Nutrition Support for the Mechanically Ventilated Patient

Carol Rees Parrish, RD, CNSD and Stacey Falls McCray, RD, CNSD

Providing nutrition support to the mechanically ventilated patient is the standard of care. When delivered appropriately, nutrition support provides energy, protein, and nutrients needed to fuel the immune system; promotes wound healing; and prevents excess breakdown of lean body mass. However, if not properly managed, nutrition support can induce complications. Accumulated data suggest the route of nutrition support may influence the incidence of complications. Evidence exists for the preferred use of enteral support over total parenteral nutrition (TPN) whenever possible.

Q: When should nutrition support be initiated?

In order to maintain lean body mass (including diaphragmatic mass) and immune function, nutrition support should be started on day 3 for patients requiring mechanical ventilation. Malnourished patients should start nutrition support within 24 hours. An accumulating body of evidence suggests that early initiation of enteral nutrition may attenuate the acute phase response.

Q: What is the best way to determine caloric requirements in a mechanically ventilated patient?

While there are various methods available for estimating caloric needs, there are no prospective, randomized studies to support the use of any single method. Even if exact caloric expenditures were known, it is not clear patients can actually use that amount of calories in the metabolic milieu of the stressed state. Caloric requirements vary based on age, activity level, nutritional status, severity of illness, need for wound healing, and a variety of other factors. Two common formulas for estimating energy requirements include:

▲ Harris Benedict equation—predicts resting energy expenditure (REE). The REE is not equivalent to the total number of calories required; total calorie needs are estimated by multiplying the REE by an appropriate activity/stress factor (Table 1).

Example: 76-year-old male admitted to the ICU for pneumonia and respiratory failure. The patient is 180 cm and weighs 78 kg.

Step 1. Use the formula to determine REE:

\[
66 + (13.7 \times 78) + (5 \times 180) - (6.8 \times 76) = 1518 \text{ calories}
\]

Step 2. Estimate total caloric needs by multiplying REE by an appropriate activity/stress factor:

\[
1518 \times 1.2 = 1822 \text{ calories (or about 1800 total kcal)}
\]

▲ Calories per kilogram method (based on actual or euvoelastic weight unless obese) (Table 2).

Patients with malnutrition may benefit from initial delivery of hypocaloric feedings (20-25 kcals/kg) to avoid refeeding syndrome (fluid and electrolyte shifts associated with initiation of nutrition support). Potassium, magnesium, and phosphorous should be monitored daily in patients at risk for refeeding and replaced as needed. Once electrolytes are stable, nutrition support should be advanced to meet full nutritional needs. Consider administration of vitamins, especially thiamin, during the refeeding period as well.

Overfeeding total (not just carbohydrate) calories can exacerbate hyperglycemia, cause fatty liver, increase CO₂ production, and burden the system by forcing it to deal...
with the excess caloric load (the body expends 1 kcal for every 5 kcal in excess of need). Recent evidence suggests that conservative caloric provision may be indicated in the ICU population. However, it is important to remember that prolonged underfeeding may lead to excessive loss of lean body mass.

The determination of each patient’s caloric needs should be based on the individual’s nutritional status, clinical condition, and medical history. Nutritional needs should be reassessed frequently as clinical condition changes. Actual nutrition received should be monitored as both underfeeding and overfeeding can be detrimental.

**Q:** How are protein needs determined?

Protein turnover is increased in illness. There is an obligatory loss of lean body mass in the first 10-21 days of critical illness. Protein is required to stimulate antimicrobial functions and provide substrate for synthetic functions, including wound healing. Provision of adequate protein minimizes catabolism and preserves lean body mass as much as possible. Protein needs vary according to the patient’s clinical condition and should be based on estimated actual, euvolemic weight unless obese (Table 3).

**Q:** When should TPN be used?

Parenteral nutrition should only be used in patients with a nonaccessible or nonfunctional GI tract resulting from:

- Massive GI bleed
- Acute abdomen
- Initial stage of short bowel syndrome
- Ileus obstruction
- Lengthy GI work-up requiring day after day of NPO at midnight

TPN is associated with more infectious, metabolic, and fluid complications than enteral feeding. Parenteral nutrition does not include all known nutrients, such as fiber, glutamine, carnitine, or short-chain fatty acids. Prolonged parenteral nutrition may lead to atrophy of the gastrointestinal tract. TPN is also approximately four times the cost of enteral feeding. The potential for enteral feedings should be reevaluated daily in patients on TPN.

**Q:** What can be done to decrease risk of aspiration pneumonia?

Aspiration pneumonia can result from aspiration of oropharyngeal as well as gastric secretions.

**Table 1**  
Harris Benedict equation for predicting resting energy expenditure

<table>
<thead>
<tr>
<th>Activity factors</th>
<th>Females: 655 + 9.6 (wt in kg) + 1.7 (ht in cm) - 4.7 (age) = REE</th>
<th>Males: 66 + 13.7 (wt in kg) + 5 (ht in cm) - 6.8 (age) = REE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective surgery</td>
<td>1.0-1.1</td>
<td>1.0-1.1</td>
</tr>
<tr>
<td>Multiple fractures</td>
<td>1.1-1.3</td>
<td>1.1-1.3</td>
</tr>
<tr>
<td>Severe infection</td>
<td>1.2-1.6</td>
<td>1.2-1.6</td>
</tr>
<tr>
<td>Burns</td>
<td>1.5-2.1</td>
<td>1.5-2.1</td>
</tr>
</tbody>
</table>

**Q:** What is the best enteral formula to use in patients requiring mechanical ventilation?

Formula selection should be based on calorie and protein needs, fluid status, renal function, and volume sensitivity. Most patients tolerate standard, intact enteral products. Calorically dense products are available for patients who require volume restriction. Fiber-containing formulas may be beneficial in normalizing bowel function and maintaining healthy gut mucosa and flora.

Specialized or disease specific formulas, albeit plentiful, have yet to be shown superior to standard products by large, prospective, randomized, clinical studies. Additionally, most of these formulas are significantly more expensive than standard formulas. Some specialized products are discussed in Table 4.

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**Table 3**  
Estimated protein needs

<table>
<thead>
<tr>
<th>Clinical condition</th>
<th>Recommended protein level (grams/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild-moderate stress</td>
<td>1.2-1.3</td>
</tr>
<tr>
<td>Moderate-severe stress</td>
<td>1.5-2.0</td>
</tr>
<tr>
<td>Severe stress with wound healing</td>
<td>1.6-2.0</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>1.3-1.5</td>
</tr>
<tr>
<td>CAPD</td>
<td>1.5</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>1.6</td>
</tr>
<tr>
<td>End-stage liver disease</td>
<td>1.0-1.5</td>
</tr>
</tbody>
</table>
The following steps may help to decrease (although cannot eliminate) the risk of aspiration from gastric secretions:

▲ Maintain a semirecumbent position with the head (shoulders) elevated to 30°-40° (patients with femoral lines can be at 30° if there is no contraindication to that position)
▲ Routinely verify appropriate placement of feeding tube
▲ Clinically assess GI tolerance:
  —abdominal distension/fullness/discomfort
  —vomiting
  —excessive residual volumes
▲ Remove naso/oro enteric feeding tubes as early as possible

It is unclear whether gastric vs small-bowel feeding tubes, use of continuous or intermittent feeding techniques, or the size of the feeding tube play a role in aspiration risk. Efficacy of monitoring techniques to detect the occurrence of gastric aspiration, such as the addition of blue food coloring to tube feedings or glucose monitoring of tracheal aspirate, has not been proven.

Q: How should one treat residual volumes?

Residual volumes (RV) are routinely checked as a way to assess tube feeding tolerance and signify aspiration risk. Although checking RV is a common clinical practice, there are no data correlating a specific RV with increased aspiration events. If an RV is to be checked, remember to take into account flow of normal secretions from mouth to stomach (approximately 2-3 L/day or 100-150 mL/hour). If gastric residuals limit tube feeding delivery, consider the following steps:

▲ Place the patient on his right side for 15-20 minutes before checking an RV to avoid the cascade effect (build-up of secretions/tube feedings in the noncontracting fundic portion of the stomach)
▲ Seek transpyloric access of feeding tube
▲ Try using a prokinetic agent
▲ Switch to a more calorically dense product to decrease total volume needed
▲ Tighten glucose control to <200mg% to avoid gastroparesis from hyperglycemia

▲ Use narcotic alternatives

Q: What should the clinician do if a patient on tube feeding develops diarrhea?

Although tube feedings are often blamed for causing diarrhea, enteral feeding is rarely the culprit. When diarrhea is reported, the first step should be to quantify the actual stool volume to determine significance. It is not uncommon for sick patients to have loose stools, and a volume of <250 mL/day should not be cause for concern. Diarrhea rarely means that the patient is not using the nutrition being provided.

The following steps may be helpful in evaluating the cause of diarrhea. Nutrition support should not be withheld for diarrhea; continue tube feedings while the cause of diarrhea is investigated and treated.

▲ Check meds (did meds switch from IV to enteral route when enteral access achieved?) Common offenders include:
  —Theophylline and acetaminophen elixir
  —NeutraPhos
  —Lactulose
▲ Check for C. difficile
▲ Try fiber (few clinical studies; however, it supports the health of colonocytes)

Once infectious causes are ruled out, try an antidiarrheal agent (consider set versus as-needed dose).

Q: How should enteral feeding be monitored?

Once calorie and protein goals

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<table>
<thead>
<tr>
<th>Table 4 Specialized nutritional formulas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formula type</strong></td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Renal formulas</td>
</tr>
<tr>
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<th>Comment</th>
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</thead>
<tbody>
<tr>
<td>Renal formulas</td>
<td>The fact that a patient is on dialysis does not require that a specialized renal product be used. Renal products should be reserved for patients with uncontrollable potassium, phosphorous and magnesium levels. (Note: appropriate glucose control and calorie provision should be addressed first.)</td>
</tr>
<tr>
<td>Pulmonary formulas</td>
<td>Clinical trials have not shown a benefit when patients do not receive excess total calories.</td>
</tr>
<tr>
<td>Diabetes specific formulas</td>
<td>There is insufficient data to support their use, especially in stressed patients.</td>
</tr>
<tr>
<td>Elemental formulas</td>
<td>The surface area of the GI tract is enormous; most absorption occurs in the first 5 feet of small bowel. Use of these formulas should be reserved for patients with known mucosal diseases that have failed standard polymeric and semi-elemental formulas.</td>
</tr>
</tbody>
</table>
Nutrition support is a hotly debated topic in most intensive care units. Is enteral nutrition or TPN best? Is gastric or small-bowel feeding safer? Are specialized formulas needed? These are only some of the issues, and the fact remains that there is a paucity of clear, solid data. Folklore has become the standard of practice in many areas of medicine; it is richly found in nutrition support. We must be careful not to get caught up in the trappings of our beliefs about nutrition support. Instead, we must continue to evaluate our own practices and fine-tune our skills of clinical assessment and common sense.

Bibliography

For an update on enteral feeding in the hospitalized patient, the following texts will be available in February 2003:

▲ Parrish CR, Krenitsky J, McCray S. University of Virginia Health System Nutrition Support Traineeship Syllabus. University of Virginia Medical Center Nutrition Services Department, Charlottesville, Va. In press. E-mail Linda Niven at ltn6m@virginia.edu for details.
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