2. If PN is thought to be required for 5 days or less.
3. If the patient cannot tolerate the extra intravenous fluid required for PN or has severe hyperglycemia or electrolyte abnormalities on the planned day of PN initiation
4. If the patient has an uncontrolled bloodstream infection or severe hemodynamic instability.
5. If new placement of an intravenous line solely for PN poses undue risks based on clinical judgment
6. On an individualized basis, if aggressive nutritional support is not desired by the competent patient or legally authorized representative, such as in premorbid patients or those with terminal illness.

PN can be delivered either as peripheral vein solutions or as central vein solutions through a percutaneous subclavian vein or internal jugular vein catheter for infusion into the superior vena cava (nontunneled in the hospital setting), through a subcutaneously tunneled central venous catheter (e.g., Hickman catheter) or central venous port (for chronic home PN therapy), or through a peripherally inserted central venous catheter (PICC). Although data are limited, it is clearly preferable to manage long-term central venous PN to be managed at home with the use of a tunneled central venous catheter rather than a PICC line because of the higher rate of local complications (e.g., phlebitis, catheter breakage) and possibly catheter-associated infections with PICC lines.

A comparison of typical fluid, macronutrient, and micronutrient content of peripheral and central vein PN solutions is shown in Table 68-3. Intravenous lipid emulsions (typically added to PN as a 20% soybean oil–based solution in the United States) provide both essential linoleic and α-linolenic fatty acids and energy (10 kcal/g); these are typically infused over a 24-hour period in the complete PN administration bag. The maximal recommended rate of fat emulsion infusion is approximately 1.0 g/kg/day. Most patients are well able to clear triglyceride from plasma after intravenous administration of fat emulsion. Recently, an intravenous lipid emulsion of 80% olive oil/20% soybean oil was approved for use in adult PN in the United States. It is important to monitor blood triglyceride levels at baseline and then approximately weekly and as indicated to assess clearance of intravenous fat; triglyceride levels should be maintained lower than 400 mg/dL to decrease the risk of pancreatitis or diminished pulmonary diffusion capacity in patients with severe chronic obstructive lung disease.

Central venous administration of PN allows higher concentrations of dextrose (3.4 kcal/g) and amino acids (4 kcal/g) to be delivered as hypertonic solutions; thus, lower amounts of fat emulsion are needed to reach caloric goals (see Table 68-3). Requirements for potassium, magnesium, and phosphorus are typically higher with central vein PN compared to peripheral vein PN. The higher concentrations of dextrose and amino acids allow most patients to achieve caloric and amino acid goals with only 1 to 1.5 L of PN per day. In central vein PN, initial orders typically provide 60% to 70% of non–amino acid calories as dextrose and 30% to 40% of non–amino acid calories as fat emulsion. These percentages are adjusted as indicated based on levels of blood glucose and triglyceride, respectively. Based on comprehensive data associating hyperglycemia with hospital morbidity and mortality, expert panels now recommend tight blood glucose control in ICU settings (between 80 and 130 to 150 mg/dL) and close blood glucose monitoring. Separate intravenous insulin infusions should usually be administered in the ICU when patients receiving central vein PN develop hyperglycemia.

TABLE 68-3 COMPOSITION OF TYPICAL PARENTERAL NUTRITION SOLUTIONS

COMPONENT*	PERIPHERAL PN	CENTRAL PN
Volume (L/day)	2-3	1-1.5
Dextrose (%)	5	10-25
Amino acids (%)†	2.5-3.5	3-8
Lipid (%)‡	3.5-5.0	2.5-5.0
Sodium (mEq/L)	50-150	50-150
Potassium (mEq/L)	20-35	30-50
Phosphorus (mmol/L)	5-10	10-30
Magnesium (mEq/L)	8-10	10-20
Calcium (mEq/L)	2.5-5	2.5-5
Trace elements§		
Vitamins‖		

*Electrolytes in parenteral nutrition (PN) are adjusted as indicated to maintain serially measured serum levels within the normal range. The percentage of sodium and potassium salts as chloride is increased to correct metabolic alkalosis, and the percentage of salts as acetate is increased to correct metabolic acidosis. Regular insulin is added to PN as needed to achieve blood glucose goals (separate intravenous insulin infusions are commonly required with hyperglycemia in intensive care unit settings).

†Provides all essential amino acids and several nonessential amino acids. The dose of amino acids is adjusted downward or upward to goal as a function of the degree of azotemia or hyperbilirubinemia in patients with renal or hepatic failure, respectively.

‡Lipid is given as soybean oil– or olive oil/soybean oil–based fat emulsion in the United States. In Europe and other non-U.S. countries, intravenous fish oil, olive oil, medium-chain triglycerides, and combinations of these are available for use in PN. Lipid is typically mixed with dextrose and amino acids in the same PN infusion bag ("all-in-one" solution).

§Trace elements added on a daily basis to peripheral vein and central vein PN are mixtures of chromium, copper, manganese, selenium, and zinc. (These elements can also be supplemented individually.)

‖Vitamins added on a daily basis to peripheral vein and central vein PN are mixtures of vitamins A, B_1 (thiamine), B_2 (riboflavin), B_3 (niacinamide), B_6 (pyridoxine), B_{12}, C, D, and E, biotin, folate, and pantothenic acid. Vitamin K is added on an individual basis (e.g., for patients with cirrhosis). Specific vitamins can also be supplemented individually.

Specific requirements for intravenous trace elements and vitamins have not been rigorously defined for patient subgroups, and in most stable patients, therapy is directed at meeting published recommended doses using standardized intravenous preparations to maintain blood levels in the normal range (see Table 68-3). Several studies have shown that a significant proportion of ICU patients have low levels of zinc, selenium, vitamin C, vitamin E, and vitamin D despite receiving specialized PN (or EN). Depletion of these essential nutrients may impair antioxidant capacity, immunity, wound healing, and other important body functions, and supplementation is recommended if serum concentrations are low. For example, zinc (and other micronutrients such as copper) should probably be increased in the PN of patients with burns, large wounds, significant gastrointestinal fluid losses, and other conditions if serum concentrations indicate low levels. Recent data suggest that thiamine depletion is not uncommon in patients receiving chronic diuretic therapy or in those with severe malabsorption.

The most common complication of peripheral vein PN is local phlebitis resulting from use of the catheter. In such cases, a small dose of hydrocortisone and heparin is typically added to the solution. Alterations in blood electrolytes can be treated with adjustment of concentrations in the peripheral PN prescription. Hypertriglyceridemia typically responds well to lowering of the total PN lipid dose. Central vein PN is associated with a much