th>Assessment Tool</th>
<th>Parameters</th>
<th>Illness Severity</th>
<th>Other Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini nutritional assessment</td>
<td>Weight, height, mid-arm and calf circumferences, diet history, appetite, feeding mode</td>
<td>Albumin, prealbumin, cholesterol, lymphocyte count</td>
<td>Self-perception of nutrition and health status</td>
</tr>
<tr>
<td>Subjective global assessment</td>
<td>Weight history, diet history</td>
<td>Primary diagnosis, stress level</td>
<td>Physical symptoms (SC fat, muscle wasting, ankle and sacral edema, functional capacity, GI symptoms)</td>
</tr>
<tr>
<td>NRS 2002</td>
<td>Weight loss, BMI, food intake</td>
<td>Stress level</td>
<td></td>
</tr>
<tr>
<td>NUTRIC Score</td>
<td>Age, days in hospital to ICU admission</td>
<td>APACHE II, SOFA score, number of comorbidities, IL-6</td>
<td></td>
</tr>
</tbody>
</table>

## NRS 2002 and NUTRIC Score

### NRS 2002 Score
- Score ≥ 3: enteral or parenteral nutrition should be considered
- Score ≥ 5: High nutritional risk

### NUTRIC Score
- Score ≥ 6: High nutritional risk

<table>
<thead>
<tr>
<th>Impaired Nutritional Status</th>
<th>Severity of Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent Score 0</td>
<td>Normal nutritional status</td>
</tr>
<tr>
<td>Mild Score 1</td>
<td>Wt loss &gt; 5% in 3 mos Or Food intake below 50-75% of normal requirement in preceding week</td>
</tr>
<tr>
<td>Moderate Score 2</td>
<td>Wt loss &gt; 5% in 2 mos Or BMI 18.5–20.5 + impaired general condition Or Food intake 25-50% of normal requirement in preceding week</td>
</tr>
<tr>
<td>Severe Score 3</td>
<td>Wt loss &gt; 5% in 1 month (15% in 3 mos) Or BMI &lt;18.5 + impaired general condition Or Food intake &lt; 25% of normal requirement in preceding week</td>
</tr>
</tbody>
</table>

**Note:** If age ≥ 70 years, add 1 point

**Disease states in italics are based on clinical judgement.**

**Total score** = (Points for nutritional status) + (Points for disease severity) + (Points for age)

### Factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>&lt;50</td>
<td>50-74</td>
<td>≥ 75</td>
<td>-</td>
</tr>
<tr>
<td>APACHE II Score</td>
<td>&lt;15</td>
<td>15-19</td>
<td>20-27</td>
<td>≥ 28</td>
</tr>
<tr>
<td>Baseline SOFA Score</td>
<td>&lt;6</td>
<td>6-9</td>
<td>≥ 10</td>
<td>-</td>
</tr>
<tr>
<td># Comorbidities</td>
<td>0-1</td>
<td>≥ 2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Days in hospital to ICU admit</td>
<td>0</td>
<td>≥ 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Interleukin-6 (μ/ml)</td>
<td>0-399</td>
<td>≥ 400</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Total Score** = (Total from six separate factors)
Applying Best Practices to Ensure Safe and Appropriate Use of Parenteral Nutrition

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Outline

• Introduction
• Indication
• Route and Timing
• Dosing and Formulation
• Preparation
• Barriers to Successful PN Therapy
Introduction
Parenteral Nutrition (PN)

- Valuable therapeutic intervention
  - Variety of practice settings and patient populations

- Most complex prescription drug
  - High-alert medication
  - Medication safety officer awareness

- PN-use process
  - Involves several departments and clinicians
PN-Use Process

- PN Prescribed
- PN Order Verified/Reviewed
- PN Order Compounded, Labelled, & Dispensed
- PN Administered
- Patient Assessed, Monitored, & Re-Assessed
Pharmacist Needs Assessment

- Malnutrition is prevalent
- Inadequate education and training
- Awareness of the wide array of PN products
- Applying pharmaceutics to clinical practice
- Management varies considerably from best practices
Guidance Documents

• Sterile products
  – American Society of Health-System Pharmacists
    • Technical assistance bulletins
    • Guidelines (compounding; use of automated compounding device; outsourcing)
  – United States Pharmacopeia (USP)
    • National Coordinating Committee for Large Volume Parenterals
    • USP Chapter <797>
  – Institute for Safe Medication Practices
    • Guidelines for safe preparation of sterile compounds
Guidance Documents

• PN-Specific
  – American Society for Parenteral & Enteral Nutrition (ASPEN)
    • Consensus recommendations
    • Clinical practice guidelines
    • Appropriateness of use recommendations
    • Standardized competencies
  – United States Pharmacopeia
    • USP Chapter <799>
How many PN prescriptions do you review in your typical shift?

a. None
b. 1 – 5
c. 6 – 12
d. > 12
Indications
PN Order Verification

- Patient name and other identifiers
- Birth date and/or age
- Allergies and associated manifestations
- Height and dosing weight (metric units)
- Diagnoses
- Indication(s)
- Administration route and vascular access device
- Date/time of order submission and administration
- Volume and rate of infusion
## Indications for PN

- Unable to obtain safe enteral access
- Failed trial of enteral nutrition
- Failed enteral access
- Bowel obstruction
- Paralytic ileus
- Incomplete resuscitation or hemodynamic instability
- Uncontrolled diarrhea
- High output fistula
- Intestinal failure, not otherwise specified
Consensus Recommendation

When Is Parenteral Nutrition Appropriate?

Patricia Worthington, MSN, RN, CNSC\(^1\); Jane Balint, MD\(^2\);
Matthew Bechtold, MD, FACP, FASGE, FACP, AGAF\(^3\);
Angela Bingham, PharmD, BCPS, BCNSP, BCCCP\(^4\);
Lingtak-Neander Chan, PharmD, BCNSP, CNSC, FACN\(^5\); Sharon Durfee, RPh, BCNSP\(^6\);
Andrea K. Jevenn, RD, LD, CNSC\(^7\); Ainsley Malone, MS, RD, CNSC, FAND, FASPEN\(^8\);
Maria Mascarenhas, MBBS\(^9\); Daniel T. Robinson, MD\(^10\); and Beverly Holcombe, PharmD, BCNSP, FASHP, FASPEN\(^11\)
Table 1. Elements of Appropriate PN Use.

- Identify clinical indications for PN, including manifestations of acute and chronic intestinal failure
- Recognize situations in which PN is not likely to be of benefit
- Initiate PN based on gastrointestinal function, nutrition status, and clinical status
- Select the vascular access device best suited to the therapy planned
- Implement measures to promote safety and reduce adverse outcomes
- Evaluate response to therapy
- Adjust in the therapeutic plan based on ongoing monitoring
- Assess continued need for PN
- Transition promptly to oral or enteral nutrition as feasible
- Collaborate across disciplines and departmental boundaries

PN, parenteral nutrition.
Table 10.1. Common Indications for Home Parenteral Nutrition\textsuperscript{2,3,36}

<table>
<thead>
<tr>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short bowel syndrome</td>
</tr>
<tr>
<td>Crohn’s disease</td>
</tr>
<tr>
<td>Intestinal motility disorders</td>
</tr>
<tr>
<td>Chronic bowel obstruction due to benign adhesions or strictures</td>
</tr>
<tr>
<td>Radiation enteritis</td>
</tr>
<tr>
<td>Malabsorptive disorders</td>
</tr>
<tr>
<td>Intestinal and pancreatic fistula</td>
</tr>
<tr>
<td>Gastrointestinal malignancy</td>
</tr>
<tr>
<td>Malignant bowel obstruction, carcinomatosis</td>
</tr>
<tr>
<td>Complications of bariatric surgery</td>
</tr>
<tr>
<td>Gastrochisis</td>
</tr>
<tr>
<td>Long-segment Hirschsprung’s disease</td>
</tr>
</tbody>
</table>
Route and Timing
Route and Timing

• Route
  – Vascular access device
    • Central vein, preferred over peripheral vein
  – Dedicated lumen
    • Distal tip in superior vena cava near right atrial junction

• Timing of initiation
  – As soon as possible if malnourished
  – Within 3-5 days if at risk for malnutrition
Table 4.1. Clinical Conditions Warranting Cautious Initiation of Parenteral Nutrition in Adults.\textsuperscript{52,53}

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Suggested Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperglycemia</td>
<td>Glucose greater than 180 mg/dL</td>
</tr>
<tr>
<td>Azotemia</td>
<td>Blood urea nitrogen greater than 100 mg/dL</td>
</tr>
<tr>
<td>Hypertriglyceridemia</td>
<td>Serum triglycerides greater than 200 mg/dL</td>
</tr>
<tr>
<td>Hyponatremia</td>
<td>Serum sodium less than 130 mEq/L</td>
</tr>
<tr>
<td>Hypernatremia</td>
<td>Serum sodium greater than 150 mEq/L</td>
</tr>
<tr>
<td>Hypokalemia</td>
<td>Serum potassium less than 3 mEq/L</td>
</tr>
<tr>
<td>Hypomagnesemia</td>
<td>Serum magnesium less than 1.3 mEq/L</td>
</tr>
<tr>
<td>Hypocalcemia</td>
<td>Ionized calcium less than 4.5 mg/dL</td>
</tr>
<tr>
<td>Hypophosphatemia</td>
<td>Serum phosphorus less than 2 mg/dL</td>
</tr>
</tbody>
</table>

Reprinted from Worthington P, Balint J, Bechtold M et al. When is parenteral nutrition appropriate? \textit{JPEN J Parenter Enteral Nutr.} 2017; 41:324-77. With permission from ASPEN.
Dosing and Formulation
Which of the following represents the maximum recommended rate of IV lipid emulsion (ILE) infusion?

a. 4 mg/kg/min
b. 25 mg/kg/hr
c. 110 mg/kg/hr
d. 2 g/kg/day
e. I’m not sure
PN Dosing Review

• A dose for each nutrient “per day”
  – Macronutrient
    • Amino acids, dextrose, lipid
  – Micronutrient
    • Electrolytes, vitamins, trace elements

• Evaluate in context of clinical status
  – Indication
  – Body weight
  – Organ function
  – Concurrent medication (including previous PN order)
Energy Requirements

• Requirements
  – Predictive equations
  – Weight-based
  – Measured

• Empiric values will vary depending on the patient
  – BMI < 30 kg/m² → 25 kcal/kg/day
  – BMI 30-39.9 kg/m² → 15 kcal/kg/day
  – BMI ≥ 40 kg/m² → 10 kcal/kg/day
Energy Requirements

• Source
  – Carbohydrate and lipid are energy substrates
  – Amino acids are primarily an anabolic substrate
  – Net physiologic effect is dependent on absolute and relative amounts of each macronutrient

<table>
<thead>
<tr>
<th>Approx IV Energy</th>
<th>Source</th>
<th>Max Dose</th>
<th>Max Infusion Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4 kcal/g</td>
<td>Carbohydrate</td>
<td>~5 g/kg/day</td>
<td>~3-4 mg/kg/min</td>
</tr>
<tr>
<td>10 kcal/g</td>
<td>Lipid</td>
<td>~1 g/kg/day</td>
<td>~110 mg/kg/hr</td>
</tr>
</tbody>
</table>
Protein Requirements

• Requirements
  – Weight-based
  – Measured

• Empiric values will vary depending on the patient
  – Maintenance ~1.0-1.5 g/kg/day
  – Repletion ~1.5-2.5 g/kg/day
# Daily IV Micronutrient Dosing

<table>
<thead>
<tr>
<th>Electrolytes</th>
<th>Na 1-2 mmol/kg</th>
<th>Mg 4-12 mmol</th>
</tr>
</thead>
<tbody>
<tr>
<td>K 1-2 mmol/kg</td>
<td></td>
<td>Ca 5-7.5 mmol</td>
</tr>
<tr>
<td>Cl and Acetate</td>
<td></td>
<td>P 20-40 mmol</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vitamins</th>
<th>Retinol 1 mg</th>
<th>Thiamine 3-6 mg</th>
<th>Vitamin C 100-200 mg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calciferol 5 µg</td>
<td>Riboflavin 3.6 mg</td>
<td>Pantothenic acid 15 mg</td>
</tr>
<tr>
<td></td>
<td>Tocopherol 10 mg</td>
<td>Niacin 40 mg</td>
<td>Biotin 60 µg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pyridoxine 4-6 mg</td>
<td>Cobalamin 5 µg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phylloquinone 150 µg</td>
<td>Folate 400-600 µg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trace Elements</th>
<th>Zn 3-4 mg</th>
<th>Cu 0.3-0.5 mg</th>
<th>Se 60-100 µg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cr &lt;12 µgMn 55 µg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PN Formulation Review

- Osmolarity
  - Peripheral access limitation

- Compatibility
  - All ingredients (at ordered doses and PN volume)

- Stability
  - Of critical ingredients in admixture (at ordered doses and PN volume)
    - Lipid emulsion
    - Medication
## Total Nutrient Admixture Formulation Limits

### Macronutrient

<table>
<thead>
<tr>
<th>Macronutrient</th>
<th>Final Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amino acids</td>
<td>4 – 8%</td>
</tr>
<tr>
<td>Dextrose</td>
<td>&gt; 10%</td>
</tr>
<tr>
<td>Lipid</td>
<td>2 – 5%</td>
</tr>
</tbody>
</table>

### Micronutrient

<table>
<thead>
<tr>
<th>Micronutrient</th>
<th>Upper Limit Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca (mEq/L) + PO₄ (mmol/L)</td>
<td>≤ 30</td>
</tr>
<tr>
<td>Ca (mEq/L) + Mg (mEq/L)</td>
<td>≤ 20</td>
</tr>
<tr>
<td>Na + K + Ca + Mg (mEq/L)</td>
<td>≤ 175</td>
</tr>
<tr>
<td>Zn (mg/L)</td>
<td>≤ 12</td>
</tr>
</tbody>
</table>
• Rarely is an unstable PN admixture actually *this* obvious to the naked eye
• Notice what appear to be free oil droplets throughout
  • If infused, these larger particles would eventually clog or rupture the filter, but not before many smaller particles are infused through the filter and obstruct capillaries with subsequent end-organ effects
• Thankfully not infused … but was ordered, reviewed, verified, and made!
Documentation

• Any identified problem with dosing or formulation
• Interventions to address dosing or formulation problem
• Document all steps as required for record keeping
Preparation
Preparing the PN

• Compounding PN
  – Automated compounding device
    • Use vendor-validated initial set-up
    • Barcode technology to verify products
    • Trace tubing from each source container

• Activating multichambered PN product
  – Identify correct product and volume
    • Inspect for damage
    • Completely activate
    • Make necessary additions

• Manual additions
  – Independent verification
Products

• Multichambered PN product
  – Two chambers
  – Three chambers

• Macronutrients
  – Amino acids (AA) – ingredients are product-specific
  – IV lipid emulsions (ILE) – ingredients are product-specific
ILE Products

• First-generation
  – Cottonseed oil-based (e.g., Lipomul)†

• Second-generation
  – Soybean oil-based (e.g., Intralipid, Nutrilipid)

• Third-generation
  – Mixed oils
    • Medium chain-long chain triglycerides (MCT-LCT)‡
    • Soybean oil-olive oil (e.g., Clinolipid)‡
    • Soybean oil-MCTs-olive oil-fish oil (e.g., Smoflipid)
  – Modular oils
    • Fish oil (e.g., Omegaven)‡

†Removed from market.
‡Not yet available in the U.S.
Barriers to Successful PN Therapy
Address Barriers to Successful PN Therapy

• Administrative support
  – Integrated computerized provider order entry with clinical decision support
  – Policies, procedures, and practices based on available guidance documents
  – Training to complement or supplement knowledge and skills from pharmacy school and residencies

• Additional knowledge/skills support
  – ASHP, ASPEN, USP documents
  – ASPEN (www.nutritioncare.org)
    • Nutrition Support Fundamentals and Nutrition Support Review Course
    • Nutrition Self-Assessment program
    • PN Safety webinar series
Initiating and Managing Parenteral Nutrition Therapy: Clinical Case Studies

Joseph I. Boullata, Pharm.D., BCNSP, FASPEN, FACN,
and
Phil Ayers, Pharm.D., BCNSP, FASHP
Use of Parenteral Nutrition in an Acutely Ill Patient

Joseph I. Boullata, Pharm.D., BCNSP, FASPEN, FACN
Inpatient

60-year-old man with bicuspid AV with aortic stenosis and ascending aortic dilation, admitted for elective AVR and AAA repair

PMH – GERD, dysphagia, and recurrent diverticulitis (3 episodes in 9 mo)

PSH – cholecystectomy, inguinal hernia repair with mesh placement

AEH – aspartame \(\rightarrow\) headache; lobster \(\rightarrow\) hives

Meds at home – famotidine, fish oil capsules, aluminum hydroxide/magnesium carbonate, and ibuprofen prn
Inpatient: Hospital Course

Significant post-op events

• Day 1: GI bleed within hours, required resuscitation and embolization of left gastric artery
• Day 2: continued IV pantoprazole, epinephrine and phenylephrine, as well as propofol, hydromorphone, a \( \beta \)-blocker and antimicrobial regimen
• Day 3: NPO, extubated for 2\(^{nd}\) time, hemodynamically stable, s/p VFSS SLP recommends standard aspiration precautions, regular diet with mechanical soft/chopped, small bites and sips
• Day 6: severe abdominal pain, fever, increased WBC, abdominal CT reveals multiple diverticular abscesses too small to drain, GI surgery recommends ‘bowel rest’ and an antimicrobial regimen
• Day 7: PN ordered for midline catheter administration
Inpatient: Nutrition Assessment on Day 7

History – poor oral intake (<75%) for several months, fatigue and weight loss with recurrent bouts of diverticulitis managed with NPO and antimicrobials

Vitals – 99°F 117/65 mmHg 78 bpm 18 bpm 75 kg and 1.75 m (BMI 24.5 kg/m²) Is/Os 1600/1850 mL (80 kg at admission, 90 kg 6-mo ago)

Physical – no abnormal lesions, abd soft but significant bilateral tenderness, peripheral muscle wasting, grip strength not tested but BIA → FM 22 kg (29%), FFM 53 kg (70%), total body water 53%, phase angle 5.9°

Labs –

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Na</th>
<th>K</th>
<th>Cl</th>
<th>CO₂</th>
<th>Ca</th>
<th>Mg</th>
<th>P</th>
<th>BUN</th>
<th>Cr</th>
<th>AST</th>
<th>ALT</th>
<th>AP</th>
<th>TB</th>
<th>INR</th>
<th>Gluc</th>
<th>Prealb</th>
<th>CRP</th>
<th>TG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>141</td>
<td>4.2</td>
<td>117</td>
<td>21</td>
<td>8.2</td>
<td>1.8</td>
<td>2.8</td>
<td>14</td>
<td>0.8</td>
<td>19</td>
<td>20</td>
<td>89</td>
<td>0.4</td>
<td>1.2</td>
<td>138</td>
<td>---</td>
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<tr>
<td>Day 3</td>
<td>139</td>
<td>4.0</td>
<td>110</td>
<td>20</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>18</td>
<td>1.1</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>126</td>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>Day 7</td>
<td>143</td>
<td>3.6</td>
<td>106</td>
<td>24</td>
<td>7.9</td>
<td>1.2</td>
<td>2.1</td>
<td>22</td>
<td>0.8</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>1.1</td>
<td>102</td>
<td>15</td>
<td>22</td>
<td>142</td>
</tr>
</tbody>
</table>
How would you describe this patient’s nutrition status?

a. Well nourished
b. At risk for malnutrition
c. Moderate malnutrition
d. Severe malnutrition
e. I’m not sure
Does this patient have an indication for PN?

a. Yes
b. No
c. I’m not sure
Inpatient: PN Order (Day 7)

Amino acids (Plenamine) 100 g
Dextrose 100 g
ILE (Nutrilipid) 50 g

NaCl 80 mmol
KCl 20 mmol
Ca gluc 5 mmol
Mg sulf 8 mmol
K phos 12 mmol

Multivitamins 10 mL
Multi-trace 3 mL
QS SWI 2000 mL

Total: 1160 kcal
Is the PN order appropriate based on clinical dosing criteria?

a. Yes
b. No
c. I’m not sure
Is the PN order appropriate based on compatibility and stability criteria?

a. Yes
b. No
c. I’m not sure
Inpatient: PN Order Review (Day 7)

Clinical
- Amino acids 1.3 g/kg
- Dextrose 1.3 g/kg (~1 mg/kg/min)
- Lipid 0.7 g/kg (~30 mg/kg/hr)
- Energy 15.5 kcal/kg
- Fluid 27 mL/kg

Formulation
- Midline catheter is ‘peripheral’
  - Estimated osmolarity excessive
- Dextrose too low for TNA stability
- No micronutrient incompatibilities

<table>
<thead>
<tr>
<th>Dose</th>
<th>Volume</th>
<th>Final Conc</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAs (g)</td>
<td>100</td>
<td>666.7</td>
</tr>
<tr>
<td>Dext (kcal)</td>
<td>340</td>
<td>143</td>
</tr>
<tr>
<td>Fat (kcal)</td>
<td>500</td>
<td>250.0</td>
</tr>
</tbody>
</table>

Est mOsm/L: 3221

Plus SWFI: 790
Total Volume: 2000
Inpatient: PN Order (Day 9)

Amino acids (Plenamine) 140 g ↑
Dextrose 210 g ↑
ILE (Nutrilipid) 60 g ↑

NaCl/Na acet 80 / 30 mmol
KCl 20 mmol
Ca gluc 5 mmol
Mg sulf 8 mmol
K phos 28 mmol ↑

Multivitamins 10 mL
Multi-trace 3 mL
QS SWI 1600 mL ↓

1765 kcal
Inpatient: PN Order Review (Day 9)

Clinical
- Amino acids 1.9 g/kg
- Dextrose 2.8 g/kg (~1.9 mg/kg/min)
- Lipid 0.8 g/kg (~33 mg/kg/hr)
- Energy 23.5 kcal/kg
- Fluid 21 mL/kg

Formulation
- PICC confirmed central
- Amino acids too high
  - Increase volume to 2000 mL
- No micronutrient incompatibilities
Case Review

• Patient with severe malnutrition requiring nutrition support intervention through the central venous route

• Pharmacist, dietitian, and prescriber worked together to provide a PN order that would be a stable admixture through a central vein

• Patient received goal PN for 7 days before transitioning to a regular diet
Use of Parenteral Nutrition in Patient with Enterocutaneous Fistula (ECF)

Phil Ayers, Pharm.D., BCNSP, FASHP
Case Study

LH 37-year-old woman with ECF on home PN (HPN). Patient is currently receiving chemotherapy with plans for surgical repair of ECF January 2018.

62 inches (157.5 cm), 46 kg, BMI 18.5 k/m²

PMH: peritoneal carcinoma, multiple sclerosis

PSH: colon resection, small bowel resection, ileostomy, hysterectomy
Case Study

10/18 – PN day 161 providing 1.9 g/kg/day protein, 32 kcal/kg/day, and 52 mL/kg/day

Weekly comprehensive metabolic panel, magnesium, phosphorus, triglycerides, prealbumin, complete blood count with differential

Table 2. Medicare Criteria for HPN.  

A. Massive small bowel resection within 3 mo of initiating HPN  
HPN therapy needed >90 d  
≤5 ft (153 cm) of small bowel distal to the ligament of Treitz  

C. Bowel rest for at least 3 mo  
HPN therapy needed >90 d,  
Symptomatic pancreatitis with/without pseudocyst,  
Severe exacerbation of regional enteritis, or  
Proximal enterocutaneous fistula where distal enteral tube feeding is not possible  

E. Malabsorption and malnutrition  
HPN therapy needed >90 d  
10% weight loss over ≤3 mo  
Serum albumin ≤3.4 g/dL  
Severe fat malabsorption  
- Standard 72-h fecal fat test  
- Fecal fat exceeds 50% of oral/enteral intake on a diet of at least 50 g/d of fat  

F. Severe motility disorder (of small intestine and/or stomach) and malnutrition  
HPN therapy needed >90 d  
10% weight loss over ≤3 mo  
Serum albumin ≤3.4 g/dL  
Unresponsive to max doses of prokinetic medication  
(presence of daily nausea/vomiting)  
Motility disorder demonstrated via  
- Solid meal gastric emptying study or barium/radiopaque pellets that do not reach the right colon by 6 h  

G/H: Above condition with malnutrition and failed enteral tube feeding trial  
10% weight loss within 3 mo + serum albumin ≤3.4 g/dL + failed tube feeding trial + > 90 d HPN + 1 condition below:  
- Moderate fat malabsorption (fecal fat >25% of enteral intake on a diet of 50 g/d of fat measured with a 72-h fecal fat test)  
- Malabsorption as confirmed by Sudan stain or d-xylene stool test  
- Gastroparesis as described in scenario F where isotope or pellets fail to reach the jejunum in 3–6 h, manometric motility studies with results consistent with abnormal gastric emptying, unresponsive to prokinetic medication  
- Small bowel dysmotility with gastric to right colon transit between 3 and 6 h, unresponsive to prokinetic medication  
- Small bowel resection leaving >5 ft of small bowel beyond the ligament of Treitz  
- Short bowel syndrome not as severe as scenario B  
- Mild to moderate exacerbation of regional enteritis or enterocutaneous fistula  
- Partial mechanical small bowel obstruction and surgery is not an option  

HPN, home parenteral nutrition.
<table>
<thead>
<tr>
<th>Common Indications for Home Parenteral Nutrition.\textsuperscript{2,3,36}</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Short bowel syndrome</td>
</tr>
<tr>
<td>• Crohn’s disease</td>
</tr>
<tr>
<td>• Intestinal motility disorders</td>
</tr>
<tr>
<td>• Chronic bowel obstruction due to benign adhesions or strictures</td>
</tr>
<tr>
<td>• Radiation enteritis</td>
</tr>
<tr>
<td>• Malabsorptive disorders</td>
</tr>
<tr>
<td>• Intestinal and pancreatic fistula</td>
</tr>
<tr>
<td>• Gastrointestinal malignancy</td>
</tr>
<tr>
<td>• Malignant bowel obstruction, carcinomatosis</td>
</tr>
<tr>
<td>• Complications of bariatric surgery</td>
</tr>
<tr>
<td>• Gastroschisis</td>
</tr>
<tr>
<td>• Long-segment Hirschsprung’s disease</td>
</tr>
</tbody>
</table>
Table 4.1. Clinical Conditions Warranting Cautious Initiation of Parenteral Nutrition in Adults.\textsuperscript{52,53}

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Suggested Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperglycemia</td>
<td>Glucose greater than 180 mg/dL</td>
</tr>
<tr>
<td>Azotemia</td>
<td>Blood urea nitrogen greater than 100 mg/dL</td>
</tr>
<tr>
<td>Hypertriglyceridemia</td>
<td>Serum triglycerides greater than 200 mg/dL</td>
</tr>
<tr>
<td>Hyponatremia</td>
<td>Serum sodium less than 130 mEq/L</td>
</tr>
<tr>
<td>Hypernatremia</td>
<td>Serum sodium greater than 150 mEq/L</td>
</tr>
<tr>
<td>Hypokalemia</td>
<td>Serum potassium less than 3 mEq/L</td>
</tr>
<tr>
<td>Hypomagnesemia</td>
<td>Serum magnesium less than 1.3 mEq/L</td>
</tr>
<tr>
<td>Hypocalcemia</td>
<td>Ionized calcium less than 4.5 mg/dL</td>
</tr>
<tr>
<td>Hypophosphatemia</td>
<td>Serum phosphorus less than 2 mg/dL</td>
</tr>
</tbody>
</table>

Reprinted from Worthington P, Balint J, Bechtold M et al. When is parenteral nutrition appropriate? JPNJ Parenter Enteral Nutr. 2017; 41:324-77. With permission from ASPEN.
ASPEN-FELANPE Clinical Guidelines: Nutrition Support of Adult Patients with Enterocutaneous Fistula (ECF)

- Published in Journal of Parenteral and Enteral Nutrition (JPEN) in January 2017
- GRADE process
- 7 Questions addressed in the guidelines with quality of evidence

1. What factors best describe nutrition status?
2. What is the preferred route of nutrition support?
3. What protein and energy intake provide best clinical outcomes?
4. Is fistuloclysis associated with better outcomes than standard care?
5. Are immune-enhancing formulas associated with better outcomes than standard formulas?
6. Does the use of somatostatin or somatostatin analogue provide better outcomes?
7. When is home parenteral nutrition support indicated?

What is the preferred route of nutrition support?

### Quality of Evidence: Very low

**Routes of Nutrition Therapy in ECF Patients**

- **NPO 24-48 hours**
  - Resuscitation
  - Correct fluid/electrolytes
  - Diagnostic workup

- **ECF < 500 mL/24 hours**
  - Site:
    - Esophageal, Gastric or Duodenal, if feeding tube tip below ECF
    - Distal small intestine or colon
  - EN may be feasible and tolerated
  - PN if ECF output manageable

- **ECF ≥ 500 mL/24 hours**
  - Site:
    - Proximal small bowel or feeding tube not possible to place below ECF
  - Initiate PN +/- EN

When is home parenteral nutrition support indicated?

Quality of evidence: Based on Consensus

- Patient is medically stable
- Fistula output is manageable
- High-output (>500 mL/24 hr) when surgical repair is not yet advised
- Sustain National Patient Registry for Nutrition Care: Adult HPN indication for ECF-19%

A patient with an enteroatmospheric fistula with high output may require up to ________ protein.

a. 0.8 g/kg/day  
b. 1 g/kg/day  
c. 1.5 g/kg/day  
d. 2.5 g/kg/day
What protein and energy intake provide best clinical outcomes?
Quality of Evidence: Consensus only

- Protein 1.5-2 g/kg/day
  - Up to 2.5 g/kg/day in patients with enteroatmospheric fistula and high fistula output
- Energy intake appropriate to the patient’s energy requirements based on results of nutrition assessment (observational studies report 25-30 kcal/kg/day)

Table 13.2: Laboratory Monitoring During PN (Adult and Pediatric) 

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial</th>
<th>Days 1-7</th>
<th>Ongoing, Stable</th>
<th>Discharge (or Until Stable)</th>
<th>Long-Term PN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose, BUN, creatinine, electrolytes, calcium, magnesium, phosphorus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AST, ALT</td>
<td>Daily</td>
<td>Daily</td>
<td>Daily</td>
<td>Daily</td>
<td>Daily</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Weekly</td>
</tr>
<tr>
<td>Total bilirubin, direct bilirubin</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
</tr>
<tr>
<td>Platelet count</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
</tr>
<tr>
<td>INR, PTT</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
</tr>
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<td>TSH</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
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<tr>
<td>Iron indices</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
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<tr>
<td>Zn, Se, Mg, Cu</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
</tr>
<tr>
<td>Vitamin A, B, D, E</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
</tr>
<tr>
<td>Vitamin B12, folate, folic acid</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
</tr>
<tr>
<td>ALT, ALP, amylase, lipase, amylase</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
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<tr>
<td>Creatinine</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
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<tr>
<td>Total proteins, albumin</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
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<td>As clinically indicated</td>
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<tr>
<td>Hemoglobin, platelet count, MCV, MCH, MCHC</td>
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<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
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<tr>
<td>Hematocrit, WBC, RBC, band, metamyelocyte, myelocyte, lymphocyte, monocyte, eosinophil, basophil</td>
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<td>As clinically indicated</td>
<td>As clinically indicated</td>
<td>As clinically indicated</td>
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</tr>
<tr>
<td>Ingredient</td>
<td>Quantity</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>----------------------------</td>
<td>----------</td>
<td></td>
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</tr>
<tr>
<td>Amino acids (Travasol)</td>
<td>87 g</td>
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<tr>
<td>Dextrose (70%)</td>
<td>189 g</td>
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</tr>
<tr>
<td>ILE (Smoflipid)</td>
<td>50 g</td>
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<tr>
<td>NaCl</td>
<td>180 mEq</td>
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<tr>
<td>KCl</td>
<td>30 mEq</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K acetate</td>
<td>30 mEq</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca gluc</td>
<td>5 mEq</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mg sulf</td>
<td>16 mEq</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>K phos</td>
<td>10 mmol</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Multivitamins</td>
<td>10 mL</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Multi-trace (conc)</td>
<td>1 mL</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Folic acid</td>
<td>1 mg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QS SWI</td>
<td>2400 mL</td>
<td></td>
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</tbody>
</table>
Table 1. Evaluation of Fluid Balance.

<table>
<thead>
<tr>
<th>Type of Parameter</th>
<th>Assessment Type</th>
<th>Sign or Symptom of Dehydration</th>
<th>Sign or Symptom of Fluid Overload</th>
</tr>
</thead>
</table>
| Subjective or physical symptom | Patient reported | • Dry mouth  
• Excessive thirst  
• Dark-colored urine  
• Dizziness  
• Headache  
• Cramping in extremities  
• Dry skin  
• Poor skin turgor | • Shortness of breath  
• Tachypnea  
• Edema |
| Objective sign | Intake and output documentation | • ≥2 kg weight loss in 48 hours  
• Negative fluid balance (I > O for 48 hours)  
• <1 L urine output in 24 hours  
• Increased GI losses from baseline | • ≥2 kg weight loss in 48 hours  
• Positive fluid balance (I > O by 1 L for 2 consecutive days)  
• Decreased GI losses from baseline |
| Laboratory values | Levels increase:  
• Chloride  
• Serum urea nitrogen  
• Creatinine  
Levels may increase or decrease:  
• Sodium  
• Tachycardia  
• Hypotension, specifically orthostatic | Levels decrease:  
• Sodium  
• Chloride  
• Creatinine  
• Albumin |  
• Hypertension |

GI, gastrointestinal; I, input; O, output.
Four-Week PN with Soybean Oil, Medium Chain Triglycerides, Olive Oil, and Fish Oil (SMOF) vs. Soybean Oil (SO) Emulsion in Patients with Intestinal Failure

- Double-blind, multicenter, randomized controlled trial
- 73 patients (n = 34 in SMOF group and n = 39 in SO group)
- PN similar: 1.3 g/kg/day IVFE, 3 g/kg/day dextrose, and 1.2 g/kg/day protein
- After 4 weeks, mean concentrations of alanine aminotransferase (ALT), aspartate aminotransferase (AST), and total bilirubin significantly lower in SMOF group vs. SO group

LH May-November: AST/ALT/Total Bilirubin

Ceftriaxone for UTI

UTI = urinary tract infection
Which ILE has the lowest content of phytosterol?

a. Clinolipid
b. Intralipid
c. Nutrilipid
d. Smoflipid
ILE and Phytosterol Content

Case Review:
Considerations for the Home PN Candidate

- Appropriate candidate
- Hemodynamically stable
- Competent
- Monitor for complications
Key Takeaways

• Visceral proteins are not the gold standard for the diagnosis of malnutrition
• Competent pharmacists review every PN order
• Competent pharmacist-pharmacy technician team prepare every PN admixture
• Patient should be metabolically stable before discharging on home parenteral nutrition therapy
• P&Ps and practices reflect available best practices
What will you do as a follow-up to today’s program? (Select all that apply)

- Interpret serum albumin and prealbumin with caution
- Assess nutrition status before recommending PN therapy
- Review all PN regimens against dosing & formulation guidelines
- Revisit PN preparation steps to align with best practices
- Revise P&P to align with current best practices
Selected Resources


- Ensuring the Safe Use of Parenteral Nutrition → [www.pnsafeuse.org](http://www.pnsafeuse.org)
Selected Resources (cont.)


Faculty Discussion and Questions

- **Orlando Audience**
  - PRINT your questions on a question card and a staff monitor will pick it up OR
  - Proceed to nearest microphone to ask your question

- **Webinar audience**
  - Expand control panel (click on orange arrow) and type in your question