Enteral Nutrition Overview

Christine Trapp PhD RD LD
Dietitian Consultant
Global Nutrition Services LLC
Indications for use

• Functional GI, but clinical conditions in which oral intake is
  – Impossible
  – Inadequate
  – Unsafe
NUTRITION ASSESSMENT

FUNCTIONAL GI TRACT?

YES

ENTERAL NUTRITION ?

NO

PARENTERAL NUTRITION
ENTERAL NUTRITION

Long-term
Gastrostomy
Jejunostomy

Short-term
Nasogastric
Nasoduodenal
Nasojejunal

GI Function

Normal
Compromised

Intact Nutrients
Defined Formula
NUTRIENT TOLERANCE

Intact Nutrients

Adequate Progress to Oral Feedings

Inadequate PN Supplementation

Progress to Total Enteral Feedings

Defined Formula

Adequate Progress to More Complex Diet and Oral Feedings as Tolerated
Important factors to consider

• Clinical status
• Diagnosis
• Prognosis
• Risks and benefits of therapy
• Discharge plans
• Quality of life
• Ethical issues
• Patient’s and the family’s wishes
Contraindications to EN support

- Non-operative mechanical GI obstruction
- Intractable vomiting/diarrhea refractory to medical management
- Severe short-bowel syndrome
- Paralytic ileus
- Distal high-output fistulas
- Severe GI bleed
- Severe GI malabsorption
- Inability to gain access to GI tract
- Need is expected for < 5-7 days for malnourished patients or 7-9 days if adequately nourished
- Aggressive intervention not warranted or not desired
• Paralytic ileus
  – Now known that the absence of bowel sounds does not necessarily preclude safe EN

• Vomiting an diarrhea
  – Simultaneous gastric decompression
  – Use of prokinetic agents
• Minimally functional digestive and absorptive capabilities
  – Elemental formula
  – Small peptide formula
RISKS AND BENEFITS
– First-pass metabolism (liver)
– Stimulates release of CCK
– Fiber, intact protein, peptides, specialized fatty acids
– Maintain normal intestinal pH and flora
– Fuel source for the bowel
– Reduces infectious complications
– Less costly than PN
• Early EN – may promote high gastric residuals
  ↑ risk of aspiration pneumonia
  ↑ Bacterial colonization of the stomach

Benefits significantly outweigh the Risks
HOW TO DECIDE WHAT FORMULA TO FEED
Patient variables

- Nutritional status and requirements
- Electrolyte balance
- Digestive and absorptive capacity
- Disease state
- Renal function
- Medical or drug therapy
- Routes available for administration
Enteral Formulations

• General Characteristics
  – Digestibility/availability of nutrients
  – Nutritional adequacy
  – Viscosity
  – Osmolality
  – Ease of use
  – Cost
Standard/Polymeric Formulations

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Fat</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-90% of calories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primarily corn syrup solids</td>
<td>Corn oil</td>
<td>Casein Soy protein isolates</td>
</tr>
<tr>
<td></td>
<td>Soybean oil</td>
<td></td>
</tr>
<tr>
<td>Most formulas do NOT contain lactose</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Standard Polymeric Formulas

<table>
<thead>
<tr>
<th>Formula</th>
<th>kcal/ml</th>
<th>PRO</th>
<th>CHO</th>
<th>FAT</th>
<th>PRO source</th>
<th>n6:n3</th>
<th>fiber (g/L)</th>
<th>osmolality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutren 1.0</td>
<td>1</td>
<td>16%</td>
<td>51%</td>
<td>33%</td>
<td>caseinate</td>
<td>4.1:1</td>
<td>(14)</td>
<td>315</td>
</tr>
<tr>
<td>Nutren Replete</td>
<td>1</td>
<td>25%</td>
<td>45%</td>
<td>30%</td>
<td>caseinate</td>
<td>2.3:1</td>
<td>(14)</td>
<td>300</td>
</tr>
<tr>
<td>Promote</td>
<td>1</td>
<td>25%</td>
<td>52%</td>
<td>23%</td>
<td>caseinate &amp; soy protein isolate</td>
<td>5.3:1</td>
<td>(14.4)</td>
<td>340</td>
</tr>
<tr>
<td>Jevity 1 Cal</td>
<td>1.06</td>
<td>17%</td>
<td>54%</td>
<td>29%</td>
<td>caseinate &amp; soy protein isolate</td>
<td>4.2:1</td>
<td>14.4</td>
<td>300</td>
</tr>
<tr>
<td>Osmolite 1 Cal</td>
<td>1.06</td>
<td>17%</td>
<td>54%</td>
<td>29%</td>
<td>caseinate &amp; soy protein isolate</td>
<td>5:01</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>Fibersource HN</td>
<td>1.2</td>
<td>18%</td>
<td>53%</td>
<td>29%</td>
<td>soy protein isolate &amp; soy protein concentrate</td>
<td>2.7:1</td>
<td>10</td>
<td>490</td>
</tr>
<tr>
<td>Jevity 1.2 Cal</td>
<td>1.2</td>
<td>19%</td>
<td>53%</td>
<td>29%</td>
<td>caseinate &amp; soy protein isolate</td>
<td>4.2:1</td>
<td>18</td>
<td>450</td>
</tr>
<tr>
<td>Isosource HN</td>
<td>1.2</td>
<td>18%</td>
<td>53%</td>
<td>29%</td>
<td>soy protein isolate</td>
<td>2.7:1</td>
<td>0</td>
<td>490</td>
</tr>
<tr>
<td>Osmolite 1.2 Cal</td>
<td>1.2</td>
<td>19%</td>
<td>53%</td>
<td>29%</td>
<td>caseinate &amp; soy protein isolate</td>
<td>5:01</td>
<td>0</td>
<td>360</td>
</tr>
<tr>
<td>Isosource 1.5 Cal</td>
<td>1.5</td>
<td>18%</td>
<td>44%</td>
<td>38%</td>
<td>caseinates</td>
<td>4.1:1</td>
<td>8</td>
<td>650</td>
</tr>
<tr>
<td>Jevity 1.5 Cal</td>
<td>1.5</td>
<td>17%</td>
<td>54%</td>
<td>29%</td>
<td>caseinate &amp; soy protein isolate</td>
<td>5.4:1</td>
<td>22</td>
<td>525</td>
</tr>
<tr>
<td>Osmolite 1.5 Cal</td>
<td>1.5</td>
<td>17%</td>
<td>54%</td>
<td>29%</td>
<td>caseinate &amp; soy protein isolate</td>
<td>NA</td>
<td>0</td>
<td>525</td>
</tr>
<tr>
<td>Nutren 2.0</td>
<td>2</td>
<td>16%</td>
<td>39%</td>
<td>45%</td>
<td>caseinate</td>
<td>4.6:1</td>
<td>0</td>
<td>746</td>
</tr>
<tr>
<td>TwoCal HN</td>
<td>2</td>
<td>17%</td>
<td>43%</td>
<td>40%</td>
<td>caseinates</td>
<td>NA</td>
<td>5</td>
<td>725</td>
</tr>
</tbody>
</table>
## Blenderized formula

<table>
<thead>
<tr>
<th></th>
<th>kcal/ml</th>
<th>PRO</th>
<th>CHO</th>
<th>FAT</th>
<th>PRO source</th>
<th>n6:n3</th>
<th>fiber</th>
<th>osmolality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compleat</td>
<td>1.07</td>
<td>18%</td>
<td>48%</td>
<td>34%</td>
<td>milk, chicken</td>
<td>3.0:1</td>
<td>6 g/L</td>
<td>340</td>
</tr>
<tr>
<td>Compleat Pediatric</td>
<td>1</td>
<td>15%</td>
<td>50%</td>
<td>35%</td>
<td>chicken, milk, pea puree</td>
<td>3.7:1</td>
<td>6 g/0.9L</td>
<td>380</td>
</tr>
</tbody>
</table>
Homemade Tube Feedings

• Liquefied in blender and bolus fed through a GT
• Safe and effective use has not been reported in peer-reviewed publications
• Reasons given for use
  – Lower cost
  – Perceived health benefit from variety
  – Psychosocial considerations
• Recommend diet be analyzed for nutritional adequacy
• **Contraindications**
  – Acute illness or immunosuppression
  – GT size < 10 Fr in place (>14 Fr preferred)
  – Fluid restrictions or intakes less than 30 oz/d
  – Continuous drip feedings requiring a tube feeding unrefrigerated for more than 2h
  – Jejunostomy tubes requiring continuous feeds
  – Multiple food allergies/intolerances or special diet restrictions
  – Lack of resources (electricity, refrigeration, hot water, etc.)
Diabetic formulas

- High in PRO
- Low in CHO
- High in FAT
- Caloric density varies from 1.0-1.5 formulas

- Glucerna 1.0
- Glucerna Select
- Glucerna 1.2
- Glucerna 1.5
- Nutren Glytrol
- Diabetasource AC
  - + arginine
**Renal formulas**

- Low in phosphorus, potassium, calcium and sodium
- High kcal (1.8-2.0 kcal/ml)
- Low CHO, high Fat

**Nepro**
- High protein – designed for pt’s receiving dialysis

**Suplena**
- Low protein

**Novasource Renal**
- High protein, +arginine

**RenalCal**
- Low protein, +arginine
Pulmonary formulas

- Low CHO
  - ? Decrease pCO2
- High Fat
- High kcal (1.5 kcal/ml)

- Nutren Pulmonary
- Pulmocare
Immune enhancing formulas

- Caloric density ranges from 1.0-1.5 kcal/ml
- CHO ranges from moderate to very low
- Typically additional arginine
  • to support proliferation and function of immune cells
- Some contain glutamine
  • for GI-tract integrity and energy for immune cells
- Typically, additional EPA/DHA
  • to help modulate inflammation and support immune function
• **Impact**
  - 22% PRO, 53% CHO, 25% FAT
  - 12.5 g arginine
  - 1.7 g EPA/DHA

• **Impact Glutamine**
  - 24% PRO, 46% CHO, 40% FAT
  - 15 g glutamine
  - 16.3 g arginine

• **Impact 1.5**
  - 22% PRO, 38% CHO, 40% FAT
  - 12.5 g arginine
  - 1.7 g EPA/DHA

• **Oxepa**
  - 17% PRO, 28% CHO, 55% FAT
  - 4.6 g EPA

• **Pivot 1.5**
  - 25% PRO, 45% CHO, 30% FAT
  - 13 g arginine
  - 6.5 g glutamine
  - 2.6 g EPA
  - 1.3 g DHA
## Elemental and Semi-elemental Formulations

<table>
<thead>
<tr>
<th>Carbohydrate</th>
<th>Fat</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrolyzed cornstarch Malodextrin</td>
<td>Fatty acid esters MCT Structured lipids Fish oil</td>
<td>Hydrolyzed Casein Hydrolyzed Whey protein Crystalline L-amino acids Hydrolyzed Lactalbumin Soy protein isolate</td>
</tr>
</tbody>
</table>
Semi-elemental formulas

- **Optimental**
  - 67% whey protein hydrolysate, 28% partially hydrolyzed sodium caseinate, and 5% added arginine
  - (21% PRO, 54% CHO, 25% FAT)

- **Peptamen and Peptamen with Prebio**
  - enzymatically hydrolyzed whey protein
  - (16% PRO, 51% CHO, 33% FAT)

- **Peptamen 1.5**
  - enzymatically hydrolyzed whey protein
  - (18% PRO, 49% CHO, 33% FAT)
Semi-elemental immune-enhancing formulas

• **Crucial**
  – enzymatically hydrolyzed casein, L-arginine
  – Supplemental arginine and omega-3 fatty acids to help support immune function
  – (25% PRO, 36% CHO, 39% FAT)

• **Peptamen AF**
  – enzymatically hydrolyzed whey protein
  – Omega-3 fatty acids to help modulate the inflammatory response
  – (25% PRO, 36% CHO, 39% FAT)

• **Perative**
  – Partially Hydrolyzed Sodium Caseinate, Whey Protein Hydrolysate
  – Added arginine
  – (21% PRO, 55% CHO, 25% FAT)
Elemental formulas

• Tolerex
  – 100% free amino acids
  – Additional glutamine and arginine
  – (8.2% PRO, 90.5% CHO, 1.3% FAT)

• Vital HN
  – Peptides and free amino acids
  – (16.7% PRO, 73.8% CHO, 9.8% FAT)

• Vivonex
  – 100% free amino acids
  – Additional glutamine and arginine
  – Vivonex Plus (18% PRO, 76% CHO, 6% FAT)
  – Vivonex RTF (20% PRO, 70% CHO, 10% FAT)
  – Vivonex TEN (15% PRO, 82% CHO, 3% FAT)
Order Sets

- Enteral formula
- Route of delivery
- Advancement schedule
- Goal for formula delivery
- Monitoring parameters
- Routine aspects of care
  - Flushing protocols
    - Patency
    - Hydration
  - Aspiration precautions
- Assessment of tolerance
1. Physician authorizes dietitian to initiate, advance and monitor TF in consultation with physician. 
   Physician to select feeding schedule as ordered below.

2. **TUBE FEEDING TYPE:**
   - NG
   - Peg Tube
   - J-Tube
   - Oral Gastric

3. **TUBE FEEDING FORMULA:** Please choose one of the following
   - Standard with Fiber (1-1.2 cal/ml)
   - Elemental (1-1.2 cal/ml)
   - Renal (2 cal/ml)
   - Diabetic (1-1.2 cal/ml)
   - High Calorie/High Protein (2 cal/ml)
   - Other:

4. **TUBE FEEDING SCHEDULE:** (HOB elevated to greater than or equal to 30° at all times unless contraindicated.)
   Please choose one of the following:
   - **CONTINUOUS TUBE FEEDING** (Rate = total volume divided by 24 hours) Start TF full strength 25 ml/hr, increase ___ ml every 4 hours until goal of 75 ml/hr x 24 hrs is reached. Dietitian to assess patient and order final TF rate to meet needs.
   - If TF is interrupted for test/procedures, Nursing to adjust TF rate of 1 to 1.2 cal/ml formulas as needed to meet patient's 24 hr volume goal ordered, and not to exceed maximum TF rate of □ 150 ml/hr or □ ___ ml/hr rate
   - **CONTINUOUS CYCLIC** (10-12 hrs per day/night) Max rate recommended = 150 ml/hr
     - Start TF full strength at 25 ml/hr, increase ___ ml every 4 hours until goal of ___ ml/hr is reached.
     - (Time of day ___ to ___)
   - **INTERMITTENT BOLUS** (by gravity), Max rate recommended = 500 ml/bolus.
     - Start full strength bolus at 120 ml/bolus. Advance by ___ ml every 4 hours until goal (see below) is reached.
     - Bolus goal volume = ___ ml/bolus, (frequency) ___ X (time) □ 24 hrs/□ from ___ to ___

5. **TUBE FEEDING FLUSHES:**
   - Standard flush following Water Flush Guidelines (see page 2)
   - ___ ml additional water every ___ hours or □ BID/□ TID/□ QID/□ Daily

6. **TUBE OCCLUSION TX:**
   - Wokase-8 tablet and sodium bicarbonate 325 mg per Tube Occlusion Guideline (see page 2).

7. **CHECK GASTRIC RESIDUAL** (See Enteral Feeding Guidelines pg 2) No residual check with small bowel tube placement.
   - Gastric Residual greater than 200 ml more than 2 consecutive hrs → replace 200 ml, discard the remainder, continue to hold TF and Notify physician: □ anytime day or night; □ only between these hours: ___

8. **BOWEL MANAGEMENT**
   - Senna 187 mg NG/FT every evening PRN
   - Docusate Sodium 100 mg NG/FT BID PRN
   - Milk of Magnesia 30 ml NG/FT daily PRN
   - Bisacodyl Suppository 10 mg daily PRN
   - Other:

9. **LAB ORDERS:**
   - Comprehensive Metabolic Panel, □ Phosphorus, □ Magnesium, □ Prealbumin now and repeat weekly.
   - Repeat above labs (other frequency):

10. **Other:**

---

**Brantley S L Nutr Clin Pract 2009;24:335-343**

[Signature]

Physician Signature: __________________________

Date: ____________ Time: ____________
• Factors Affecting Patency
  – Characteristics of the formula
    • Concentrated (thick)
    • High protein
    • Fiber-enriched
  – The feeding tube
  – Medication administration
• Flush tube
  – at regular intervals with water
  – Before and after medications with water
• Acidic irrigants (cranberry juice) tend to promote clogging!
Infection control

- Adherence to basic principles of infection control
  - Hand washing
  - Cleansing tops of cans before opening
  - Wearing gloves during transfer of formula from cans to administration sets
  - Observing cutoffs for hang times for open delivery systems
    - Sterile open system (institution) 8h
    - Sterile open system (home) 12h
    - Sterile closed system (per manufacturer’s guidelines 24-48h)
  - No “topping-of” existing feeding solutions
  - Avoid manipulation of prefilled closed system containers
Medication Administration

- Orally is preferred
- NEVER mix with enteral formula
- Flush before and after
- Other characteristics of medications (such as sorbitol content and osmolality) can contribute to diarrhea.
Oral Hygiene

- Patients/clients with no oral intake are vulnerable to dental problems.
- Poor oral hygiene and dental disease increase risk of aspiration pneumonia
- Appropriate oral hygiene
  - Brushing 2x/day
  - Rinsing with mouthwash
  - Lip balm to protect lips
# Monitoring

<table>
<thead>
<tr>
<th>Physical Assessment</th>
<th>Clinical signs of fluid and nutrient excess or deficiency.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital signs</td>
<td></td>
</tr>
<tr>
<td>Actual fluid and nutrient intake</td>
<td></td>
</tr>
<tr>
<td>Measurement of output</td>
<td></td>
</tr>
<tr>
<td>Weight trend</td>
<td></td>
</tr>
<tr>
<td>Laboratory data (initially, and at least every 3-6 mo)</td>
<td>CBC, glucose, BUN, creatinine, electrolytes, Ca, Mg, P, liver fxn tests, TG serum proteins, PT/INR, urine, CRP</td>
</tr>
<tr>
<td>Markers for nutritional adequacy</td>
<td>Albumin, prealbumin trend, nitrogen balance studies</td>
</tr>
<tr>
<td>Review of medications</td>
<td></td>
</tr>
<tr>
<td>Changes in GI function</td>
<td></td>
</tr>
</tbody>
</table>
Transitional Feeding

- Hold enteral feedings for an hour or so before scheduled meals to stimulate appetite
- Nocturnal infusion only
- When oral intake reaches > 50% of estimated needs x 2-3 days, feeding can decreased
COMPLICATIONS
Nausea and Vomiting

- Delayed gastric emptying
  - Hypotension
  - Sepsis
  - Stress
  - Opiate medications
  - Anticholinergics
  - Excessively rapid infusion of formula
  - Infusion of very cold solution
  - Infusion of a high fat solution

- Obstipation

- C-diff
• Reduce or discontinue all narcotic medications
• Switch to a lowfat and/or isotonic formula
• Administer the feeding solution at room temperature
• Reduce the rate of infusion by 20-25 ml/h
• Provide small boluses (50-100 ml/feeding)
• Prokinetic agents
Abdominal distension

- GI ileus
- Obstruction
- Obstipation
- Ascites
- Diarrheal illness
Maldigestion & Absorption

• Clinical manifestations
  – Unexplained weight loss
  – Steatorrhea
  – Diarrhea
  – Anemia
  – Tetany
  – Bone pain
  – Pathological fractures
  – Bleeding
  – Dermatitis
  – Neuropathy
  – Glossitis
  – Edema
Diagnostic studies

• Screening (gross & microscopic examination of the stool, radiological examination of intestinal transit time, serum carotene concentration)

• Maldigestion/malabsorption of specific nutrients
  – Lactose tolerance test
  – Schilling test (B12)
  – other

• Endoscopic small bowel biopsy
  – Celiac disease
  – Tropical sprue
  – Whipple’s disease
Diarrhea

• Common causes
  – Medications (sorbitol-based, antibiotics)
  – Infection (C-difficile, nonclostridial bacteria)
  – Formula intolerance (osmolarity, fat content)
  – Specific component of the formula (lactose)
Algorithm for the Treatment of Diarrhea

1. Provide adequate fluids to maintain hydration & electrolyte balance

2. Reduce fluid & electrolyte losses
   a. Provide soluble fiber
   b. Change to continuous duodenal infusion
   c. Reduce rate of infusion

3. Determine etiology
   Enteric pathogen or inflammation or disease process?
   YES
   NO
Treat accordingly

Enteric Pathogen

C. difficile
Salmonella
Shigella
Campylobacter
Yersinia
E. coli

Disease/Inflammation

Malabsorption syndromes
Diabetes
Pancreatic insufficiency
Bile salt malabsorption
Fecal impaction

Diarrhea continues
Pharmocological

If possible, change offending medication

- Antibiotics
- Sorbitol containing medications
- H2 blockers
- Lactulose/laxatives
- Magnesium-containing antacids
- Potassium and phosphorus supplements
- Antineoplastics
- Quinidine

Diarrhea continues
Antimotility medication

Loperamide HCl or diphenoxylate HCl, atropine sulfate
Codeine
Paregoric
Deodorized tincture of opium

Treatment worked
- Gradually increase TF rate to goal

Treatment didn’t work
- Change to peptide-based or elemental formula

Treatment worked
- Increase rate as tolerated to goal

Treatment didn’t work
- D/C TF
- Provide PN until diarrhea resolved
  - D5 ¼ NS via feeding tube
**Constipation**

- Dehydration
- Inadequate fiber
- Excessive fiber
- Minimum of 1 ml of fluid per kcal
- Inadequate physical activity
- Patients/clients may need stool softener
Aspiration

- HOB to 45 degrees during gastric feeding
- Check residuals
  - GRVs that exceed 200 ml should trigger a careful evaluation of the patient
- High risk patients may benefit from duodenal or jejunal feedings
POSSIBLE
METABOLIC ALTERATIONS
### Fluid & electrolyte imbalances

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
</tr>
</thead>
</table>
| Hypertonic dehydration   | • Excessive fluid loss  
• Inadequate fluid intake  
• Concentrated formula administration to a patient who cannot express thirst |
| Over-hydration           | • Excessive fluid intake  
• Rapid refeeding  
• Catabolism of LBM w/ K+ loss  
• Refeeding syndrome  
• Renal, hepatic, or cardiac insufficiency |
<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible causes</th>
</tr>
</thead>
</table>
| Hypokalemia   | • Refeeding syndrome  
                • Catabolic stress  
                • Depleted body cell mass  
                • Effect of ADH and aldosterone  
                • Diuretic therapy  
                • Excessive losses (diarrhea)  
                • Metabolic alkalosis  
                • Insulin therapy  
                • Dilution |
| Hyperkalemia  | • Metabolic acidosis  
                • Poor perfusion (e.g. CHF)  
                • Renal failure  
                • Excessive K+ intake |
<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyponatremia</td>
<td>• Dilution, from elevated levels</td>
</tr>
<tr>
<td></td>
<td>• Hepatic, cardiac, or renal insufficiency</td>
</tr>
<tr>
<td></td>
<td>• Reduced Na intake relative to output</td>
</tr>
<tr>
<td>Hypernatremia</td>
<td>• Inadequate fluid intake w/ increased loss (sweating, osmotic diuresis)</td>
</tr>
<tr>
<td></td>
<td>• Increased Na intake (IV fluid)</td>
</tr>
<tr>
<td>Hypophosphatemia</td>
<td>• Refeeding syndrome</td>
</tr>
<tr>
<td></td>
<td>• Excessive calories</td>
</tr>
<tr>
<td></td>
<td>• Binding by epinephrine</td>
</tr>
<tr>
<td></td>
<td>• Sucralfate, antacids</td>
</tr>
<tr>
<td></td>
<td>• Insulin therapy</td>
</tr>
<tr>
<td>Hyperphosphatemia</td>
<td>• Renal insufficiency</td>
</tr>
</tbody>
</table>
# Acid-base disturbances

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypercapnea</td>
<td>• Overfeeding energy</td>
</tr>
<tr>
<td></td>
<td>• Excessive CHO provision in pt with respiratory dysfunction</td>
</tr>
<tr>
<td>Problem</td>
<td>Possible Causes</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hypozincemia</td>
<td>• Excessive losses (NGT, protein-losing, enteropathy, ostomy, wound)</td>
</tr>
</tbody>
</table>
| Vitamin K deficiency | • Inadequate vitamin K intake  
• Prolonged use of low-fat or low-vitamin K formula  
• Antibiotic use, cirrhosis, malabsorption, pancreatic insufficiency |
| Thiamin deficiency   | • Chronic alcoholism  
• Advanced age  
• Long-term malnutrition  
• Malabsorption  
• Antacid therapy  
• Dialysis |
| EFA deficiency       | • Inadequate linoleic acid intake                                               |
## Glycemic control

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Causes</th>
</tr>
</thead>
</table>
| Hyperglycemia | • DM, sepsis, catabolism, trauma, or other diseases states or conditions  
|            | • Insulin resistance  
|            | • Refeeding syndrome  
|            | • Glucocorticoids  
|            | • Excessive carbohydrates                                                     |
| Hypoglycemia | • Abrupt cessation of ETF in patient receiving OHA or insulin                  |
• **Resources**

  
  
  
  