Nutritional Support | Patients with Organ Failure

Assessing energy expenditure

- Indirect calorimetry via metabolic cart: gold standard
- Modified Weir equation: utilizes respiratory quotient VCO₂/VO₂ (RQ<0.7 underfeeding, RQ>1.0 overfeeding)
- Harris-Benedict equation: predicts TEE (total energy expenditure) using wt, ht, age, activity, stress
- Ireton-Jones equation: measured in two populations (ventilator-dependent pts, spontaneously breathing pts)
- Weight-based approach: what we use today

<table>
<thead>
<tr>
<th>Average caloric intake</th>
<th>25-30 kcal/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable patients</td>
<td>25-35 kcal/kg/day</td>
</tr>
<tr>
<td>Critically ill</td>
<td>25-30 kcal/kg/day</td>
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<tr>
<td>Burn injury, severe trauma, bone marrow transplant</td>
<td>30-40 kcal/kg/day</td>
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Use middle range: 30
Use low end: 25
Start at 30 and go up

Most patients use ideal body weight, obese patients use adjusted body weight

Liver failure

- Liver failure, at all stages: protein-calorie malnutrition (PCM)
- Complications of cirrhosis: limits protein intake, ↑proteinlysis, worsens PCM
- Chronic PCM: ↑complications of hepatic disease → ↓patient survival
- Factors affecting nutrient delivery
  - Impaired oral absorption: gut wall/GI tract edema, dysgeusia, steatorrhea, GI hypermotility from drugs
  - Poor po intake: early satiety, anorexia, poor taste, Na & protein restricted diets
  - ↑Catabolism: ↑proteinlysis, ↑gluconeogenesis, GI bleed, concurrent infections
- Nutritional alterations
  - Glucose: chronic hyperinsulinemia, hyperglucagonemia, insulin resistance, ↓glycogen stores, ↓muscle glutamine depot, overall poor glycemic control
  - Protein: catabolic/proteolytic, protein intolerant, maintain nitrogen balance (0.8-1.2 g/kg/day), ↑infections, ↑bleeding episodes, liver transplant patients need 1.5 g/kg/day
  - Vitamins & trace element deficiencies: A, D, folate, thiamine, zinc
- Nutritional support
  - Protein
    - Amino acids: 0.6-0.8 g/kg/day
    - Caution: slow advancement to goal without inducing hepatic encephalopathy
    - Monitoring: prealbumin, albumin, nitrogen balance studies
    - Avoidance: avoid high sodium diet to prevent ascites
  - Glucose
    - Monitoring: serum glucose
    - Infection/sepsis + end-stage liver disease → profound hypoglycemia
  - Lipids
    - End-stage liver disease → lipid intolerance, hypertriglyceridemia
    - Profound steatorrhea → need to ↓lipid intake → but may worsen fat-soluble vitamin deficiency
  - Vitamins: normal amount added to TPN, excessive supplementation not necessary
- Branched-chain amino acids

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Branched-chain AA Val, Leu, Iso</th>
<th>Aromatic AA Phe, Tyr, Trp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal intact liver</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Liver disease</td>
<td>4</td>
<td>4↑</td>
</tr>
</tbody>
</table>

- Liver disease → ↓metabolism & excretion of aromatic AA → ↑amount of aromatic AA crosses BBB disrupts normal neurochemistry → altered mental status (hepatic encephalopathy, coma)
- Reversible process: administer Hepatamine (rich in branch-chained AA, no aromatic AA)
Renal failure

- ARF itself does not ↑ caloric requirements, but complications/infection from ARF may
- Renal failure → fluid & electrolyte abnormalities (especially K & Phos)
- Chronic renal failure → metabolic bone disease, endocrine disorders, PCM

Factors affecting nutrient delivery
- Hypervolemia: salt intake, edema
- ↓Waste product elimination: azotemia, uremia, hyperkalemia, hyperphosphatemia, metabolic acidosis
- Site & access for renal replacement therapy: hemodialysis, peritoneal dialysis, CVVHD (continuous for 48hrs)

Nutritional alterations
- Fluid restrictions
- Electrolyte abnormalities: accumulation of K, phos, Ca, Mg
- Protein:
  - Amino acid intolerance: azotemia, uremia
  - ↑Urinary protein loss: nephrotic syndrome, diabetic nephropathy
  - ↑Protein loss: hemodialysis (6-8g), CVVHD (10-12g per 24hr)
  - Need to try to maintain positive nitrogen balance
- Vitamins & trace element deficiencies: Vit D, ascorbic acid, thiamine, pyridoxine, folate, Vit B, L-carnitine, Fe

Nutritional support
- Protein
  - Always start with oral protein source
  - Requirements: initiate with 0.6-0.8 g/kg/day → advance to 1.0-1.5 g/kg/day
    - Kidney transplant patients: 1.5 g/kg/day
    - CVVHD: 2 g/kg/day → need to immediately use different TPN once CVVHD shut off
- Glucose: monitor serum glucose levels closely
- Lipids
  - All patients with renal insufficiency should receive IVLE since it is volume-sparing
  - Monitor phosphate levels: 500mL IVLE = 7.4 mM phos
  - Inadequate lipid → fat-soluble vitamin deficiency
- Vitamins: ample amounts of water-soluble vitamins (1 vial of MVI-12 is sufficient)

Complications in critically-ill patients

- Refeeding syndrome
  - Severely malnourished patients + aggressive nutrition support → electrolyte imbalances
  - Consequences: hypokalemia, hypophosphatemia, hypocalcemia, hypomagnesemia
  - Prevent by titrating caloric intake up slowly
- Overfeeding

Immunomodulating nutrition support regimens [all only available as enteral products]
- Glutamine: ↑ glutamine → ↑ IgA produced by intestinal epithelia → ↓ infection risk
- Arginine: improves collagen synthesis, wound healing, T-cell function
- Omega-3 fatty acids: down-regulation of cytokines (ω3 already in IVLE)