TPN per Pharmacy
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General Considerations
- Starting TPN is never an emergency.
- PPN may be used when needed less than 2 weeks, if patient has good veins. Max osmolality of 900 through the peripheral vein.
- Central line access needed for TPN (subclavian, PICC, IJ, I-Port, etc.)

The Basics
Who needs TPN?
Why do they need TPN?
How do I provide TPN?
What complications do I worry about?

Who needs TPN?/Why do they Need TPN?
- If the gut works, use it!!!!
- TPN is indicated in patients who can not, will not, or should not eat or receive enteral nutrition.
- Usually indicated in patients with GI abnormalities (obstruction, fistula, malabsorption, short gut, etc.)

How to provide TPN?
- 1. Calorie needs
- 2. Fluid needs
- 3. Electrolyte needs
- 4. Special populations

Calories
- Harris Benedict Equation
  Men: 66+(13.7 x wt)+(5 x ht)−(6.8 x age)
  Women: 655+(9.6 x wt)+(1.7 x ht)−(4.7 x age)
- Indirect calorimetry
- Kcal/kg
  Healthy, maintenance: 20-25 kcal/kg
  Malnourished or stressed: 25-30 kcal/kg
  Severe stress: 30-35 kcal/kg
### Stress Factors for Harris Benedict

<table>
<thead>
<tr>
<th>Condition</th>
<th>UAMS</th>
<th>Pharmacotherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation</td>
<td>0.85-1</td>
<td>NA</td>
</tr>
<tr>
<td>Normal, nonstressed</td>
<td>1.2-1.3</td>
<td>Confined to bed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2 OOB 1.3</td>
</tr>
<tr>
<td>Mild stress, Postop</td>
<td>1.25-1.35</td>
<td>Postop 1</td>
</tr>
<tr>
<td>uncomplicated</td>
<td></td>
<td>Mild trauma 1.2</td>
</tr>
<tr>
<td>Severe Stress</td>
<td>1.35-1.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Burns</td>
<td>2 or &gt;</td>
<td>Up to 2</td>
</tr>
</tbody>
</table>

### Dextrose

- 3.4 kcal/gm
- Primary energy source for TPN.
- Dextrose is oxidized at a maximum rate of 4-7mg/kg/minute. Recommended doses rarely exceed 5mg/kg/min.
- Overfeeding with dextrose can lead to a fatty liver.
- Inexpensive
- Start low and titrate up to goal as BS tolerates.

### Amino Acids

- 4 kcal/gm
- Standard amino acid products are essentially the same except electrolyte content (Cl and Acetate amounts in the base).
- Modified amino acid solutions not used much anymore (Hepatamine, NephrAmine, etc.), usually modify amounts of standard AA used.
- Can start with goal protein.

### Estimated Daily Protein Needs

<table>
<thead>
<tr>
<th>Condition</th>
<th>Daily protein need</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal nonstressed</td>
<td>0.8gm/kg</td>
</tr>
<tr>
<td>Stressed, Oncology, Surgical</td>
<td>1.0-1.5gm/kg</td>
</tr>
<tr>
<td>Severely Stressed, Multiple</td>
<td>1.5-2.5gm/kg</td>
</tr>
<tr>
<td>Trauma, Burns</td>
<td></td>
</tr>
<tr>
<td>Renal Failure (no dialysis)</td>
<td>0.6-0.8gm/kg</td>
</tr>
<tr>
<td>Renal Failure with dialysis</td>
<td>1.2-1.5gm/kg</td>
</tr>
<tr>
<td>Hepatic Encephalopathy</td>
<td>Start with 0.4-0.5gm/kg</td>
</tr>
</tbody>
</table>

### Lipids

- Fat = 9 kcal/gm, however, lipid emulsions also contain glycerol and egg phospholipids which contribute to the caloric amount from lipid emulsions. (10%=1.1cal/gm, 20%=2cal/gm).
- Daily dosage of lipids should not exceed 2.5gm/kg/d in adults.
- Limiting to 1gm/kg/d in critically ill patients
- Derived from soybean oil or a combination of soybean and safflower oil.
- Propofol contains 10% lipid emulsion.

### Lipids, cont.

- May be infused over 4-6 hours, however, rapid infusion may saturate the reticuloendothelial system. The longer the infusion time, the less interference with the RES, therefore may infuse over 12-24 hours. CDC recommends no longer than 12 hour hang time.
- 4-10% of daily caloric requirement should be provided as essential fatty acids to prevent EFA deficiency.
Fluid Requirements

- 1500 mls per meter square per day
- Mls/kg/day method: active young adults 35 mls/kg/day, average adults 30 mls/kg/day, elderly 25 mls/kg/day
- Ideal weight: 1st 10kg of IBW 100 mls/kg/day
  2nd 10kg of IBW 50 mls/kg/day
  weight >20kg 20 mls/kg/day

Guessing (this is what is done most often!)

Usual Electrolyte Requirements

- Sodium, mEq: 60-100
- Potassium, mEq: 60-100
- Magnesium, mEq: 12-24
- Calcium, mEq: 10-15
- Phosphate, mmol: 20-45
- Chloride, mEq: *
- Acetate, mEq: *
- *Requirement varies with acid-base balance, in general CI should not exceed Na to avoid metabolic acidosis.

Daily Electrolyte Requirements

<table>
<thead>
<tr>
<th>Sodium</th>
<th>Chloride</th>
<th>1-2-3 mEq/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acetate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphate</td>
<td></td>
</tr>
<tr>
<td>Potassium</td>
<td>Chloride</td>
<td>0.5-1.2 mEq/kg/day</td>
</tr>
<tr>
<td></td>
<td>Acetate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phosphate</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>Gluconate</td>
<td>5 mEq/L</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Sulfate</td>
<td>8-24 mEq/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-16 mEq/day</td>
</tr>
</tbody>
</table>

exceptions to the rule

- Increased Requirements:
  1. Na, K, Cl: vomiting, NG suction, gastrostomy output
  2. Na, K, HCO3: diarrhea, ostomies, high output fistulas
  3. K, PO4, Mg: refeeding syndrome

Exceptions to the Rule, cont.

- Decreased Requirements:
  1. Na: CHF
  2. Na, K, Mg, PO4, Cl: renal failure

Electrolyte Content Of Body Fluids

<table>
<thead>
<tr>
<th></th>
<th>Na mEq/L</th>
<th>K mEq/L</th>
<th>Cl mEq/L</th>
<th>HCO3 mEq/L</th>
<th>Volume (L)/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>50</td>
<td>35</td>
<td>40</td>
<td>45</td>
<td>0.5-2</td>
</tr>
<tr>
<td>Ileostomy</td>
<td>140</td>
<td>20</td>
<td>100</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Gastric</td>
<td>80</td>
<td>10</td>
<td>100</td>
<td>-----</td>
<td>2</td>
</tr>
<tr>
<td>Bile</td>
<td>145</td>
<td>5</td>
<td>100</td>
<td>40</td>
<td>1.5</td>
</tr>
<tr>
<td>Pancreatic</td>
<td>140</td>
<td>5</td>
<td>75</td>
<td>85</td>
<td>0.75-1</td>
</tr>
</tbody>
</table>
Drug Induced Electrolyte Disorders

- Drug induced renal losses:
  - Alcohol – Mg
  - Aminoglycosides – K, Mg
  - Amph B – K, Mg
  - Cyclosporin - Mg
  - Diuretics – K, Mg (especially furosemide)
  - Digitalis – Mg
  - Cisplatin – K, Mg
  - High dose Penicillins – K
  - Mineralcorticoids – K
  - Etc.

- Drug induced transcellular shift:
  - Albuterol – K
  - Sodium Bicarbonate – K
  - Insulin - K

Monitoring

- Fluids: Monitor weight daily, I’s & O’s, and what type of fluid is being lost (NG, ostomy, etc.).
- Labs: Daily BMP (Na, K, Cl, CO2, BUN, Cr, Glucose, Ca, Mg, PO4) until stable, CBC; weekly albumin, prealbumin, triglycerides, and LFT’s;
- Nitrogen balance: N2 balance = N2 in – N2 out. N2 in = protein intake(gm)/6.25; N2 out = 24 hour urine urea N2 (UUN) + 4

Obese Patients at UAMS

- MICU patients: 11-14 kcal/kg actual weight or 23-25 IBW, 2-2.5 gm/kg IBW
- Renal obese: Use adjusted BW for kcal and protein – if on CRRT 1.5gm/kg and up to 2.5gm/kg, if on HD 1-2.1.5 gm/kg protein
- SICU patients: 15-18 kcal/kg actual body weight (maybe up to 20), BMI 30-40 2gm/kg IBW for protein, BMI>40 2.5gm/kg protein.

Other Special Populations

- Renal Insufficiency/Failure
- Hepatic failure
- Pulmonary Failure
- Patients with high output fistulas
- Short Bowel Syndrome

Drug Induced Electrolyte Disorders, cont.

- Drug induced transcellular shift:
  - Albuterol – K
  - Sodium Bicarbonate – K
  - Insulin - K

Special Populations, Obese Patients

- Obese Critically ill patients – various recommendations for feeding obese patients
- ASPEN guidelines for critically ill adults: 11-14 kcal/day actual body weight or 22-25 kcal/day IBW. Protein >/=2gm/kg IBW if BMI is 30-40, or >/=2.5gm/kg IBW if BMI>40.
Complications With TPN

- Refeeding syndrome - recognize who is at risk, start low with calories and advance as electrolyte abnormalities are corrected.
- Hyperglycemia – is patient diabetic or is the hyperglycemia due to the stress response?
- Hepatic complications – LFT's increased – is it the TPN? What should be done?

Hepatic Abnormalities and TPN

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Peak onset</th>
<th>Magnitude</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaline Phosphatase</td>
<td>10-14 days</td>
<td>2-4 X</td>
<td>54%</td>
</tr>
<tr>
<td>SGOT</td>
<td>10-30 days</td>
<td>3 X</td>
<td>68%</td>
</tr>
<tr>
<td>Bilirubin</td>
<td>10-30 days</td>
<td>0.25 X</td>
<td>21%</td>
</tr>
</tbody>
</table>

Prevention of Hepatic Abnormalities with TPN

- Gut mucosal stimulation/glutamine – feed the gut.
- Avoid overfeeding – if abnormal LFT's, decrease calories.
- Give balanced calories (carbohydrates and fat calories to provide calories and EFA's).

Prevention of Hepatic Abnormalities with TPN, Cont.

- Look for alternative etiologies (hepatitis, obstruction, drugs, sepsis).
- Rule out abscesses or other septic sources.
- In adults, ? Trial of metronidazole 260mg q6h.

Questions?