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GENERAL OVERVIEW

Because of the prevalence of malnutrition in hospitalized patients and the relationship between malnutrition and morbidity and mortality, the University of Kentucky Hospital established the Nutrition Support Service (NSS) in 1988. The purpose of the NSS is to provide consultation to primary medical and surgical services regarding the delivery of parenteral and enteral nutrition support to
patients who are actually or potentially nutritionally compromised due to disease or injury. The NSS participates in development of hospital guidelines regarding preparation, administration, and monitoring of nutritional therapies.

NUTRITION SUPPORT SERVICE CONSULT PROCEDURE:
Consultation is provided for all adult patients in the TICU, NSICU, Burn Unit, SICU & MICU. Patients will receive a consult within 48-72 hours of ICU admission. NSS consultations are also available upon a request basis. Phone # 257-5386
Consults for other units – Phone # 323-6987

ESTIMATING NUTRITIONAL NEEDS:
1. Ideal Body Weight: (IBW)
   Women: 100 lbs for the first 5 feet; add 5 pounds for each inch above 5 feet.
   Men: 106 lbs for the first 5 feet; add 6 pounds for each inch above 5 feet.
   - Obesity: Patients above 125% of IBW, calculate an adjusted body weight:
     \[ \text{Adjusted Body Weight} = (\text{Actual weight} - \text{IBW}) \times 0.25 + \text{IBW} \]
   - Less than 5 feet tall: 100 lbs then subtract 2.5 pounds for each inch below 5 feet

2. Estimating caloric requirements: Kcal/Kg, MSJ, HBE
   - KCAL/Kg – Not likely valid if BMI >30 (consider using Ideal body weight or adjusted BW)
     - Wound Healing: 30-35 kcal/kg, increase to 35-40 kcal/kg if the pt is underweight or losing weight.
     - Sepsis and Infection: 20-30 kcal/kg
     - Trauma: 25-30 kcal/kg
     - Acute Spinal Cord Injury (SCI) 23kcal/kg or HBE w/o stress factor
     - Chronic SCI: 20-23kcal/kg depending on activity
     - Stroke: 19-20kcal/kg or (HBE x .95-1.15)
     - COPD: 25-30 kcal/kg
     - ARF: 25-35 kcal/kg
     - Hepatitis: 25-35 kcal/kg if well-nourished (@ 30kcal/kg), 30-40 kcal/kg if malnourished
     - Cirrhosis without encephalopathy: 25-35 kcal/kg
     - Cirrhosis with encephalopathy: 35 kcal/kg
     - Severe Acute Pancreatitis: 35 kcal/kg
     - Organ Transplant: 30-35 kcal/kg

Multiply the MSJ by the appropriate "injury factor" which corresponds to the degree of stress and/or the disease.

<table>
<thead>
<tr>
<th>Estimated Caloric Needs:</th>
<th>HBE or MSJ x Injury factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury Factors:</td>
<td></td>
</tr>
<tr>
<td>Surgery:</td>
<td></td>
</tr>
<tr>
<td>Major Elective</td>
<td>1.2 - 1.3</td>
</tr>
<tr>
<td>Major Non-elective</td>
<td>1.3 - 1.5</td>
</tr>
<tr>
<td>Minor Elective</td>
<td>1.2</td>
</tr>
<tr>
<td>Minor Non-elective</td>
<td>1.2 - 1.3</td>
</tr>
<tr>
<td>Infection w/temp</td>
<td>1.2 - 1.3</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Burns: 10% TBSA - 1.2, 20% TBSA - 1.5, 30% TBSA 1.7, 40% TBA - 1.8, >50% TBSA 2.0

- In the critically ill obese patient, permissive underfeeding or hypocaloric feeding with EN is recommended.
  - BMI : 30-35 - **22–25 kcal/kg ideal body weight/day**
BMI >35, the goal of the EN regimen should not exceed 60% to 70% of target energy requirements or 11–14 kcal/kg actual body weight/day (or 22–25 kcal/kg ideal body weight/day).

4. Estimated Daily Protein Needs:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Protein Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance, Unstressed</td>
<td>0.8 - 1.0 g/kg/BW*</td>
</tr>
<tr>
<td>Mild stress</td>
<td>1.0 - 1.2 g/kg/BW*</td>
</tr>
<tr>
<td>Anabolism, Mod. stress</td>
<td>1.2 - 1.5 g/kg/BW*</td>
</tr>
<tr>
<td>Infection, Major Surgery, Cancer</td>
<td>1.3 - 1.6 g/kg BW*</td>
</tr>
<tr>
<td>Multiple trauma or CHI</td>
<td>1.4 - 1.6 g/kg BW*</td>
</tr>
<tr>
<td>Major Trauma with CHI, Burns</td>
<td>1.5 - 2.0 g/kg BW*</td>
</tr>
<tr>
<td>Burns</td>
<td>2.0 - 3.0 g/kg BW*</td>
</tr>
</tbody>
</table>

*BW - Use actual body weight unless above 125% of IBW, otherwise use ADJUSTED body wt. (Assumes normal renal and hepatic function)

5. Estimated fat needs: 25-30% of total kcal/day ** Maximum 55% of kcal/day **

** May need to increase lipid to decrease glucose intake in patients with hyperglycemia

6. Measuring Energy Expenditure: Indirect Calorimetry (Metabolic Cart Study)

- Most accurate measurement of caloric needs
- Weir Formula applied to calculate caloric expenditure using the oxygen consumed and carbon dioxide produced from the oxidation of carbohydrate, fat, or protein.
- All critically ill mechanically ventilated patients receiving EN or TPN are eligible to have an oxygen consumption study
- Metabolic carts are typically performed every 10 days or more frequently as needed.

- **Weir Formula:** Kcal/day = (3.94 x VO2L/d) + (1.11 x VCO2L/d) - (2.17gm urine N2/d):
  - VO2 = oxygen consumed, VCO2 = carbon dioxide produced

- Respiratory quotient (RQ) is the ratio of CO2 produced to O2 consumed. RQ = \( \frac{CO2}{O2} \)

- RQ provides an index of substrate utilization, values and explanations below

<table>
<thead>
<tr>
<th>RQ</th>
<th>Substrate Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 – 1.3</td>
<td>Lipogenesis (overfeeding), Hyperventilation, or system “leak”</td>
</tr>
<tr>
<td>0.9 – 1.0</td>
<td>Primary carbohydrate oxidation, Metabolic acidosis</td>
</tr>
<tr>
<td>0.82 – 0.85</td>
<td>Normal, &quot;mixed&quot; substrate oxidation</td>
</tr>
<tr>
<td>0.80</td>
<td>Primary protein oxidation</td>
</tr>
<tr>
<td>0.70</td>
<td>Primary fat oxidation, SIRS with progressive, Decompensation, Increased Branched Chain Amino acid oxidation, Metabolic alkalosis, or Ethanol oxidation</td>
</tr>
<tr>
<td>&lt;.67 &amp; &gt;1.3</td>
<td>Outside range – question tests validity</td>
</tr>
</tbody>
</table>

Ideal RQ is 0.82-0.85, but consider the patient's condition and metabolic status when evaluating the RQ. For example, agitated or restless patients may have an elevated RQ independent of the substrates oxidized.

NUTRIENTS:

1. Carbohydrates:

- Preferred fuel for CNS, red and white blood cells, and granulation tissue. Typically provides 50% of the calorie intake.
- Functions as a readily available energy source for cellular functions.
- Minimum of 100-150 gm of glucose should be provided daily.
- Provides 4 Kcals/gm in regular diet. (TPN = 3.4 calories/gm)
- Optimal glucose infusion rate is 4-7mg/kg/min not to exceed 7mg/kg/min in adults, not to exceed 5mg/kg/min in sepsis

2. Protein:

- Provides amino acids necessary for the synthesis of structural protein, growth, neuromuscular, enzymatic, mental processes, and immunologic function.
RDA is 0.8 gm/kg IBW, if unstressed (maintenance)
Optimal prealbumin: Men (20 – 40 mg/dl) Women (15 – 35 mg/dl), at risk (11-19mg/dl), deficit (<11mg/dl), poor prognosis (<4mg/dl)

Nitrogen Balance: Determines the degree of protein catabolism (assumes normal renal function)

\[
N_2 \text{ Balance} = N_2 \text{ Intake} - N_2 \text{ Loss}, \quad \text{where} \\
N_2 \text{ Intake} = \frac{\text{gms protein consumed/24 hours}}{6.25} \\
N_2 \text{ Loss} = \text{gms urine urea nitrogen} + 4 \text{ (non-urinary urea losses*)}
\]

- Unmeasured fecal and dermal losses constitute 2-4 grams/day. Nitrogen loss may be underestimated with large volumes of diarrhea, NG, or fistula drainage, or with major drainage of wounds or burns.
- A positive nitrogen balance of +2 - +4 gms is optimal.
- Urine collection will be inaccurate in patients on continuous bladder irrigations.

3. Fat:
- Maintains the function and integrity of cellular and subcellular membranes, provides padding to organs, provides insulation for the body, and serves as precursors of prostanoids (prostaglandins, prostacyclins, and thromboxanes) and the leukotrienes. Important in platelet function, wound healing, and maintenance of skin and hair.
- Most concentrated source of calories providing 9kcals/gm
- Parenteral lipid emulsion provides fat ONLY as long chain triglycerides derived from safflower or soybean oil.
- Provide: 30-40% of calories from fat with a maximum of 55% or 2.0 gm/kg.
- Complications related to IV fats include: hepatomegaly, impaired clotting, reduced antibody inhibition of neutrophil chemotaxis, impaired phagocytosis, and depressed reticuloendothelial system function, resulting in impaired bacterial clearance and enhanced bacterial virulence.
- Current lipid emulsions contain a high concentration of linoleic acid (W-6 PUFA). Excess W-6 PUFA function as precursors for prostaglandins and leukotrienes of the 2 and 4 series, and may enhance vasoconstriction, platelet aggregation, monokine depression, and immunosuppression.
- Propofol in 10% intralipid emulsion: calculate 1.1 kcal/ml from administration

- Monitoring lipid tolerance:
  - Obtain *fasting triglycerides (TRIG) prior to infusing lipid.
  - Hypertriglyceridemia (> 300mg/dl) indicates poor lipid clearance and may reflect a change in the patient's condition, i.e., multi-system organ failure, SIRS, liver failure, or renal failure. Decrease the daily lipid dose and/or extend the frequency of dosing. (Optimal TRIG<200)
  - Elevations of serum TRIG (>1000mg/dl) may result in pancreatitis.
* Fasting = minimum of 6 hours without lipid infusion.

4. Electrolytes & Free Water:
- All TPN and enteral formulas contain a standard amount of electrolytes.
- Enteral formulas are all relatively low in sodium.
- Specialty enteral formulas have modified electrolyte concentrations.
- Most people require 1ml of free water for each 1kCal; free water needs vary by clinical conditions and disease states

5. Vitamins:
- A multivitamin is added daily to TPN solutions unless otherwise ordered.
- Enteral products vary in the amount and type of vitamins in each 240ml can.

6. Trace Elements:
- Trace element doses recommended by the AMA Nutrition Advisory Group (NAG).
- Long-term TPN patients require daily selenium additives unless in renal failure.
- The recommendations for daily parenteral administration of zinc, copper, manganese, and chromium, and selenium are given below. See page 8 for a complete list.

<table>
<thead>
<tr>
<th>Element</th>
<th>Dose</th>
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<tbody>
<tr>
<td>Copper</td>
<td>0.5-1.5mg</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.15-0.8mg</td>
</tr>
<tr>
<td>Chromium</td>
<td>10-15mcg</td>
</tr>
<tr>
<td>Selenium</td>
<td>20-80 mcg</td>
</tr>
<tr>
<td>Zinc</td>
<td>2.5-mg</td>
</tr>
</tbody>
</table>

ACUTE RENAL FAILURE:
1. Caloric requirements: approximately 25-35 kcal/kg/day
2. Protein Requirements

<table>
<thead>
<tr>
<th></th>
<th>Amount (gm/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predialysis</td>
<td>0.6-0.8 gm/kg/day</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>1.2-1.3 gm/kg/day</td>
</tr>
<tr>
<td>CRRT</td>
<td>1.5-2.5 gm/kg/day</td>
</tr>
<tr>
<td>PD</td>
<td>1.2-1.3 gm/kg/day</td>
</tr>
</tbody>
</table>

3. Avoid Fat soluble vitamins with **chronic** renal failure to avoid Vit A toxicity.
4. Supplement B-complex vitamins for dialysis patients.
5. Intradialytic Parenteral Nutrition (IDPN): Not administered at UKMC.

**LIVER FAILURE:**

1. Hepatitis:
   - 25-35 kcal/kg if well nourished. If malnourished, 30-40 kcal/kg.
   - 120-140% of REE without ascites. 150-175% of REE if ascites, infection, or malabsorption are present or if nutritional repletion is necessary.
   - 1.2-1.5 gm PRO/kg/day.

2. Cirrhosis without encephalopathy:
   - No protein restriction (1.0-1.2 gm/kg/day).
   - High complex CHO, high calorie diet (25-35 kcal/kg/day).
   - Frequent small meals and bedtime snack.
   - Water restriction only if hyponatremia.
   - Sodium restriction only if ascites or edema is present.
   - MVI, calcium, zinc and magnesium supplements as needed.

3. Cirrhosis with acute encephalopathy:
   - Temporary protein restriction (0.6-0.8 gm/kg/day) until cause of encephalopathy is diagnosed and eliminated.
   - BCAA if refractory encephalopathy or negative nitrogen balance.
   - Resume normal protein intake (1.0-1.2 gm/kg/day) as soon as possible.
   - Provide high-calorie feeding regimen (35 kcal/kg/day).
   - Water restriction if hyponatremia.
   - Sodium restriction if ascites or edema.

4. Cirrhosis with chronic encephalopathy:
   - Protein restriction (0.6-0.8 gm/kg/day) of standard protein.
   - Encourage vegetarian diet or high-fiber diet with low animal protein.
   - Frequent, small, carbohydrate-rich meals and a bedtime snack.
   - Sodium restriction if severe ascites and edemas.
   - Water restriction only if severe hyponatremia.
   - Vitamin and mineral supplements as needed.

* Indirect calorimetry is beneficial to determine energy needs in this patient population.
** If available, estimated dry weight should be used for calculations.

**BURNS:**

1. Severely burned patients require increased intake of protein until significant wound healing is achieved.
2. Some literature supports to use of supplemental arginine, glutamine, and HMB for wound healing. However, supplemental arginine is not recommended for septic patients.
3. Macronutrient distribution:
   - CHO: 50-60%
   - FAT: 10-30% with a minimum of 2-4% as EFAs
   - PRO: 20-25% (~1.5-2.0 gm/kg/day up to 3-4 gm/kg/day in patients with large surface area burns)

4. Wound nitrogen loss (grams of nitrogen/kg/day)
   - <10% .02 N/kg/day, 11-30% .05 N/kg/day, >31% .12 N/kg/day

5. Recommended vitamin and mineral supplementation:
   - <20% TBSA burned or reconstructive patient:
     1. One MVI daily
   - >20% TBSA burned
     1. One MVI daily
2. 500 mg of ascorbic acid twice daily
3. 8,000-10,000 IU of vitamin A daily
4. 45-50 mg of elemental zinc daily

ENTERAL NUTRITION SUPPORT:

Indications: Patients with a functional GI tract but are unable to take adequate oral diet.

1. Carbohydrate (CHO):
   - Concentration & form of CHO constitute major differences between formulas.
   - Forms of CHO include:
     - Simple sugars and monosaccharides (glucose and fructose).
     - Disaccharides (sucrose, lactose, and maltose) require enzymatic conversion to monosaccharides in the intestinal brush border prior to absorption.
     - Polysaccharides and oligosaccharides, produced from hydrolysis of starch, result in glucose polymers of intermediate chain lengths.
     - Starch hydrolysis increases the solubility and osmolality of the product.

2. Protein:
   - Source, form, and concentration vary between formulas.
   - Three major categories are classified by degree of digestion required:
     - Intact protein, found in whole foods, requires complete digestion.
     - Hydrolyzed protein - enzymatically hydrolyzed to smaller peptide fragments and free amino acids, partially hydrolyzed protein requires digestion while di and tri-peptides are absorbed directly. Useful in conditions such as short bowel and Crohn's disease and pancreatic insufficiency.
     - Crystalline amino acids – theoretically require minimal digestion. The small particle size increases the osmolality.

3. Fat:
   - Increases the caloric density but does not contribute to the osmolality.
   - Most formulas contain long chain triglycerides (LCT) with variable amounts of medium-chain triglycerides (MCT) and mono and diglycerides.
   - MCT are transported via the portal system directly into the blood stream where they are oxidized to ketones and carbon dioxide. MCT does not require emulsification for absorption, and their use is indicated with CF, liver disease, pancreatitis, and other disorders where fat absorption may be impaired.

How to Choose an Enteral Product:
- Product type depends on patient's needs and functional status of the GI tract.
- Caloric density ranges from 1.06-2kcal/ml.
- Some products have nutrient modifications (e.g. CHO, fat) for certain clinical conditions.
- Most patients will tolerate a standard 1.0 calorie/ml isotonic feeding. Patients requiring volume restriction or high calorie or high protein requirements may benefit from a calorie dense, high nitrogen product.
- Elemental or semi-elemental feedings are very low in fat and are easily digested or absorbed. These feedings may be appropriate for patients with GI disorders such as Crohn's disease or pancreatic insufficiency.
- Some products contain fiber to aid in resumption of normal bowel function since most feedings are fairly low in residue. (Jevity, Nepro, Ensure Plus)
- Hepatic and Renal formulas:
  - Renal Formula is indicated for elevated electrolytes prior to hemodialysis.
  - Hepatic formula is NOT indicated for acute encephalopathy when other sources are likely the cause (infection & hydration). Only indicated for chronic encephalopathy. Protein restriction is not indicated in encephalopathy.

Selection of Enteral Access Devices:
- Factors to consider when selecting the appropriate type of enteral access include anatomic alterations of the GI tract, cost-effectiveness, patient comfort, duration of feeding, tolerance of pre vs. post pyloric feeding.
- Enteral access devices include small-bore feeding tubes, percutaneous endoscopic gastrostomy/percutaneous endoscopic jejunostomy, surgical gastrostomy or jejunostomy.
- Non-weighted oral or nasal small-bore feeding tubes placed blindly, endoscopically, or fluoroscopically are used in adults since they do not require removal prior to MRI.

Placement of Enteral Access:
- Administer 10mg IV metaclopramide 15-20 minutes prior to insertion to facilitate post-pyloric placement.
- If duodenal intubation is not achieved, two attempts or if initial attempts produce adverse changes in vital signs and/or ICP, endoscopic placement for a postpyloric feeding tube (with sedation) is recommended.
• Longer (12 Fr, 60") non-weighted FT are also placed endoscopically or during laparotomy.
• Either gastric or small feeding is acceptable in the ICU. Small bowel feeding is preferable for patients with high risk of aspiration or susceptible to altered gastric emptying such as those with head injury, diabetic gastroparesis, critical illness etc.
• NG feeding may be acceptable in patients who are alert and at low risk for aspiration such as those with head and neck cancer, hyperemesis gravidarum, etc.

Caution:

• Because of the small risk of tube perforation, the wire stylet should not be replaced (without physician supervision) while the tube is still in the patient.
• Malpositioning of a FT can cause perforation of the lung with resultant PTX.
• Blind nasal placement of a feeding tube should be avoided in patients with complex facial and/or basilar skull fractures because there is a small but real risk of intracranial placement of the tube.

Initiating Enteral Nutrition:

• Administration rates are difficult to standardize since patient tolerance varies.
• Start slowly @25ml/hr, increase gradually depending on the patient response.
• Increase rate by 25cc/hour every 6-8 hours until final rate is obtained.
• There is NO ADVANTAGE to diluting an isotonic feeding.

Delivery Method:

• Continuous or cyclic: tube feeding via a pump is preferred and decreases aspiration risk.
• Intermittent feeding: usually 240-480ml, over a 45-60 minute period 5-8 times per day. Preferred by ambulatory patients. Disadvantage includes: poor tolerance since a larger feeding volume is administered over a short time.
• Bolus feeding: rapid infusion via syringe through a gastrostomy tube but not a nasoenteral FT. Often poorly tolerated as this may result in nausea, diarrhea, distention, cramps, or aspiration. Bolus feeding is discouraged in the ICU.

Care of the Feeding Tube

• Flush the feeding tube with 20-30cc of warm water every 2 - 4 hours and before and after the tube is clamped. Warm water irrigation helps to ensure tube patency and prevents residue buildup.
• Never aspirate duodenal contents through the small bowel feeding tube. The purpose of aspiration is to assess gastric residuals. Aspirating a small bowel feeding tube provides no information and frequently results in tube clogging.

GUIDELINES FOR MEDICATION ADMINISTRATION VIA FEEDING TUBES:
Some medications may be administered through the FT as a less expensive alternative to parenteral delivery. However, many drug preparations are incompatible for this route of administration and could result in altered drug bioavailability or costly procedures to replace clogged feeding tubes.

• NEVER physically mix medications with the enteral feeding formulas, especially syrups which will curdle the protein.
• Flush feeding tube with 30ml of water BEFORE AND AFTER each medication administration and stopping the feedings.
• Avoid combining multiple medications for administration due to possible drug-drug interactions.
• Most liquid medications are hypertonic and should be diluted with 30-60ml of water prior to administration.
• Administer each drug separately and flush the feeding tube with at least 15 ml of water between and after each dose.
• NEVER crush or dissolve specially formulated dosage preparations such as SA, SL, XL, EC etc.. unless formulated for this purpose. Examples: CalanR SR, InderalR LA, ProcardiaR XL, Pancrease MT.
• Only administer sucralfate (CarafateR), omeprazole, antacids, iron salts, and ketoconazole (NizoralR) into the stomach, NOT a feeding tube located in the small bowel.
• Stop continuous tube feedings for 1 hour before and 1 hour after each phenytoin (DilantinR) dose to maximize the drug absorption.
• When diarrhea occurs, determine if any medication contains excessive quantities of sorbitol. Examples include: acetaminophen elixir, codeine solution, diazepam solution, LomotilR, furosemide solution, guaifenesin syrup, lithium citrate syrup, metoclopramide syrup, morphine sulfate solution potassium chloride elixirs, and some theophylline solutions.
**COMPLICATIONS OF ENTERAL FEEDINGS:**

Complications of enteral feeding range in severity from mild to life-threatening. Complications, possible causes, and suggested treatments for common problems are described on the following four pages.

1. **GASTROINTESTINAL**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Possible Cause</th>
<th>Possible Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea &amp; Vomiting:</td>
<td>Rapid infusion rate</td>
<td>Start tube feeding slowly, increase gradually as tolerated.</td>
</tr>
<tr>
<td>Gastric feeding intolerance</td>
<td>Feed beyond the pylorus.</td>
<td></td>
</tr>
<tr>
<td>High fat formulas</td>
<td>Use lower fat formula, particularly if (delay gastric emptying)</td>
<td>Use lower fat formula, particularly if patient has biliary tract disease.</td>
</tr>
<tr>
<td>Delayed Gastric Emptying:</td>
<td>Commonly associated with critical illness and certain disease process eg., CNS, disorders, DKA, pulmonary disease, trauma, malnutrition/hepatic coma, MI hypercalcemia, diabetes, barbiturate coma</td>
<td>Position FT beyond pylorus.</td>
</tr>
<tr>
<td>Drug therapy (i.e., digoxin, narcotics)</td>
<td>Re-evaluate drug regimen.</td>
<td></td>
</tr>
<tr>
<td>High Gastric Residuals:</td>
<td>Decreased gastric motility.</td>
<td>Residuals &gt;500ml, replace stomach contents &amp; hold gastric feeding. Place feeding tube distal to pylorus. Consider a prokinetic agent.</td>
</tr>
<tr>
<td>Constipation:</td>
<td>Inadequate water intake.</td>
<td>Monitor intake and output.</td>
</tr>
<tr>
<td>Low residue/low fiber TF</td>
<td>Change to high fiber</td>
<td></td>
</tr>
<tr>
<td>Decreased bowel motility</td>
<td>Increase physical activity as tolerated.</td>
<td></td>
</tr>
<tr>
<td>Fecal impaction</td>
<td>Rectal exam to rule out</td>
<td></td>
</tr>
</tbody>
</table>

Diarrhea is the most common tube feeding complication. Unfortunately, most health care workers believe that the principle cause of diarrhea is enteral feeding. Tube feeding is rarely directly responsible for the diarrhea. The cause is usually multi-factorial in nature and frequently medication related.

Diarrhea:

<table>
<thead>
<tr>
<th>Possible Cause</th>
<th>Possible Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid drugs may contain</td>
<td>Evaluate drug regimen.</td>
</tr>
<tr>
<td>sorbitol: acetaminophen, Magnesium-containing antacids, digitalis, lactulose, propranolol, potassium</td>
<td>If possible, change to other medications with fewer GI side-effects Administer anti-diarrheal agents</td>
</tr>
<tr>
<td>Delivery rate/method</td>
<td>Chg to calorie dense TF and lower rate. Continuous better tolerated than bolus feeds</td>
</tr>
<tr>
<td>Low fiber/low residue</td>
<td>Usually associated with long-term feeding. Change to higher fiber</td>
</tr>
<tr>
<td>Concurrent antibiotic therapy may alter intestinal flora causing bacterial overgrowth. C.Difficile colitis and pseudomembrane formation can occur.</td>
<td>Send stool for C.Difficile toxin. Consider endoscopy for patients with severe diarrhea and systemic symptoms.</td>
</tr>
<tr>
<td>Contaminated solution or infusion set</td>
<td>Formula hangs no longer than 12 hours. Change bag and set every 24 hours.</td>
</tr>
<tr>
<td>Osmolarity of formula</td>
<td>Initiate isotonic formulas and advance only as tolerated.</td>
</tr>
<tr>
<td>Complication</td>
<td>Possible Cause</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mechanical:</td>
<td></td>
</tr>
<tr>
<td>Feeding Tube Occlusion:</td>
<td>Improper medication administration</td>
</tr>
<tr>
<td></td>
<td>Use of viscous formula.</td>
</tr>
<tr>
<td>Metabolic:</td>
<td></td>
</tr>
<tr>
<td>Volume Overload:</td>
<td>Renal or cardiac insufficiency</td>
</tr>
<tr>
<td></td>
<td>Excess fluid administration</td>
</tr>
<tr>
<td>Hypoglycemia:</td>
<td>Sudden cessation of feeding with continued insulintherapy</td>
</tr>
<tr>
<td>Hyperglycemia:</td>
<td>Stress response, diabetes, or glucose intolerance without adequate insulin therapy.</td>
</tr>
<tr>
<td></td>
<td>High carbohydrate formula</td>
</tr>
<tr>
<td></td>
<td>Overfeeding</td>
</tr>
<tr>
<td>Electrolyte imbalance:</td>
<td>Volume and/or electrolyte issues</td>
</tr>
<tr>
<td>Essential Fatty Acid Deficiency:</td>
<td>Inadequate intake of linoleic acid.</td>
</tr>
<tr>
<td>INFECTIOUS:</td>
<td></td>
</tr>
<tr>
<td>Acute Aspiration Pneumonia:</td>
<td>Aspiration of gastric contents, primarily in comatose, weak, or debilitated patients, and in patients with neuromuscular disorders or CVA. Patients with tracheostomies are at high risk.</td>
</tr>
<tr>
<td></td>
<td>Tube mal-position</td>
</tr>
<tr>
<td></td>
<td>Supine position of patient during and after feeding</td>
</tr>
<tr>
<td></td>
<td>Chest percussion and postural drainage while on continuous, bolus or intermittent NG feedings</td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td>Contamination of formula or administration set by personnel or by passing tube through colonized nasal passages.</td>
</tr>
<tr>
<td>Refeeding Syndrome</td>
<td>Occurs when previously malnourished</td>
</tr>
</tbody>
</table>
patients are fed high CHO loads, results in rapid fall in K, Mg, and phos this. Start feeds slowly and replace with slide scale electrolytes
GUIDELINES FOR APPROPRIATE TPN INDICATIONS IN ADULTS:

TPN INDICATIONS: TPN should only be considered when nutritional support is indicated but adequate nutrients cannot be delivered through the GI tract. It is not indicated when anticipated use is for ≤ 72 hours.

ABSOLUTE INDICATIONS FOR ADULT TPN:
1. Inability to absorb adequate nutrients via the GI tract resulting from one of the following conditions:
   a.) Massive small bowel resection: (Less than 100 cm of small bowel or 60 cm of small bowel with an IC valve and colon)
   b.) Chronic malabsorption from a chronic disease or radiation
2. Enterocutaneous fistulas:
   a.) When bowel rest is indicated for at least 7 days (including pre and post-operative periods).
   b.) High output enterocutaneous fistula that is or has been stimulated by enteral nutrition.

RELATIVE INDICATIONS FOR ADULT TPN:
1. Severe malnutrition (prealbumin <10) along with along with one of the following
   a.) Malabsorption or inability to absorb adequate nutrients via the GI tract for greater than 7-10 days
   b.) Major GI Surgery or post-operative small bowel obstruction present and inability to utilize the GI tract for > 7 days
   c.) Suspected GI ischemia.
   d.) Mechanical bowel obstruction with inability to utilize the GI tract for > 7 days
   e.) Prolonged hemodynamic instability precluding the advancement of enteral nutrition due to the use of vasopressors for hypotension for more than 5 days
   f.) Enteral feeding access not possible due to one of the following conditions:
      o Obstructing lesions of the aerodigestive tract e.g. pharynx, esophagus
      o Gastric outlet obstruction
      o Tracheo-esophageal fistula
2. Gastrointestinal hemorrhage (upper) where enteral access is not feasible for 5-7 days.
3. Severe hemorrhagic pancreatitis requiring bowel rest for >7 days. (Defined as three or more of Ranson's early objective signs of severity of acute pancreatitis

THE TERMINAL PATIENT:
TPN is a form of medical treatment. Its use should be decided after considering the benefits and burdens as measured scientifically and clinically as well as assessed in light of the patient's wishes and values. TPN should not be instituted or continued in patients who have an untreatable terminal illness, when life expectancy is less than three months. There is no evidence to suggest that it increases survival, quality of life, or reduces suffering. In fact, attendant complications associated with TPN may outweigh any derived benefit.

REFERENCES:

TPN is NOT indicated if a patient has a functional GI tract:
1. Patient refuses enteral access
2. TPN used for < 7 days due to no clinical benefit
3. Poor gastric empty without proper small bowel enteral access
4. Short term colonic ileus

ORDERING ADULT PARENTERAL NUTRITION SOLUTIONS AT UKMC:
Adult TPN/PPN Orders are electronic forms: TPN COM
Central venous access must be confirmed prior to administering TPN. In a multi-lumen catheter, one port should be designated as a TPN port and no other solutions should be infused through this port while TPN is being infused.
1. All TPN orders, including changes or discontinuations, must be ordered by 2 PM. Orders after 2 PM will be implemented the next day.
2. TPN will be initiated at 9PM per Nursing Policy in order to minimize error.
4. 10% dextrose with MVI @ 40ml/hr can be initiated until TPN started.
5. If a critical situation occurs that requires an immediate change in the TPN solution (i.e. hyperkalemia), discontinue the TPN and infuse 10% dextrose.
6. All TPN bags contain a 24-hour supply and are hung at 9PM per Nursing Policy.
7. Lipids are administered at 0900 for optimal clearing to obtain a fasting TGLY.
8. IV Room phone number 323-6963.

Initiating TPN Infusion:
1. Initiate TPN at 25ml/hr for 8 hours, increase by 25ml/hr every 8 hours to the final goal rate.
2. **Blood sugar must be <250mg/dL** prior to initiating or increasing the rate.
3. Obtain fingerstick glucose every six hours until TPN target rate is reached and for next 72 hours. Monitor glucose daily if ≤ 150mg/dl, else every 6 hours if sliding scale insulin is required for elevated glucose.

Discontinuing (Weaning) TPN Infusion:
1. **Taper TPN to 1/2 rate for 4 hours** then D/C, slower if insulin is in the TPN or patient’s glucose is labile.
2. **It is not necessary to taper TPN infusions if TF are being administered.**
3. Discontinue when oral/enteral intake is near 50% of caloric needs.
4. Notify pharmacy of D/C order by 2 PM to prevent TPN waste.

Medication compatible to mix in TPN: Insulin, Famotidine

**UKMC STANDARD ADULT PARENTERAL NUTRITION SOLUTIONS:**

Amino Acids
1. Standard TPN Amino acid concentration is 6% amino acid concentration providing 60g/L of protein.
2. A 4.25% (42.5g/L), 5% (50g/L), or 3% amino acid (30g/L) concentration is also available.

Dextrose
1. Final dextrose concentration may be: 10%, 15%, 20%, or 25%.
2. Peripheral Parenteral Nutrition only contains 10% dextrose & 3% amino acids for less total osmolarity (<900mOsm).
3. Carbohydrate calories: 3.4kcal/gram
   - 1L of 25% dextrose = 850kcal
4. Osmolality: 50mOsm/1% dextrose
   - 25% dextrose = 1250mOsm/L

Electrolytes
1. Three standard electrolyte solutions are available for specific clinical conditions.
2. Most patients, with normal renal function, should tolerate the regular electrolyte formula.
3. Daily electrolyte supplementation must be managed independently of the TPN.
4. Maximum phos is 25mMol/L and Calcium 10mEq/L with 6% amino acids. Amino acids <6% may NOT have additional phosphorus or calcium supplemented.
5. Recommended **maximum** electrolyte concentrations per liter of TPN:
   - Na-130 mEq/L, K-80mEq, Mg-12mEq/L, Ca-10 mEq/L, Phos 25mM/L

6. The electrolyte concentrations of the 3 formulas at UKMC are **per liter**.
7. 

<table>
<thead>
<tr>
<th></th>
<th>Low K (Potassium)</th>
<th>No K (Potassium)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>77 mEq</td>
<td>77 meq</td>
</tr>
<tr>
<td>K</td>
<td>40.5 mEq</td>
<td>20 mEq</td>
</tr>
<tr>
<td>Cl</td>
<td>90.5 mEq</td>
<td>86 mEq</td>
</tr>
<tr>
<td>Ace</td>
<td>92.8 mEq</td>
<td>86 mEq</td>
</tr>
<tr>
<td>Mg</td>
<td>8 mEq</td>
<td>5 mEq</td>
</tr>
<tr>
<td>Ca</td>
<td>5 mEq</td>
<td>4.6mEq</td>
</tr>
<tr>
<td>Phos</td>
<td>15 mM</td>
<td>7.5 mM</td>
</tr>
</tbody>
</table>

K = Potassium, Mg = Magnesium, Ace = Acetate, Phos = Phosphorus, Cl= Chloride, Na = Sodium

Multi-Vitamins and Trace Elements:
1. Parenteral multi-vitamin (MVI) and trace element (TE) formulations are added daily to TPN unless otherwise ordered.
2. Certain diseases may require dose modification of vitamins and trace elements

3. The vitamin content for each TPN is listed below:

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>3300 IU</td>
<td>B1 (Thiamine) 6 mg</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>200.00 mg</td>
<td>B2 (Riboflavin) 3.6 mg</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>200.00 IU</td>
<td>B3 (Niacin) 40. mg</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>10 IU</td>
<td>B6 (Pyridoxine) 3. mg</td>
</tr>
<tr>
<td>B12</td>
<td>5</td>
<td>Biotin 60 mcg</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>15 mg</td>
<td>Folic Acid 600 mcg</td>
</tr>
</tbody>
</table>

IU = international units

4. Daily trace element (5ml) doses are as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>4 mg</td>
</tr>
<tr>
<td>Copper</td>
<td>1 mg</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.8 mg</td>
</tr>
<tr>
<td>Chromium</td>
<td>10 mcg</td>
</tr>
</tbody>
</table>

Vitamin K
1. 1.5mg vitamin K daily
2. Patients receiving warfarin should have consistent daily vitamin K or eliminated from the TPN.

Fat
1. A 20% fat emulsion is compatible for concomitant infusion with TPN solutions at the low Y site
2. A 20% fat emulsion provides 2kcal/ml.
3. Lipids must be infused with a 0.45micron filter (lipids administration set)

Histamine Antagonist: Famotidine, may be added to the TPN but adjust accordingly for renal function.

Glycemic Control:
1. Goal of insulin therapy per UK standardized insulin protocol.
2. For glucose intolerance, establish insulin needs with IV or SQ sliding scale.
3. Check finger stick glucose every 6 hours for all patients with insulin in TPN until stable for 3 days.

SAMPLE TPN CALCULATIONS:

A 24 hour TPN bag of 25% dextrose and 6% amino acids (AA) @75ml/hr along with a 250ml bottle of 20% intralipid will provide:
1. 75ml/hr x 24hr = 1800ml/day
2. 60g/L (AA) x 1.8L/day = 108g/day of protein
3. 3.4kcal/g x 250g/L = 450g/day x 3.4kcal/g x 1530Kcal/day (dex)
4. 250ml (20% lipids) x 2kcal/ml = 500kcal
5. 1530kcal + 500kcal = 2030 non-protein kcals

COMPLICATIONS OF TPN: generally classified as mechanical, metabolic, or infectious

Mechanical: Catheter related/Pneumothorax, Tension pneumothorax, Hydrothorax, Puncture of subclavian/carotid artery, Air embolism, Dysrhythmia, Venous thrombosis, Thrombo-phlebitis

Metabolic: Hypoglycemia, Hyperglycemia, Pre-renal Azotemia, TPN Hepatic Dysfunction

Infectious: Catheter-related sepsis, fungemia

HOME PARENTERAL NUTRITION:
The following must be addressed when a patient is going home on TPN:
1. Contact the Nutrition Support Service ASAP for home nutrition consultation.
2. Contact the home infusion and home health companies.
3. Assess the patient's or caregiver's competency for administering home TPN.
4. Weekly BMP, Mg, and Phos or twice weekly if the patient is less stable
GUIDELINES FOR THE PROVISION AND ASSESSMENT OF NUTRITION IN THE ADULT CRITICALLY ILL PATIENT:

INTRODUCTION

The significance of nutrition in the hospital setting cannot be overstated. This significance is particularly noted in the ICU. Critical illness is typically associated with a catabolic stress state in which patients commonly demonstrate a systemic inflammatory response. This response is coupled with complications of increased infectious morbidity, multi-organ dysfunction, prolonged hospitalization, and disproportionate mortality. Over the past three decades, the understanding of the molecular and biological effects of nutrients in maintaining homeostasis in the critically ill population has made exponential advances. Traditionally, nutrition support in the critically ill population was regarded as adjunctive care designed to provide exogenous fuels to support the patient during the stress response. This support had three main objectives: to preserve lean body mass, to maintain immune function, and to avert metabolic complications. Recently, these goals have become more focused on nutrition therapy, specifically attempting to attenuate the metabolic response to stress, prevent oxidative cellular injury, and favorably modulate the immune response. Nutritional modulation of the stress response to critical illness includes early enteral nutrition (EN), appropriate macronutrient and micronutrient delivery, and meticulous glycemic control. Delivering early nutrition support therapy, primarily using the enteral route, is seen as a proactive therapeutic strategy that may reduce disease severity, diminish complications, decrease length of stay in the ICU, and favorably impact patient outcome.

Initiate Enteral Feedings:

1. Traditional nutrition assessment tools are not validated in critical care (albumin, prealbumin, and anthropometry). Before initiation of feedings, assessment should include evaluation of weight loss and previous nutrient intake before admission, level of disease severity, comorbid conditions, and function of the gastrointestinal tract (Grade E).
2. Nutrition support therapy in the form of EN should be initiated in the critically ill patient who is unable to maintain volitional intake (Grade C).
3. EN is the preferred route of feeding over parenteral nutrition (PN) for the critically ill patient who requires nutrition support therapy (Grade B).
4. Enteral feeding should be started early within the first 24–48 hours following admission (Grade C). The feedings should be advanced toward goal over the next 48–72 hours (Grade E).
5. In the setting of hemodynamic compromise (patients requiring significant hemodynamic support, including high-dose catecholamine agents, alone or in combination with large volume fluid or blood product resuscitation to maintain cellular perfusion), EN should be withheld until the patient is fully resuscitated and/or stable (Grade E).
6. In the ICU patient population, neither the presence nor the absence of bowel sounds and evidence of passage of flatus and stool is required for the initiation of enteral feeding (Grade B).
7. Either gastric or small bowel feeding is acceptable in the ICU setting. Critically ill patients should be fed via an enteral access tube placed in the small bowel if at high risk for aspiration or after showing intolerance to gastric feeding (Grade C). Withholding of enteral feeding for repeated high gastric residual volumes alone may be a sufficient reason to switch to small bowel feeding (the definition for high gastric residual volume is likely to vary from one hospital to the next, as determined by
individual institutional protocol) (Grade E) (see No. 4 of Monitoring Tolerance and Adequacy of EN section for recommendations on gastric residual volumes, identifying high-risk patients, and reducing chances for aspiration).

When to use Parenteral Nutrition:

1. If early EN is not feasible or available over the first 7 days following admission to the ICU, no nutrition support therapy (standard therapy) should be provided (Grade C). In the patient who was previously healthy before critical illness with no evidence of protein–calorie malnutrition, use of PN should be reserved and initiated only after the first 7 days of hospitalization (when EN is not available) (Grade E).

2. If there is evidence of protein–calorie malnutrition at admission and EN is not feasible, it is appropriate to initiate PN as soon as possible following admission and adequate resuscitation (Grade C).

3. If a patient is expected to undergo major upper gastrointestinal surgery and EN is not feasible, PN should be provided under very specific conditions:
   - If the patient is malnourished, PN should be initiated 5–7 days preoperatively and continued into the postoperative period (Grade B).
   - PN should not be initiated in the immediate postoperative period, but should be delayed for 5–7 days (should EN continue not to be feasible) (Grade B).
   - PN therapy provided for a duration of <5–7 days would be expected to have no outcome effect and may result in increased risk to the patient. Thus, PN should be initiated only if the duration of therapy is anticipated to be ≥7 days (Grade B).

Dosing of Enteral Feeding:

1. The target goal of EN (defined by energy requirements) should be determined and clearly identified at the time of initiation of nutrition support therapy (Grade C). Energy requirements may be calculated by predictive equations or measured by indirect calorimetry. Predictive equations should be used with caution, as they provide a less accurate measure of energy requirements than indirect calorimetry in the individual patient. In the obese patient, the predictive equations are even more problematic without availability of indirect calorimetry (Grade E).

2. Efforts to provide >50% to 65% of goal calories should be made to achieve the clinical benefit of EN over the first week of hospitalization (Grade C).

3. If unable to meet energy requirements (100% of target goal calories) after 7–10 days by the enteral route alone, consider initiating supplemental PN (Grade E). Initiating supplemental PN before this 7–10-day period in the patient already on EN does not improve outcome and may be detrimental to the patient (Grade C).

4. Ongoing assessment of adequacy of protein provision should be performed. The use of additional modular protein supplements is a common practice, as standard enteral formulations tend to have a high nonprotein calorie:nitrogen ratio. In patients with body mass index (BMI) <30, protein requirements should be in the range of 1.2–2.0 g/kg actual body weight per day, and may likely be even higher in patients with burn or multiple trauma (Grade E).

5. In the critically ill obese patient, permissive underfeeding or hypocaloric feeding with EN is recommended. For all classes of obesity where BMI is >30, the goal of the EN regimen should not exceed 60% to 70% of target energy requirements or 11–14 kcal/kg actual body weight/day (or 22–25 kcal/kg ideal body weight/day). Protein should be provided in a range >=2.0 g/kg ideal body weight/day for class I and class II patients (BMI 30–40), >=2.5 g/kg ideal body weight/day for class III (BMI >=40). Determining energy requirements is discussed elsewhere (Grade D).
Monitoring Tolerance and Adequacy of EN:

1. In the ICU setting, evidence of bowel motility (resolution of clinical ileus) is not required to initiate EN in the ICU (Grade E).
2. Patients should be monitored for tolerance of EN (determined by patient complaints of pain and/or distention, physical examination, passage of flatus and stool, abdominal radiographs) (Grade E). Inappropriate cessation of EN should be avoided (Grade E). Holding EN for gastric residual volumes <500 mL in the absence of other signs of intolerance should be avoided (Grade B). Making the patient nil per os surrounding the time of diagnostic tests or procedures should be minimized to prevent inadequate delivery of nutrients and prolonged periods of ileus. Ileus may be propagated by NPO status (Grade C).
3. Use of enteral feeding protocols increases the overall percentage of goal calories provided and should be implemented (Grade C).
4. Patients placed on EN should be assessed for risk of aspiration (Grade E). Steps to reduce risk of aspiration should be used (Grade E). **The following measures have been shown to reduce risk of aspiration:**
   - In all intubated ICU patients receiving EN, the head of the bed should be elevated 30°–45° (Grade C). For high-risk patients or those shown to be intolerant to gastric feeding, delivery of EN should be switched to continuous infusion (Grade D).
   - Agents to promote motility, such as prokinetic drugs (metoclopramide and erythromycin) or narcotic antagonists (naloxone and alvimopan), should be initiated where clinically feasible (Grade C).
   - Diverting the level of feeding by postpyloric tube placement should be considered (Grade C).
   - Use of chlorhexidine mouthwash twice a day should be considered to reduce risk of ventilator-associated pneumonia (Grade C).
5. Blue food coloring and glucose oxidase strips, as surrogate markers for aspiration, should **NOT** be used in the critical care setting (Grade E).
6. Development of diarrhea associated with enteral tube feedings warrants further evaluation for etiology (Grade E).

Selection of Appropriate Enteral Formulation:

1. Immune-modulating enteral formulations (supplemented with agents, such as arginine, glutamine, nucleic acid, omega-3 fatty acids, and antioxidants) should be used for the appropriate patient population (major elective surgery, trauma, burns, head and neck cancer, and critically ill patients on mechanical ventilation), being cautious in patients with severe sepsis (for surgical ICU patients Grade A) (for medical ICU patients Grade B). ICU patients not meeting criteria for immune-modulating formulations should receive standard enteral formulations (Grade B).
2. Patients with acute respiratory distress syndrome and severe acute lung injury should be placed on an enteral formulation characterized by an anti-inflammatory lipid profile (i.e., omega-3 fish oils, borage oil) and antioxidants (Grade A).
3. To receive optimal therapeutic benefit from the immune-modulating formulations, at least 50% to 65% of goal energy requirements should be delivered (Grade C).
4. If there is evidence of diarrhea, soluble fiber-containing or small peptide formulations may be used (Grade E).

Adjunctive Therapy:

1. Administration of probiotic agents has been shown to improve outcome (most consistently by decreasing infection) in specific critically ill patient populations involving transplantation, major abdominal surgery, and severe trauma (Grade C). **No recommendation can currently be made for use of probiotics in the general ICU population because of a lack of**
consistent outcome effect. It seems that each species may have different effects and variable impact on patient outcome, making it difficult to make broad categorical recommendations. Similarly, no recommendation can currently be made for use of probiotics in patients with severe acute necrotizing pancreatitis, based on the disparity of evidence in the literature and the heterogeneity of the bacterial strains used.

2. A combination of antioxidant vitamins and trace minerals (specifically including selenium) should be provided to all critically ill patients receiving specialized nutrition therapy (Grade B).

3. The addition of enteral glutamine to an EN regimen (not already containing supplemental glutamine) should be considered in burn, trauma, and mixed ICU patients (Grade B).

4. Soluble fiber may be beneficial for the fully resuscitated, hemodynamically stable critically ill patient receiving EN who develops diarrhea. Insoluble fiber should be avoided in all critically ill patients. Both soluble and insoluble fiber should be avoided in patients at high risk for bowel ischemia or severe dysmotility (Grade C).

When Indicated, Maximize Efficacy of PN

1. If EN is not available or feasible, the need for PN therapy should be evaluated (see recommendations No. 1, 2, and 3 of When to Use PN section and No. 3 of Dosing of Enteral Feeding section) (Grade C). If the patient is deemed to be a candidate for PN, steps to maximize efficacy (regarding dose, content, monitoring, and choice of supplemental additives) should be used (Grade C).

2. In all ICU patients receiving PN, mild permissive underfeeding should be considered, at least initially. Once energy requirements are determined, 80% of these requirements should serve as the ultimate goal or dose of parenteral feeding (Grade C). Eventually, as the patient stabilizes, PN may be increased to meet energy requirements (Grade E). For obese patients (BMI >=30), the dose of PN with regard to protein and caloric provision should follow the same recommendations given for EN in recommendation C5 (Grade D).

3. In the first week of hospitalization in the ICU, when PN is required and EN is not feasible, patients should be given a parenteral formulation without soy-based lipids (Grade D).

4. A protocol should be in place to promote moderately strict control of serum glucose when providing nutrition support therapy (Grade B). A range of 110–150 mg/dL may be most appropriate (Grade E).

5. When PN is used in the critical care setting, consideration should be given to supplementation with parenteral glutamine (Grade C).

6. In patients stabilized on PN, periodically repeat efforts should be made to initiate EN. As tolerance improves and the volume of EN calories delivered increases, the amount of PN calories supplied should be reduced. PN should not be terminated until >=60% of target energy requirements are being delivered by the enteral route (Grade E).

Pulmonary Failure:

1. Specialty high-lipid low-carbohydrate formulations designed to manipulate the respiratory quotient and reduce CO₂ production are not recommended for routine use in ICU patients with acute respiratory failure (Grade E) (this is not to be confused with the recommendation No. 2 of Selection of Appropriate Enteral Formulation section for acute respiratory distress syndrome/acute lung injury).

2. Fluid-restricted calorically dense formulations should be considered for patients with acute respiratory failure (Grade E). 16.

3. Serum phosphate levels should be monitored closely, and replaced appropriately when needed (Grade E).

Renal Failure:
1. ICU patients with acute renal failure or acute kidney injury should be placed on standard enteral formulations, and standard ICU recommendations for protein and calorie provision should be followed. If significant electrolyte abnormalities exits or develop, a specialty formulation designed for renal failure (with appropriate electrolyte profile) may be considered (Grade E).

2. Patients receiving hemodialysis or continuous renal replacement therapy should receive increased protein, up to a maximum of 2.5 g/kg/day. Protein should not be restricted in patients with renal insufficiency as a means to avoid or delay initiation of dialysis therapy (Grade C).

**Hepatic Failure:**

1. Traditional assessment tools should be used with caution in patients with cirrhosis and hepatic failure, as these tools are less accurate and less reliable because of complications of ascites, intravascular volume depletion, edema, portal hypertension, and hypoalbuminemia (Grade E).

2. EN is the preferred route of nutrition therapy in ICU patients with acute and/or chronic liver disease. Nutrition regimens should avoid restricting protein in patients with liver failure (Grade E).

3. Standard enteral formulations should be used in ICU patients with acute and chronic liver disease. The branched chain amino acid formulations should be reserved for the rare encephalopathic patient who is refractory to standard therapy with luminal-acting antibiotics and lactulose (Grade C).

**Acute Pancreatitis:**

1. At admission, patients with acute pancreatitis should be evaluated for disease severity (Grade E). Patients with severe acute pancreatitis should have a nasoenteric tube placed and EN initiated as soon as fluid volume resuscitation is complete (Grade C).

2. Patients with mild to moderate acute pancreatitis do not require nutrition support therapy (unless an unexpected complication develops or there is failure to advance to oral diet within 7 days) (Grade C).

3. Patients with severe acute pancreatitis may be fed enterally by the gastric or jejunal route (Grade C).

4. Tolerance to EN in patients with severe acute pancreatitis may be enhanced by the following measures:
   - Minimizing the period of ileus after admission by early initiation of EN (Grade D).
   - Displacing the level of infusion of EN more distally in the gastrointestinal tract (Grade C).
   - Changing the content of the EN delivered from intact protein to small peptides, and long-chain fatty acids to medium-chain triglycerides or a nearly fat-free elemental formulation (Grade E).
   - Switching from bolus to continuous infusion (Grade C).

5. For the patient with severe acute pancreatitis, when EN is not feasible, use of PN should be considered (Grade C). PN should not be initiated until after the first 5 days of hospitalization (Grade E).

**Nutrition Therapy End-of-Life Situations:**

Specialized nutrition therapy is not obligatory in cases of futile care or end-of-life situations. The decision to provide nutrition therapy should be based on effective patient/family communication, realistic goals, and respect for patient autonomy (Grade E).
| Product Name | Category | Features | Cal/mL | PRO (g) | PRO % Cal | FAT (g) | FAT % Cal | CHO (g) | CHO % Cal | Fiber (g) | Na (mEq) | K (mEq) | Ca (mg) | Mg (mg) | Vit K (mcg) | % Water | Osmolality (mOsm/kg H2O) | Cal to meet 100% RDIs* |
|--------------|----------|----------|--------|---------|-----------|---------|-----------|---------|-----------|-----------|-----------|---------|---------|---------|---------|----------------|---------|------------------|---------------------|
| Osmolite® 1 Cal | Isotonic | Isotonic; lactose- and gluten-free, low-residue, kosher | 1.06 | 0.443 | 16.7 | 0.35 | 29 | 0.144 | 54.3 | - | 0.404 | 40.2 | 760 | 760 | 305 | 61 | 84 | 300 | 1400 |
| Jevity® 1.2 Cal | High Protein | Contains dietary fiber and scFOS®; concentrated calories, high protein; lactose- and gluten-free, kosher | 1.2 | 0.555 | 18.5 | 0.39 | 29 | 0.169 | 52.5 | 18 | 58.7 | 47.4 | 1200 | 1200 | 400 | 80 | 81 | 450 | 1200 |
| Pivot® 1.5 Cal | Immune Enhancing | Contains scFOS, L-arginine, inherent glutamine, EPA, DHA; elevated levels of antioxidants; lactose- and gluten-free, low-residue | 1.5 | 0.938 | 25 | 0.51 | 30 | 0.172 | 45 | 7.5 | 61 | 51.2 | 1000 | 1000 | 400 | 80 | 76 | 595 | 1500 |
| Peptamen® 1.5 | Elemental | Peptide-based; lactose- and gluten-free | 1.5 | 0.676 | 18 | 0.56 | 33 | 0.188 | 49 | - | 0.44 | 48 | 1000 | 1000 | 400 | 75 | 77 | 550 | 1500 |
| TwoCal® HN | Calorie and Protein Dense | Contains scFOS; lactose- and gluten-free, low-residue, kosher | 2 | 0.835 | 16.7 | 0.91 | 40.1 | 0.219 | 43.2 | 5 | 63.6 | 62.6 | 1050 | 1050 | 425 | 85 | 70 | 725 | 1900 |
| Renalcal® | Renal | Calorically dense, low-protein; lactose- and gluten-free, kosher | 2 | 0.344 | 7 | 0.82 | 35 | 0.290 | 58 | - | NL | NL | NL | NL | NL | NL | 70 | 600 | NA |
| Nepro® with Carb Steady™ | Renal (Dialysis) | Contains scFOS and dietary fiber; high protein; contains ingredients clinically shown to help manage blood-glucose response; lactose- and gluten-free, kosher | 1.8 | 0.81 | 18 | 0.96 | 48 | 0.167 | 34 | 15.6 | 46.1 | 27.2 | 1060 | 700 | 210 | 85 | 73 | 585 | 1700 |
| Ensure® Plus | Concentrated Calories | Contains scFOS and Fibersol®-2; ALA to support heart health; promotes digestive tract health; lactose- and gluten-free, low-residue, kosher | 1.5 | 0.549 | 14.8 | 0.48 | 28.2 | 0.211 | 57 | 12.7 | 40.3 | 47.7 | 1266 | 1270 | 422 | 84 | 76 | 680 | 1400 |
| Oxepa® | ALlUARDs/ SIRS/Sepsis | Contains EPA, GLA, and elevated levels of antioxidants; lactose- and gluten-free, low-residue | 1.5 | 0.627 | 16.7 | 0.94 | 55.2 | 105 | 28.1 | - | 0.57 | 50.1 | 1060 | 1060 | 425 | 85 | 79 | 535 | 1420 |

NA = Not applicable. NL = Not listed on corporate Web site. * Calories to meet 100% RDIs for key vitamins and minerals. The following are not trademarks of Abbott Laboratories: Fibersol, Peptamen, Renalcal, and scFOS. Product information is accurate at the time of printing. For more information, go to abbottnutrition.com. Abbott Laboratories is not responsible for the accuracy of other product information. Such information has been obtained from applicable Web sites or product labels and has not been otherwise verified. Refer to product labels for the most current ingredient and nutrient profiles.
<table>
<thead>
<tr>
<th>Product Name</th>
<th>Category</th>
<th>Features</th>
<th>Nutrient Values per Cal/mL</th>
<th>PER LITER</th>
<th>Calories</th>
<th>PRO (g)</th>
<th>PRO % Cal</th>
<th>FAT (g)</th>
<th>FAT % Cal</th>
<th>CHO (g)</th>
<th>CHO % Cal</th>
<th>Fiber (g)</th>
<th>Na (mEq)</th>
<th>K (mEq)</th>
<th>Ca (mg)</th>
<th>P (mg)</th>
<th>Mg (mg)</th>
<th>Vit K (mcg)</th>
<th>% Water</th>
<th>Osmolality (mOsm/kg H2O)</th>
<th>Cal to meet 100% RDIs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutri Hep</td>
<td>Hepatic</td>
<td>N6:N3 - 4:1, low aromatic amino acids</td>
<td>1L 1.5Kcal/ml</td>
<td>40 11 21.2 12 290 77 - 7 34 956 1000 376 120 76 790 1000</td>
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<tr>
<td>Glucerna® 1.5 Cal</td>
<td>Calorically dense with enhanced glycemic control</td>
<td>Contains scFOS and dietary fiber; lactose- and gluten-free, kosher</td>
<td>1L 1.5 Kcal/ml</td>
<td>82.5 22% 75 45 133.1 33 17 60 64.6 1000 1000 400 135 76% 875 1500</td>
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<tr>
<td>Resource® Breeze</td>
<td>Clear Liquid</td>
<td>Fat-free; lactose-free, may be suitable for a gluten-free diet, low-residue, kosher</td>
<td>8 fl oz 1.06 9 14 0 0 54 86 - 3.5 0.5 10 160 1 12 NL 750 NA</td>
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<tr>
<td>Juven®</td>
<td>Wound Care, HIV/AIDS</td>
<td>Patented blend of arginine, glutamine, and HMB; lactose- and gluten-free, low-residue, kosher</td>
<td>1 pkt (24 g) 78 Cal/pkt 14 g amino acids</td>
<td>0 0</td>
<td>0</td>
<td>7.7 (7.6 Grape)</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>6.9</td>
<td>200</td>
<td>95</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>451 Orange, 469 Grape (with 8 fl oz of water)</td>
<td>NA</td>
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<tr>
<td>PediaSure® Enteral Formula With Fiber and scFOS®</td>
<td>Pediatric With Fiber</td>
<td>Contains dietary fiber and scFOS; milk-based; lactose-and gluten-free, kosher</td>
<td>1 L 1 30 12 40 35 138 53 8 17 34 972 845 199 59 85 345 1000 / 1500</td>
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<tr>
<td>Vital Jr.™</td>
<td>Pediatric Semi-Elementar</td>
<td>Semi-elemental; designed for excellent tolerance and absorption; lactose- and gluten-free, kosher</td>
<td>1 L 1 30 12 40.5 33 133.8 53 3 31.2 34.6 1055 844 198 59 84 390 1000 / 1500</td>
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<tr>
<td>Resource® Beneprotein® Instant Protein Powder</td>
<td>Protein</td>
<td>Mixes easily; lactose-free, may be suitable for a gluten-free diet, kosher</td>
<td>1 scoop or 1 pkt (7 g)</td>
<td>25 6 0</td>
<td>0</td>
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<td>NL</td>
<td>NL</td>
<td>30</td>
<td>15</td>
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<tr>
<td>Resource® Benefiber®</td>
<td>Fiber</td>
<td>Lactose-free, may be suitable for a gluten-free diet, kosher</td>
<td>1 Tbsp or 1 pkt (4 g)</td>
<td>16 0 0</td>
<td>4</td>
<td>3</td>
<td>NL</td>
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<tr>
<td>MCT Oil</td>
<td>Fat - Medium Chain Triglycerides</td>
<td>More readily hydrolyzed and absorbed than fats in food; lactose-free, may be suitable for a gluten-free diet, kosher</td>
<td>1 Tbsp (15 ml)</td>
<td>115 0</td>
<td>14</td>
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</tbody>
</table>
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†Contains 7 g L-arginine and 7 g L-glutamine. Two amino acids do not meet the dietary requirements for protein.
‡Meets or exceeds 100% of the DRIs for children 1-8 years in 1000 Calories; for children 9-13 years, 1500 Calories are required.
MCT Oil is not manufactured by Abbott Laboratories.
The following are not trademarks of Abbott Laboratories: Benefiber, Beneprotein, Microlipid, Resource, and scFOS.
Product information is accurate at the time of printing. For more information, go to abbottnutrition.com. Abbott Laboratories is not responsible for the accuracy of other product information. Such information has been obtained from applicable Web sites or product labels and has not been otherwise verified. Refer to product labels for the most current ingredient and nutrition profiles.
**ENTERAL NUTRITION IN THE CRITICALLY ILL**

Patient to be extubated within 24 hours of ICU admission → **YES** → Begin PO diet if no dysphagia present following extubation

**NO**

Order feeding tube (FT) placement → Does patient have severe facial fractures, obstruction of head/neck/esophagus, or limitation to nasal FT placement?

**NO**

Does patient have severe reflux, delayed gastric emptying, high risk of aspiration, pancreatitis, major intra-abdominal surgery, or previous intolerance to gastric feeding?

**YES** → RD or RN places FT placed at bedside by RD or RN

**NO** → FT placed in Endoscopy or Radiology

**FT placed at bedside by RD or RN**

→ FT cleared for use → NO after FIRST and SECOND attempt

→ Abdominal X-ray ordered and completed for placement confirmation → NO after THIRD attempt

**RD or RN places post-pyloric FT.**

**RD or RN places gastric FT.**

* Conditions that warrant a Metabolic Cart Study:
  - Multiple trauma
  - Neurological trauma
  - Multisystem organ failure
  - Sepsis
  - SIRS
  - Respiratory distress syndrome
  - Use of paralytic or barbiturate agents
  - Large or multiple wounds
  - Burns
  - Post-operative organ transplantation
  - Malnutrition with altered body composition:
    - Underweight
    - Overweight
    - Paralysis
    - Amputations
    - Peripheral edema or Ascites

- Initiate TwoCal HN @ 10 ml/hr with goal of 45 ml/hr. Advance to goal rate within 48-72 hours when possible.
- Consult Nutrition Support for Nutrition Assessment and tube feeding modifications (Enter consult in SCM or call 7-5386).
- Bridle FT if patient has a history of pulling tubes, if FT was difficult to place at bedside, or if a nasal FT was placed in OR, endoscopy, or fluoroscopy.
- Monitoring and maintenance of enteral nutrition continually evaluated by RN and Nutrition Support Service (NSS).

**RN Responsibilities:**
- Elevate HOB > 30 degrees unless contraindicated.
- Match formula and rate to patient's feeding order.
- Check gastric residuals every 4 hours - DO NOT HOLD ENTERAL NUTRITION UNLESS RESIDUALS > 500 ml or 250-500 ml with other signs of intolerance (i.e. tube feeding reflux, vomiting, aspiration, abdominal distention, diarrhea).

**NSS Responsibilities:**
- Complete nutrition assessment ASAP.
- Follow patients daily and modify TF order as needed.
- Identify conditions that warrant a metabolic cart study and communicate with Respiratory Therapist to complete studies when appropriate.