



days after ICU admission if adequate caloric needs (e.g., >60%) cannot be achieved with oral diet and supplements alone, especially for patients with existing malnutrition. Many studies have shown that ICU patients actually receive only 60% to 75% of the amount of tube feeding ordered by physicians. This can occur because of tube feeding intolerance (e.g., high gastric residuals, emesis, diarrhea, tube dislodgement) or discontinuation of feeding for diagnostic tests or therapeutic interventions. Although supplemental PN (see later discussion) is commonly ordered in patients who are not able to achieve tube feeding rates adequate for their needs, this practice remains controversial because of the limited number of good clinical trials. Rigorous studies are now in progress to address the efficacy of this approach, motivated by data suggesting that an increase in net caloric deficit (i.e., the difference between daily caloric requirements and daily actual calories delivered, summed over time) is associated with worse clinical outcomes in medical and surgical ICU patients.

Most outpatients and hospitalized ICU and non-ICU patients tolerate standard, inexpensive enteral formulas delivered via gastric or intestinal routes that provide between 1.0 and 1.5 kcal/mL. A large variety of enteral tube feeding products is available for clinical use. The specific product chosen should be based both on clinical conditions and underlying organ function, as outlined in [E-Table 68-4](#). Because EN products can be marketed without efficacy data from randomized, controlled clinical trials, there remains a clear need for such trials to determine optimal EN formulations for different clinical conditions.

Complications of enteral feeding include diarrhea. Diarrhea is common in hospital patients receiving tube feedings but is typically caused by factors independent of the feeding, including administration of antibiotics, sorbitol-containing or hypertonic medications (e.g., acetaminophen elixir), and infections. Diarrhea caused by tube feeding itself does occur with rapid formula administration, in patients with underlying gut mucosal disease, and in those with severe hypoalbuminemia, which causes bowel wall edema. A fiber-containing enteral formula is sometimes useful to decrease diarrhea. Other complications of tube feeding include aspiration of tube feedings into the lung; mechanical problems with nasally placed feeding tubes, including discomfort, sinusitis, pharyngeal or esophageal mucosal erosion due to local tube trauma; and, with percutaneous feeding tubes, entrance site leakage, skin breakdown, cellulitis, and pain. Metabolic complications of tube feeding include fluid imbalances, hyperglycemia, electrolyte abnormalities, azotemia, and, occasionally, refeeding syndrome (discussed later). In general, if tube feedings are deemed to be required for more than 4 to 6 weeks, a percutaneous feeding tube should be placed.

In tube-fed patients who are receiving either subcutaneous or intravenous insulin to control hyperglycemia, significant hypoglycemia due to the continued actions of insulin may occur if tube feedings are discontinued inadvertently or for diagnostic or therapeutic tests. Hospitalized patients receiving tube feedings should have their blood glucose concentration monitored on a daily basis (or several times per day as indicated) and their blood electrolytes (including magnesium, potassium, and phosphorus) and renal function monitored several times each week (or daily in the ICU setting). Other blood chemistries should be determined at least weekly. This should be accompanied by close

monitoring of intake and output records (including urine, stool, and drainage outputs) and gastrointestinal tolerance. When patients are able to consume oral food, tube feeding should be decreased and then discontinued (e.g., with daily calorie counts by a registered dietitian). For patients requiring home tube feeding, it is important to consult social service professionals to ensure appropriate care and follow-up.

Administration of Parenteral Nutrition

The basic principle in considering PN therapy is that the patient must be unable to achieve adequate nutrient intake via the enteral route. PN support includes administration of standard complete nutrient mixtures that contain dextrose, L-amino acids, lipid emulsion, electrolytes, vitamins, and minerals (in addition to certain medications as indicated, such as insulin or octreotide), given via a peripheral or central vein. Administration of complete PN therapy to patients with gastrointestinal tract dysfunction has become a standard of care in most hospitals and ICUs throughout the world, although use in individual institutions varies widely. PN is life-saving in patients with intestinal failure (e.g., short bowel syndrome). Existing data indicate that PN benefits patients with preexisting moderate to severe malnutrition or critical illness by decreasing overall morbidity, and possibly mortality, compared with patients receiving inadequate EN or hydration (intravenous dextrose) therapy alone. A consensus is emerging, based on recent rigorous studies in critical illness, that PN should probably not be initiated until days 3 to 4 after ICU admission in patients who are unable to tolerate adequate EN.

Compared with PN, EN is less expensive, probably maintains intestinal mucosal structure and function to a greater extent, is safer in terms of mechanical and metabolic complications (see later discussion), and is associated with reduced rates of nosocomial infection. Therefore, the enteral route of feeding should be used and advanced whenever possible, and the amount of administered PN should be correspondingly reduced.

Generally recognized indications for PN include the following situations:

1. Patients with short bowel syndrome or other conditions causing intestinal failure (e.g., motility disorders, obstruction, severe ileus, severe inflammatory bowel disease), especially those with preexisting malnutrition.
2. Clinically stable patients in whom adequate enteral feeding (e.g., >50% of needs) is unlikely for 7 to 10 days because of an underlying illness.
3. Patients with severe catabolic stress requiring ICU care in whom adequate enteral nutrient intake is unlikely for more than 3 to 5 days.

There is no reason to withhold PN in hospitalized patients for any period of time if they exhibit preexisting moderate to severe malnutrition and are deemed to be unlikely to meet their needs by the oral or enteral route.

Generally accepted contraindications for PN include the following conditions:

1. If the GI tract is functional and access for enteral feeding is available.