Metabolic Effects of Cyclical Parenteral Nutrition
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Program Objectives
1. Describe potential metabolic effects of cyclical parenteral nutrition.
2. Discuss strategies to monitor and prevent potential complications.

Home Nutrition Support Statistics
- 40,000 people receive parenteral nutrition in their homes in the U.S.
- 152,000 people receive enteral nutrition in their homes in the U.S.
Parenteral Nutrition Formulation

What's In The Bag?
Parenteral Nutrition Consists Of:

- 3 Main Calorie Sources (3-in-1 solution)
  - dextrose (carbohydrate source)
  - amino acids (protein source)
  - lipids (fat source)
- Electrolytes
- Vitamins & Minerals
- Other additives

Administration of HPN

- Infused on Pump
- Usually initiated as continuous infusion
- Transitioned to cycled infusion
- Factors for cycling success
  - Age
  - IDDM/NIDDM
  - Medications
  - Disease states ie: pancreatitis, cardiac or renal insufficiency
Cost/Benefit Analysis of Cycling

Cost of Cycling
- Concentrated dextrose load
- Concentrated electrolyte load
- Potential to exceed electrolyte infusion rates

Benefits of Cycling
- Quality of Life
- Mimics oral feeding
- Hepato-biliary health

Cycling Protocol
- Goal is for a 10 to 16 hour infusion time
- Program pump to ramp up and down over 1 hour
- Extend ramp time depending on risk factors
- Check blood sugars and s/s of hypo- and hyper-glycemia to monitor tolerance
- Reduce by 4 hours per day to goal of 10 to 12 hours as tolerated

Parenteral Nutrition Complications and Outcomes
- Parenteral Nutrition primarily treats nutrient deficiencies and malnutrition.
- Parenteral Nutrition has little impact on the underlying disease which is often progressive.
- Mortality related to the disease is higher than PN-related mortality.
### Summary of TPN Outcome

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Survival</th>
<th>On PN at 1 year</th>
<th>Complication TPN</th>
<th>Complication Non-TPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer</td>
<td>20%</td>
<td>0.4%</td>
<td>1.1</td>
<td>3.3</td>
</tr>
<tr>
<td>GISBS</td>
<td>88%</td>
<td>4.34%</td>
<td>1.22</td>
<td>1.16</td>
</tr>
<tr>
<td>AIDS</td>
<td>10%</td>
<td>2%</td>
<td>1.6</td>
<td>3.3</td>
</tr>
<tr>
<td>Pancreatitis</td>
<td>90%</td>
<td>0%</td>
<td>1.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Hyperem</td>
<td>100%</td>
<td>0%</td>
<td>1.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

### Common Complications in HPN

- Blood glucose abnormalities
- Fluid and electrolyte alterations
- PN-related liver disease
- Metabolic bone disease

### Blood Glucose Abnormalities

#### Hypoglycemia
- Post-infusion
- Related to dextrose load and insulin secretion
- Managed with ramping the infusion down
- 1-hour vs. 2-hour ramp
- Oral glucose intake

#### Hyperglycemia
- Etiology: IDDM/NIDDM, Carbohydrate overload, Medications
- Outcome: Morbidity/Mortality, Bacteremia
Monitoring and Interventions for Hyperglycemia

Blood Sugar Goals
- ICU goal: 80-120 mg/dl
- Non-acute goal: 140-180 mg/dl
- Home Infusion: Between 150 and 180 mg/dl

Intervention
- Monitoring: 2 hours into infusion and 1 hour post-infusion
- Decrease dextrose load
- Treatment:
  - Sliding scale
  - Insulin added to PN bag: 50% of previous day’s requirement via sliding scale or 0.2 units regular insulin, dextrose

Fluid and Electrolyte Abnormalities

High Risk Conditions
- Vomiting
- Gastric suctioning/decompression
- Diarrhea
- High-output ostomies
- Enterocutaneous fistulae

Monitoring for Fluid/Electrolyte Abnormalities

Monitoring
- Lab-Values
  - Routine labs: Comprehensive Metabolic Panel with Calcium, Phosphorus and Magnesium
  - Weekly to start and taper to monthly draws
- Intake / Output Measurements
- Physical Assessment
  - Vital signs
  - Postural blood pressure assessment
  - Signs and symptoms of over- or under-hydration
  - Signs and symptoms of electrolyte alterations
Signs and Symptoms of Dehydration

- Increased thirst
- Dry mouth
- Sudden weight loss >2 lbs in less than 24 hrs (note: 1 L of water weighs 2.2 lbs)
- Urine output less than minimal requirement according to body size
- Dark, concentrated urine with a strong odor
- Weakness, chronic fatigue, low endurance
- Muscle cramps
- Cracked lips
- Premature dryness
- Low blood pressure

Signs and Symptoms of Electrolyte Issues

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>High Levels</th>
<th>Low Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium (Na)</td>
<td>Thirst, irritability</td>
<td>Confusion, lethargy, seizures, hypotension</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Diarrhea, paresthesia, tachycardia, oliguria</td>
<td>Nausea, vomiting, confusion, arrhythmias</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>Confusion, weakness, nausea, vomiting, coma</td>
<td>Tetany, irritability, seizures</td>
</tr>
<tr>
<td>Phosphorus (Phos)</td>
<td>Parasthesia, paralysis, confusion</td>
<td>CHF, arrhythmia, lethargy, confusion</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Respiratory paralysis, lethargy, hypotension, coma</td>
<td>Arrhythmia, tetany, convulsions</td>
</tr>
</tbody>
</table>

Types of PN-Associated Liver Disease

- **Steatosis**
  - Fat accumulation in the liver
  - Occurs predominately in adults
  - Occurs without significant alterations in hepatic function

- **Cholestasis**
  - Bilirubin excretion is compromised resulting in excess bilirubin in the blood and decreased bile salts in the GI tract
  - Occurs primarily in infants and children
  - Jaundice occurs as a result of high bilirubin levels
Etiology of PN-Associated Liver Disease

- Age ie: neonates
- Medication profile
- Catheter related septic events
- Recurrent bacterial overgrowth
- Enteral feeding history
- Parenteral Nutrition Factors
  - High calories
  - High carbohydrate
  - High fat and type of fat
  - Nutrient deficiencies

Monitoring and Intervention for PNALD

Monitoring
- Labs: AST, ALT, ALP, Total Bilirubin
- Biopsy – more accurate predictor of extent of involvement

Intervention is aimed at cause
- Feed enterally when possible
- Optimize HPN components
- Cycling HPN
- Minimize septic events
- Medication/supplement review
- Manage bacterial overgrowth

Etiology of Metabolic Bone Disease

- Calcium and phosphorus are minerals that are malabsorbed with fat.
- Consumers may have limited sunlight exposure due to geographic location or intentionally to protect skin health.
- Dairy products – which are good sources of calcium, Vitamin D and phosphorus – are typically limited due to lactose intolerance.
- Vitamin D is a fat-soluble vitamin and is often malabsorbed with fat.
What are the symptoms of Vitamin D deficiency?

Consumers with a Vitamin D deficiency are typically not symptomatic but can develop the following with a chronic deficiency:

- Bone pain
- Muscle weakness
- Unexpected bone fracture

Monitoring of Bone Health Status

Since consumers with a Vitamin D deficiency are typically not symptomatic in the early stages of a deficiency, routine monitoring of the following is required to properly evaluate bone health:

<table>
<thead>
<tr>
<th>Test</th>
<th>When to check</th>
<th>What it's checking</th>
<th>Is it low or high with a Vitamin D deficiency?</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-hydroxy Vitamin D</td>
<td>Every 6 months</td>
<td>Amount of Vitamin D circulating in your blood</td>
<td>Low</td>
</tr>
<tr>
<td>Ionized calcium</td>
<td>Every 6 months</td>
<td>Most accurate measurement of calcium in your blood</td>
<td>Low</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Monthly &amp; every 6 months</td>
<td>Amount of phosphate in your blood</td>
<td>Low</td>
</tr>
<tr>
<td>Alkaline phosphatase</td>
<td>Monthly &amp; every 6 months</td>
<td>Amount of phosphate in your blood</td>
<td>Low</td>
</tr>
<tr>
<td>PTH (Parathyroid Hormone)</td>
<td>As directed by doctor</td>
<td>Amount of parathyroid hormone in your blood</td>
<td>High</td>
</tr>
<tr>
<td>DEXA (Dual Energy X-Ray Absorptiometry) scan</td>
<td>Once per year</td>
<td>Actual bone density</td>
<td>Bone density decreases with chronic Vitamin D deficiency</td>
</tr>
</tbody>
</table>

Intervention to Optimize Bone Health

**Food Sources**
- Vitamin D is found in fortified foods

**Intravenous**
- IV: 200-400 IU Vitamin D
- No other IV form available

**Supplements**
- 1,000 IU Vitamin D per day
- 50,000 IU Vitamin D twice weekly for 8 weeks
- Adequate calcium, magnesium and phosphorus

**Other Medications - biphosphonates**

**Sunlight**
- Natural – arms and face 20 minutes per day
- Sunlamps
Summary

- Parenteral Nutrition and cycling can have metabolic side effects including: glucose fluctuations, fluid and electrolyte imbalances, liver and bone involvement.
- The therapeutic approach is aimed at identifying high risk patients, modifying the solution and administration technique, and monitoring tolerance.