Parenteral Nutrition

Mehdi Sadeghian

Ph.D. of Nutrition

References

ASPEN Parenteral Nutrition Handbook; 3rd edition

ESPEN guideline on clinical nutrition in the intensive care unit; 2019

The Canadian Critical Care Practice Guideline; 2015

The Hitchhiker's Guide to Parenteral Nutrition Management for Adult Patients; 2006

Hospital Discharges Linked to ICD - 9 Code 99.15

Parenteral Infusion of Concentrated Nutritional Substances

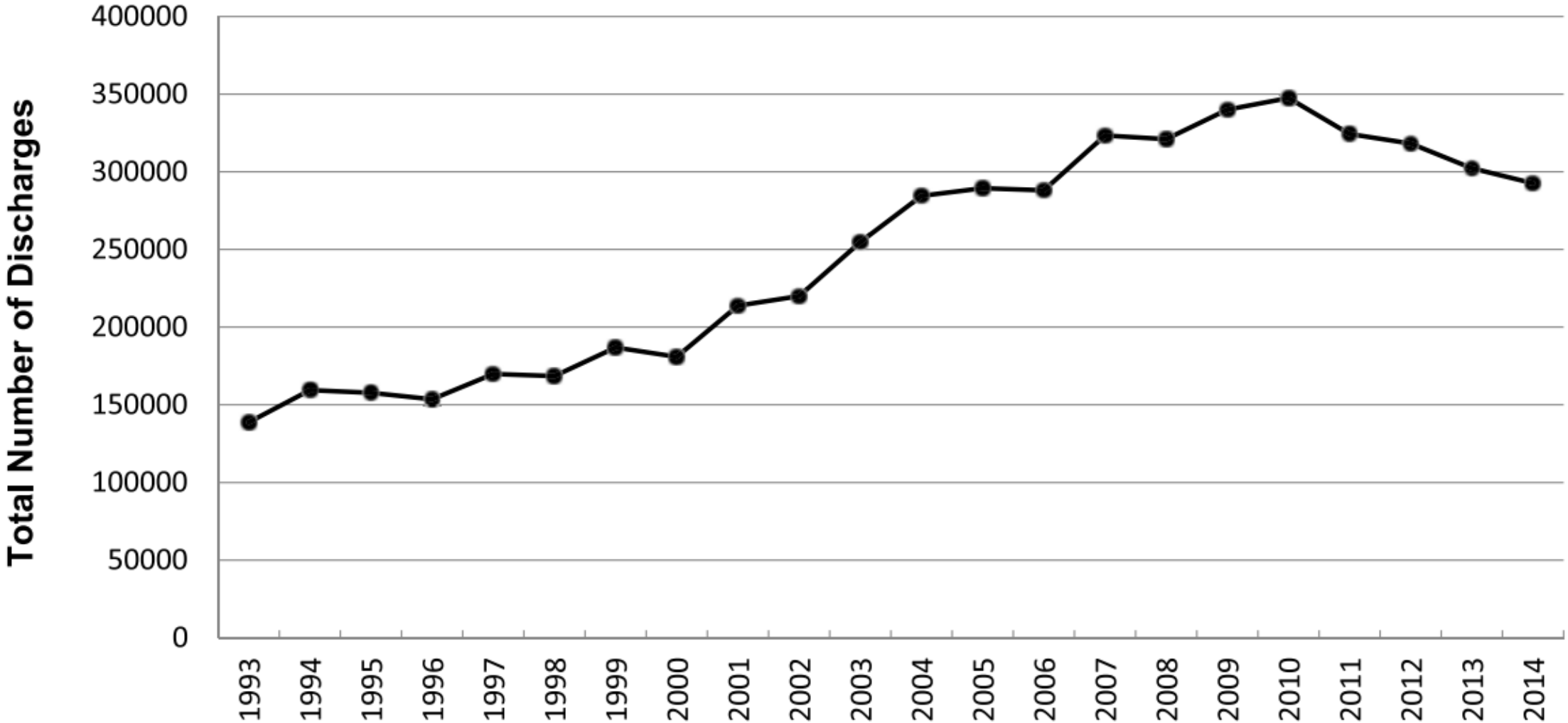


Table 1-4. Elements of Nutrition Assessment

Assessment Elements	Results
Anthropometrics	Height, weight, BMI, weight history, skin folds.
Client history	Medical, surgical, family, and psychosocial histories. Review of medications and herbal supplements. Current clinical presentation.
Biochemical data	Caution should be used with markers that are indicative of inflammation and possible protein malnutrition (serum albumin, prealbumin). Interpreting laboratory values is tailored to disease.
Nutrient intake data	Data should include oral food/beverage intake, EN, parenteral infusions, and supplements. A modified diet history or 24-hour recall can be easily used. Other options include a diet record, nutrient intake analysis and food frequency questionnaire.
NFPE findings	Includes assessment of muscle and sub-cutaneous fat status; presence of edema; identification of possible micronutrient deficiencies.
Functional status	Handgrip to assess muscle strength. Patient-reported changes in functional status. Quality-of-life measures to assess functional ability.

Nutritionally at-risk adults

- Involuntary weight loss of 10% of usual body weight within 6 months or 5% within 1 month
- Involuntary weight loss of 10 lb within 6 months
- Body mass index (BMI) less than 18.5 kg/m2
- Increased metabolic requirements
- Altered diets or diet schedules
- Inadequate nutrition intake, including not receiving food or nutrition products for more than 7 days

Table 1-6. Characteristics to Diagnose Nonsevere (Moderate) Malnutrition

Characteristic	Acute Illness or Injury	Chronic Disease	Social or Environmental Factors
Weight loss	1%–2%/1 wk 5%/1 mo 7.5%/3 mo	5%/1 mo 7.5%/3 mo 10%/6 mo 20%/1 y	5%/1 mo 7.5%/3 mo 10%/6 mo 20%/1 y
Energy intake	<75% for >7 d	<75% for ≥1 mo	<75% for ≥3 mo
Body fat	Mild depletion	Mild depletion	Mild depletion
Muscle mass	Mild depletion	Mild depletion	Mild depletion
Fluid accumulation	Mild	Mild	Mild
Grip strength	Not applicable	Not applicable	Not applicable

Table 1-5. Characteristics to Diagnose Severe Malnutrition

Characteristic	Acute Illness or In-jury	Chronic Disease	Social or Environ-mental Factors
Weight loss	>2%/1 wk >5%/1 mo >7.5%/3 mo	>5%/1 mo >7.5%/3 mo >10%/6 mo >20%/1 y	>5%/1 mo >7.5%/3 mo >10%/6 mo >20%/1 y
Energy intake	<50% for >5 d	<75% for >1 mo	<50% for >1 mo
Body fat	Moderate depletion	Severe depletion	Severe depletion
Muscle mass	Moderate depletion	Severe depletion	Severe depletion
Fluid accumulation	Moderate to severe	Severe	Severe
Grip strength	Not recommended in ICU	Reduced for age/sex	Reduced for age/sex

How to screen for the risk of malnutrition during hospital stay?

- Since there is no “gold standard” to define the "at risk patient“ and the malnourished ICU patient
- Every critically ill patient staying for more than 48 h in the ICU should be considered at risk for malnutrition.
- NUTRIC score
  - nutritional support might decrease mortality in patients with a high NUTRIC score (>5).
  - A limitation to this score is that no nutritional parameters are included.
  - The final composite NUTRIC score was correlated with mortality; mortality is not the best outcome to assess the efficacy of a nutritional intervention considering the numerous factors influencing ICU mortality

- It appears that among all the screening tools, NRS 2002 and MUST have the strongest predictive value for mortality, and they are the easiest and quickest to calculate.
- a pragmatic approach should be considered for patients at risk such as those staying in the ICU > two days, undergoing mechanical ventilation, infected, underfed >5 days, and/or presenting with a severe chronic disease.

malnutrition according to the recent ESPEN GLIM recommendations

	Phenotype criteria		
	Weight loss (%)	Body mass index (kg/m^2)	Muscle mass[a]
Stage 1/Moderate Malnutrition (Requires 1 phenotypic and 1 etiologic criterion)	5–10% within the past 6 mo, or 10–20% beyond 6 mo	<20 if <70 yr, <22 if ≥70 yr Asia:<18.5 if <70 yr, <20 if ≥70 yr	Mild to moderate deficit (per validated assessment methods – see below)
Stage 2/Severe Malnutrition (Requires 1 phenotypic and 1 etiologic criterion)	>10% within the past 6 mo, or >20% beyond 6 mo	<18.5 if <70 yr, <20 if ≥70 yr Asia: TBD	Severe deficit (per validated assessment methods – see below)

Muscle mass

- by dual-energy absorptiometry or corresponding standards using other body composition methods like bioelectrical impedance analysis (BIA), CT or MRI.
- When not available or by regional preference, physical exam or standard anthropometric measures like mid-arm muscle or calf circumferences may be used.
- Functional assessments like hand-grip strength may be used as a supportive measure

malnutrition according to the recent ESPEN GLIM recommendations

	Etiology criteria	
	Food intake, malabsorption or GI symptoms	Disease burden/ inflammation
Stage 1/Moderate Malnutrition (Requires 1 phenotypic and 1 etiologic criterion)	Any reduction of intake below ER for >2 weeks, or moderate mal-absorption/GI symptoms[b]	Acute disease/injury[d], or chronic disease-related[e]
Stage 2/Severe Malnutrition (Requires 1 phenotypic and 1 etiologic criterion)	≤50% intake of ER for >1 week, or severe mal-absorption/GI symptoms[c]	Acute disease/injury[d], or chronic disease-related[e]

- Gastrointestinal symptoms (moderate OR severe): dysphagia, nausea, vomiting, diarrhea, constipation or abdominal pain.
- Acute disease/injury-related with severe inflammation: major infection, burns, trauma or closed head injury.
- Chronic disease-related with chronic or recurrent mild to moderate inflammation: malignant disease, chronic obstructive pulmonary disease, congestive heart failure, chronic renal disease or any disease with chronic or recurrent Inflammation. CRP may be used as a supportive laboratory measure

When should nutrition therapy be initiated and which route should be used?

- In case of contraindications to oral and EN, PN should be implemented within three to seven days (To avoid overfeeding)
- When a patient is determined to be at high nutrition risk (e.g., NRS 2002 ≥ 5) or severely malnourished, and EN is not feasible, the initiation of low-dose PN should be carefully considered and balanced against the risks of overfeeding and refeeding
- caloric overfeeding may play a role in the infectious complications of PN. the energy/protein goal should be achieved progressively and not before the first 48 h. Full targeted medical nutrition therapy is considered to achieve more than 70% of the resting energy expenditure (REE), but not more than 100%

When should we apply/implement supplemental PN?

- when the level of energy needs provided by EN is below 60% three days after ICU admission, supplementary PN should be initiated to reach a maximum of 100% of the energy needs
- In non-intubated patients with dysphagia and a very high aspiration risk, postpyloric EN or, if not possible, temporary PN during swallowing training with removed nasoenteral tube can be performed.
- early EN reduced infectious complications in unselected critically ill patients, in patients with severe acute pancreatitis, and after GI surgery, whereas no evidence of superiority for early PN or delayed EN over early EN was detected

Critically ill patients with surgical complications after abdominal or esophageal surgery

- Without evidence, but based on common reasoning and pathophysiological considerations, surgical complications leading to gastrointestinal contents leaking into the abdominal cavity should always lead to withholding/stopping EN. At the time of developing such complications, patients usually have developed considerable energy deficits. Therefore, PN should be considered early after resurgery if such a problem clearly cannot be solved within the next days, but started at a slow infusion rate

Critically ill patients with surgical complications after abdominal or esophageal surgery

- Esophageal surgery commonly results in the loss of the lower esophageal sphincter function and is therefore associated with a significantly increased risk of aspiration. early EN via surgical jejunostomy vs early PN resulted in less life-threatening complications and a shorter postoperative hospital stay
- In many cases of complicated abdominal surgery, patient tolerance to EN is impaired. Furthermore, depending on surgery, maldigestion and/or malabsorption may occur. Therefore, (supplemental) PN should be considered timely to avoid prolonged nutritional deficits.

Patients with uncontrolled septic shock

- In patients with uncontrolled septic shock receiving vasopressors or inotropes, the use of EN during the first 48 h after admission is shown to be less favorable in terms of survival. PN may be the safer route in some patient groups.
- For those patients with sepsis for whom EN is not feasible for prolonged periods (e.g. bowel discontinuity, etc.), PN should be prescribed after successful resuscitation up to approximatively half of the predicted or measured energy needs and EN prescribed as soon as the clinical condition permits.

Early vs. Delayed Supplemental Parenteral Nutrition

- We strongly recommend that early supplemental PN and high IV glucose not be used in unselected critically ill patients (i.e. low risk patients with short stay in ICU).
- In the patient who is not tolerating adequate enteral nutrition, there are insufficient data to put forward a recommendation about when parenteral nutrition should be initiated.
- Practitioners will have to weigh the safety and benefits of initiating PN in patients not tolerating EN on an individual case-by-case basis.

Optimize Parenteral Nutrition and Minimize Risks: Dose of PN

- in critically ill patients who are not malnourished, are tolerating some EN, or when parenteral nutrition is indicated for short term use (< 10 days), low dose parenteral nutrition should be considered.
- There are insufficient data to make recommendations about the use of low dose parenteral nutrition in the following patients: those requiring PN for long term (> 10 days); obese critically ill patients and malnourished critically ill patients
- Low dose parenteral nutrition without lipids maybe associated with a reduction in infections in critically ill patients.
- Insufficient data to comment on the effects of low dose parenteral nutrition in obese patients.

Timing of PN Intervention

Patients	Insufficient intake	PN initiation
Well-nourished, stable adult	Not received significant (≥50% of estimated requirements) oral or enteral nutrients	After 7 days
Adults who are nutritionally at risk	Not anticipated to reach desired oral or enteral needs	3-5 days
Adults with moderate or severe malnutrition	Oral or enteral intake is not possible or sufficient	as soon as possible

Indications for PN-ASPEN guideline

- **GI function**
  - Symptoms including nausea, vomiting, diarrhea, and abdominal distention or cramps may preclude the use of the GI tract for prolonged periods
  - Treatment toxicities in patients with cancer that preclude adequate oral intake for >1 week are an indication for PN.
  - In patients with critical illness who are hemodynamically stable, PN is indicated if EN is not possible (paralytic ileus, acute GI bleed, or bowel obstruction) and hypermetabolism is expected to last >5 days
  - For the patient with severe malnutrition, PN is indicated when an impairment of the GI tract occurs
  - PN is indicated in other conditions precluding the use of the GI tract for >7–10 days in adults
  - unsuccessful or inadequate EN (high gastric residual volumes or pulmonary aspiration)

- **PN should not be initiated in adults with severe metabolic instability until the condition has improved**
- During the first 24-48 hours following a significant insult (trauma event, aspiration episode, cardiopulmonary arrest, etc), patients enter the “ebb” phase of the metabolic response, associated with hypovolemia, shock, and tissue hypoxia

- **Clinical status**
  - PN should only be initiated in patients who are hemodynamically stable and able to tolerate the fluid volume and protein, carbohydrate, and ILE

Table 4.1. Clinical Conditions Warranting Cautious Initiation of Parenteral Nutrition in Adults.[52,53]

Conditions	Suggested Criteria
Hyperglycemia	Glucose greater than 180 mg/dL
Azotemia	Blood urea nitrogen greater than 100 mg/dL
Hypertriglyceridemia	Serum triglycerides greater than 200 mg/dL
Hyponatremia	Serum sodium less than 130 mEq/L
Hypernatremia	Serum sodium greater than 150 mEq/L
Hypokalemia	Serum potassium less than 3 mEq/L
Hypomagnesemia	Serum magnesium less than 1.3 mEq/L
Hypocalcemia	Ionized calcium less than 4.5 mg/dL
Hypophosphatemia	Serum phosphorus less than 2 mg/dL

2017

Table 2-4. Clinical Conditions Warranting Cautious Use of PN[20]

Condition	Suggested Criteria[a]
Hyperglycemia	Glucose > 300 mg/dL
Azotemia	BUN > 100 mg/dL
Hyperosmolality	Serum osmolality > 350 mOsm/kg
Hypernatremia	Na > 150 mEq/L
Hypokalemia	K < 3 mEq/L
Hyperchloremic metabolic acidosis	Cl > 115 mEq/L
Hypophosphatemia	Phosphorus < 2 mg/dL
Hypochloremic metabolic alkalosis	Cl < 85 mEq/L

2020

Specific guideline

- GI disorders
  - **Crohn's disease or ulcerative colitis:** PN has not been shown to improve patient outcomes as the primary management of acute exacerbations. Bowel rest is not necessary to achieve remission
  - **Pancreatitis**: PN is unlikely to benefit patients with mild, acute, or chronic relapsing pancreatitis when the condition lasts for <1 week. PN was associated with net harm in mild pancreatitis. favorable response observed with EN in severe acute pancreatitis

Specific guideline

- Perioperative malnutrition
  - **well-nourished or mild malnutrition**: PN has been associated with net harm
  - **Moderate/severe malnutrition**: patient outcomes were improved with PN

  - **Consider** preoperative PN in severely malnourished patients unable to tolerate sufficient oral intake or EN
  - **Reserve** postoperative PN for severely malnourished patients unable to tolerate EN for **>7 days**, unless initiated preoperatively

PN in palliative care

- Limit the use of PN in palliative care to carefully selected candidates
  - with an expected survival of 2–3 months
  - oral intake or EN is not feasible
  - performance status sufficient to allow some participation in care
  - Availability of caregivers to assist with infusion procedures

Table 1.1. Examples of Conditions Likely to Require Parenteral Nutrition Across the Life Cycle.[31,32,36,38]

Category	Example	Clinical Features
Impaired absorption or loss of nutrients	Short bowel syndrome, complications of bariatric surgery, intestinal atresia, gastroschisis, volvulus, meconium ileus, necrotizing enterocolitis, mesenteric thrombosis, trauma	Bowel length—adults: 60 cm with colon in continuity, 120 cm without colon in continuity Neonate and pediatric: Inability to meet nutrient, electrolyte, and fluid requirements regardless of intestinal length Weight loss, failure to thrive, fluid and electrolyte disturbances
	High output intestinal fistula (more than 500 mL/d)	Bypasses significant absorptive mucosal area; location precludes enteral access or high-volume output with enteral nutrition
	Neutropenic colitis	Typhlitis or opportunistic infection in an immune-compromised patient
	Small bowel mucosal disease • Radiation or chemotherapy related enteritis • Congenital diseases (microvillus inclusion disease, tufting enteropathy) • Autoimmune enteropathy • Intractable diarrhea of infancy	Intractable diarrhea, weight loss, failure to thrive, unresponsive to medical management
Inability to achieve or maintain enteral access	Varies with clinical circumstances	Hemodynamic instability, active gastrointestinal bleeding, severe neutropenic fever, or low birth weight infant

Mechanical bowel obstruction	Intrinsic or extrinsic blockage of intestinal lumen • Stenosis or strictures • Inflammatory disease • Peritoneal carcinomatosis • Severe adhesive disease • Severe superior mesenteric artery syndrome	Recurrent or intractable vomiting, limited oral intake Unamenable to medical, surgical, or interventional treatment (placement of stent or enteral access device)
Need to restrict oral or enteral intake: bowel rest	Ischemic bowel	Mesenteric artery stenosis, intestinal angina, abdominal compartment syndrome, or low flow states
	Severe pancreatitis	Increased pain or serum lipase levels with enteral nutrition, infected pancreatic phlegmon or pseudocyst, complex pancreatic fistula, abdominal compartment syndrome
	Chylous fistula	Increased output with low-fat diet or elemental formula
	Preoperative status	Severely malnourished adults with nonfunctional gastrointestinal tract for 7–10 d prior to surgery
Motility disorders	Prolonged ileus	Diffuse peritonitis or related to medical treatment or other disease state Time to intervention varies per nutrition and clinical status
	Pseudo-obstruction, scleroderma, visceral organ myopathy, very long segment Hirschsprung's disease	Failure to tolerate adequate oral intake or enteral nutrition
	Severe adhesive disease	"Frozen abdomen" with chronic obstructive symptoms and malnutrition

Table 3.1. Contraindications to Enteral Access (Absolute and Relative).[16-18]

All types of enteral access • Mechanical obstruction of the gastrointestinal tract • Uncontrolled peritonitis • Uncorrected coagulopathy or thrombocytopenia • Bowel ischemia • Recent gastrointestinal bleeding with high risk of recurrent bleeding (peptic ulcer disease or esophageal varices)
Nasal placement • Basilar skull fracture: temporal, occipital, sphenoid, or ethmoid fracture • Recent transsphenoidal surgery • Facial, nasal, or sinus trauma • Significant esophageal pathology: stricture, tumor, severe esophagitis • Esophageal varices with recent banding (delay placement 72 h)
Percutaneous and surgical abdominal placement • Massive ascites • Hemodynamic instability • Morbid obesity with large panniculus • Gastric outlet or duodenal obstruction (percutaneous endoscopic or surgical gastrostomy) • Anticipated duration less than 4 wk

Table 6.1. Characteristics of Peripheral PN.[27,29]

Aspect of Peripheral PN Therapy	Clinical Considerations
Peripheral PN nutrient delivery	Frequently hypocaloric PN due to osmolarity limits Provides adequate dose of nutrients in some cases Requires relatively large fluid volumes Formulation cannot be concentrated Typically relies on lipid as a greater proportion of energy Osmolarity constraints may restrict electrolyte content
Patient-centered considerations	No evidence of severe hypermetabolism or catabolic state Able to tolerate fluid volume of 2.5–3 L/d for adults, 120–125 mL/kg/d for neonates and 1.5 times maintenance needs for pediatric patients Stable electrolyte status, without elevated needs Sufficient renal function to tolerate fluid load required

Table 6.1. Characteristics of Peripheral PN.[27,29]

Aspect of Peripheral PN Therapy	Clinical Considerations
Vascular access	Avoids risks inherent to central venous access Maximum osmolarity = 900 mOsm/L Requires assessment of risk factors for difficult intravenous access • Obesity • Extremes in age (neonates and elderly) • History of multiple venous cannulations • History of intravenous drug use Associated with increased rates of phlebitis Extravasation of nutrient admixtures can lead to tissue injury and necrosis Care setting is appropriate for management of peripheral intravenous catheters
Therapeutic goals	Expected duration 10–14 d or less Aims to prevent, rather than correct, nutrition deficits Serves as a supplement to oral intake or enteral nutrition or a bridge until central venous access device placement

Table 2-2. Contraindications to PPN[14]

Significant malnutrition (eg, >5% weight loss in last 3 mo)
Severe metabolic stress (eg, hypercatabolic, hypermetabolic)
Large nutrient or electrolyte needs (potassium is a strong vascular irritant)
Fluid restriction
Need for prolonged PN (>2 wk)
Renal or hepatic compromise

PN, parenteral nutrition; PPN, peripheral PN.

Table 2-1. Determining the Estimated Osmolarity of PN Formulations[a]

PN Component	mOsm	PN Content/L[b]	mOsm/L[b]
Dextrose	5/g	150 g	750
Amino acids	10/g	50 g	500
ILE, 20%	0.71/g (product dependent)	20 g	14
Electrolytes	1/mEq	150 mEq	150
			Total = 1414

the maximum PN osmolarity generally tolerated by a peripheral vein in adults is approximately 900 mOsm/L

Table 6
Milliosmoles of Selected Additives (15)

Additive	*mOsm/Unit*
Sterile Water	0.00
Dextrose Options (3.4 cal/g)	
Dextrose 5, 10, 30, 50, 70%	~5 mOsm/g
Amino Acid Options (4 cal/g)	
Amino Acid 8.5, 10, 15%	~10 mOsm/g
Intravenous Fat Emulsion (IVFE) Options	
10% (1.1 cal/mL)	
20% (2.0 cal/mL)	~0.280 mOsm/mL
30% (3.0 cal/mL)	
Micronutrients	
Calcium Gluconate	0.662 mOsm/mEq
Magnesium Sulfate	1 mOsm/mEq
Multi-trace Elements (MTE-5)	0.36 mOsm/ml
MVI infusion Concentrate (MVI-12)	41.1 mOsm/dose
Potassium Acetate	2 mOsm/mEq
Potassium Chloride	2 mOsm/mEq
Potassium Phosphate	2.47 mOsm/mM
Sodium Acetate	2 mOsm/mEq
Sodium Chloride	2 mOsm/mEq
Sodium Phosphate	4.0 mOsm/mM

CPN Formulations

- hyperosmolar (>1000 mOsm/L)
- “central” vein such as the superior vena cava
- CPN is preferred for use in patients who will require PN support for >7–14 days

PPN Formulations

- Also hyperosmolar (600-900 mOsm/L), which may cause phlebitis, and require frequent peripheral IV site rotations (generally every 48–72 hours).
- The use of PPN is controversial, with many advocating that the risk of complications outweighs any potential benefit, as candidates for this therapy have only minor, if any, nutrition deficits
- The patient should require <2 weeks of PPN

Use CPN when

1. Patient has failed EN trial with appropriate tube placement (postpyloric).
2. EN is contraindicated or the intestinal tract has severely diminished function because of underlying disease or treatment. Specific applicable conditions are as follows:
    - Paralytic ileus
    - Mesenteric ischemia
    - Small bowel obstruction
    - GI fistula, except when enteral access may be placed posterior to the fistula, or the volume of output (<200 mL/d) supports a trial of EN.

3. A prolonged period without enteral feeding is anticipated (eg, postoperatively). As the exact duration of starvation that can be tolerated without increased morbidity is unknown, expert opinion suggests that wound healing would be impaired if PN is not started within 5–10 days after operation for patients unable to eat or tolerate enteral feeding.[2]

CPN is withheld or withdrawn during clinical conditions in which the patient has a compromised ability to metabolize the infusion of energy substrate and nutrients and/or to process metabolic byproducts. Conditions in which nutrition support should be withheld until better tolerated are severe hyperglycemia, azotemia, encephalopathy and hyperosmolality, and severe fluid and electrolyte disturbances.

Energy Substrates

Carbohydrates

- Dextrose
- 3.4 kcal/g
- 2.5% to 70%

Lipids

- provide energy and essential fatty acids
- 10% (1.1 kcal/mL), 20% (2 kcal/mL), and 30% (3 kcal/mL)
- ILEs approved for use in the United States:
  - Long-chain fatty acid emulsions of soybean oil 100%
  - a 2-oil mixture of olive oil (80%) and soybean oil (20%)
  - a 4-oil mixture of soybean oil (30%), medium-chain triglycerides (30%), olive oil (25%), and fish oil (15%).
  - a fish oil 100% ILE for use in pediatric patients (to provide EFAs)

Energy Substrates-Lipids

- The 30% ILE formulation is approved for compounding of PN admixtures and not for direct IV administration.
- Other components: Oil, egg yolk phospholipid (emulsifier), glycerin OR glycerol (to render the formulation isotonic), sodium hydroxide (to adjust the final pH (range: 6–9), vitamin K (only soybean-based))
- hang time
  - 12 hours of opening tif ILEs are infused as separate preparations
  - A PN mixture may be administered over 24 hours (bacterial growth is inhibited as a result of reduced pH)
- The rate should not exceed 0.11 g/kg/h
  - Faster infusion rates are associated with hypertriglyceridemia and infections

Energy Substrates-Lipids

- Advantages of Mixed-oil Mixed-oil ILEs and 100% fish OVER soy oil
  - In critical illness or metabolic stress, sepsis, atopic dermatitis, or severe ulcerative colitis and elective surgery
  - Decreased peroxidation and lack of in vitro inhibition of lymphocyte function
  - reversal of intestinal failure–associated liver disease

Table 4-1. Lipid Injectable Emulsions

Brand Name	Fat Composition	Concentration of Emulsion (%)
Intralipid[5]	Soybean oil 100%	20 or 30
Nutralipid	Soybean oil 100%	20
Clinolipid[6]	Olive oil 80%; soybean oil 20%	20
SMOFlipid[7]	Soybean 30%; medium-chain triglycerides 30%; olive oil 25%; fish oil 15%	20
Omegaven[8]	Fish oil 100%	10

Composition of Parenteral Nutrition

- IV lipids that reduce the load of omega-6 fatty acids/soybean oil emulsions should be considered. However, there are insufficient data to make a recommendation on the type of lipids to be used that reduce the omega-6 fatty acid/soybean oil load
- There were emerging signals showing that fish oils IV fish oils/fish oil containing emulsions are associated with a significant reduction in infections and a trend towards a reduction in duration of ventilation. However, the committee expressed concern regarding the clinically important increase in mortality but decrease in infections in one fish oil study and the heterogeneity between trials.
- The signals for a beneficial effect of Olive oil containing emulsions was not clear (a trend towards increased infections but a significant reduction in duration of ventilation).

Strategies to Optimize Parenteral Nutrition and Minimize Risks: Use of lipids

- in critically ill patients who are not malnourished, are tolerating some EN, or when parenteral nutrition is indicated for short term use (< 10 days), withholding lipids high in soybean oil should be considered.
- There are insufficient data to make a recommendation about withholding lipids high in soybean oil in critically ill patients who are malnourished or those requiring PN for long term (> 10 days).

Energy Substrates-Protein

- Crystalline amino acids
- 4 kcal/g
- 3% to 20%
- 15% and 20% products may be used when fluid restriction is necessary
- Pediatric amino acid: greater BCAAS; lower methionine and phenylalanine; lower pH (enhances calcium and phosphate solubility)

Table 4-2. Commercially Available Crystalline Amino Acid Solutions

Brand Name	Type/Indication	Stock Concentrations (%)
Aminosyn II	Standard	8.5, 10, 15
Clinisol	Standard/fluid restriction	15
FreAmine III	Standard	10
Prosol	Standard/fluid restriction	20
Travasol	Standard	10
HepatAmine	Hepatic failure	8
Aminosyn-PF	Neonates	7, 10
PremaSol	Neonates	10
TrophAmine	Neonates	10

[a]Contains essential amino acids + arginine.
[b]Contains essential amino acids only.

Volume

- The total volume of a PN admixture is typically estimated based on weight for adults
- with the goal to maintain a urine output of 0.5–2 mL/kg/h.
- Some typical fluid losses are gastric losses through a nasogastric tube, ostomies, enterocutaneous fistulas, and chyle leaks.

Electrolytes

- potassium acetate or chloride salt can both administered to maintain acid-base balance.
- Calcium gluconate and magnesium sulfate are the preferred because they are less likely to produce physiochemical incompatibilities.

Vitamins

- Parenteral products for single vitamins are not commercially available for biotin, pantothenic acid, riboflavin, vitamin A, and vitamin E.

Soluvit

Vitamin content of an injection vial

Vitamin B_1	2.5 mg
Vitamin B_2	3.6 mg
Nicotinamide	40 mg
Vitamin B_6	4 mg
Pantothenic acid	15 mg
Vitamin C	100 mg
Biotin	60 µg
Folic acid	0.4 mg
Vitamin B_{12}	5.0 µg

Compatibility

The content of one vial should be dissolved through aseptic addition of 10 ml of any of the following solutions:

1. Vitalipid
2. Intralipid 200 mg/mL
3. Sterile water
4. Glucose solution

Soluvit

Interactions

1. Folic acid increases the metabolism of phenytoin

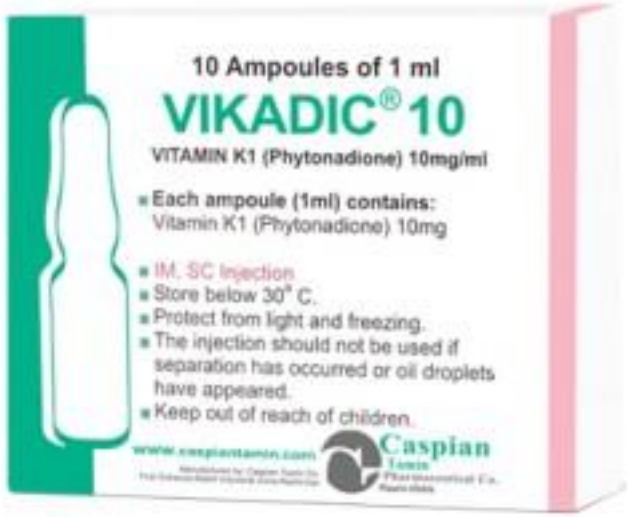
2. Pyridoxine may reduce the effect of L-dopa

Storage

To be kept at a max of 15°C and protected from light

If diluted in Intralipid, the mixture does not need to be protected from light

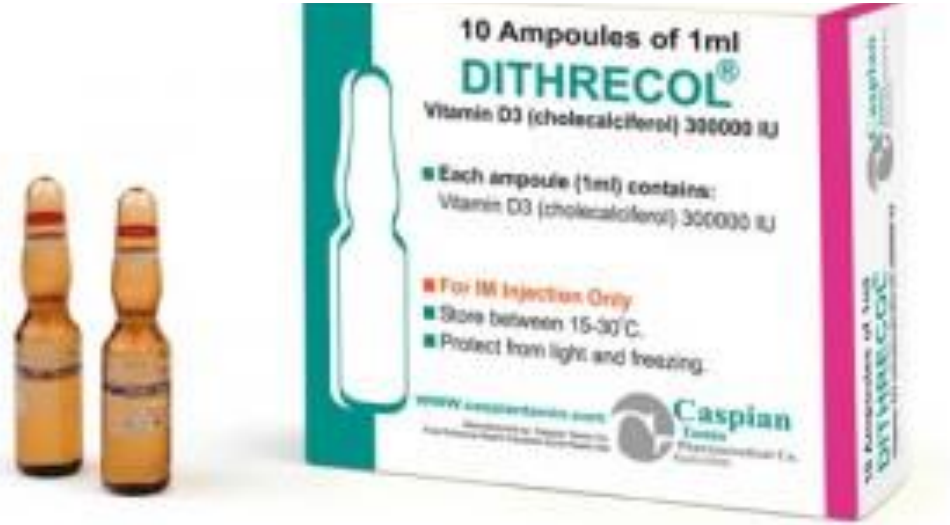
If diluted with glucose solution, the mixture must be protected against light


10 Ampoules of 1 ml
VIKADIC® 10
VITAMIN K1 (Phytonadione) 10mg/ml
Each ampoule (1ml) contains:
Vitamin K1 (Phytonadione) 10mg
IM, SC Injection
Store below 30° C.
Protect from light and freezing.
The injection should not be used if separation has occurred or oil droplets have appeared.
Keep out of reach of children.
Caspian


اسوه ـ ویتامین کا۱۰
ویتامین کا۱ (فیتونادیون)
۱۰ آمپول نیم میلی لیتری
هر آمپول (۰/۵ میلی لیتر) محتوی
۱ میلی گرم
ویتامین کا۱ (فیتونادیون)
جهت تزریق عضلانی
شرایط نگهداری: در دمای کمتر از ۳۰ درجه سانتیگراد و دور از نور
(در جای تاریک) نگهداری شده و از یخ زدگی محافظت گردد.
توجه: در صورت جدا شدن یا تغییر قطرات روغنی از مصرف دارو
خودداری کنید. تا موقع مصرف دارو را درون جعبه نگهداری کنید.
فروش بدون نسخه پزشک ممنوع است.
دارو را دور از دسترس کودکان قرار دهید.
فرآورده شرکت داروسازی اسوه تهران ـ ایران


اسوه ـ ویتامین آ
ویتامین آ
۱۰ آمپول ۱ میلی لیتری
هر آمپول (۱ میلی لیتری) محتوی
۵۰۰۰۰ واحد
ویتامین آ
فقط جهت تزریق عضلانی
شرایط نگهداری: در دمای کمتر از ۳۰ درجه سانتیگراد، دور از نور و دور
جعبه نگهداری کرده و از یخ زدگی محافظت گردد.
توجه: بعلت وجود بنزیل الکل، این دارو نباید در نوزادان نارس
پارسیله بکار رود.
فروش بدون نسخه پزشک ممنوع است.
دارو را دور از دسترس اطفال قرار دهید.
فرآورده شرکت داروسازی اسوه تهران ـ ایران


OSVE-Vitamin E
Vitamin E (dl-α-Tocopheryl acetate)
10 Ampoules of 1 ml
Each Ampoule (1 ml) Contains:
Vitamin E (dl-α-Tocopheryl acetate) 100 IU
Only Intramuscular Injection
OSVAH Pharmaceutical


10 Ampoules of 1ml
DITHRECOL®
Vitamin D3 (cholecalciferol) 300000 IU
Each ampoule (1ml) contains:
Vitamin D3 (cholecalciferol) 300000 IU
For IM Injection Only
Store between 15-30°C.
Protect from light and freezing.
Caspian

Trace elements

- the commercially available multiple trace element combinations in the United States contain 3–5 times the recommended dosages for manganese and may contribute to complications in long-term patients.
- Only iron dextran is approved for addition to PN admixtures, but this should only be considered for dextrose/amino acid (2-in-1) formulations because ILEs are disrupted by iron

Tracutil

Contraindications

- Tracutil must not be administered to neonates, infants and children (due to lack of specific studies).
- Pronounced cholestasis (serum bilirubin >140 mmol/l and elevated levels of gamma-glutamyltransferase and alkaline phosphatase)
- Hypersensitivity to any of the ingredients of Tracutil.
- Wilson's disease and disturbed iron storage (i.e. haemosiderosis or haemochromatosis).

Precautions for use and special warnings

Manganese blood levels should be regularly monitored in case of prolonged artificial nutrition. Dose reduction may be necessary, or Tracutil infusion should be stopped, if manganese accumulates.

Tracutil should be used with caution in case of impaired liver function, which may impair the biliary elimination of manganese, copper and zinc, leading to accumulation and overdose.

Composition

1 ampoule of 10 ml contains

Active ingredients:

Ferrous chloride (iron(II) chloride · $4H_2O$)	6.958 mg
Zinc chloride	6.815 mg
Manganese chloride	1.979 mg
Cupric chloride	2.046 mg
Chromic chloride	0.053 mg
Sodium molybdate dihydrate	0.0242 mg
Sodium selenite pentahydrate	0.0789 mg
Sodium fluoride	1.260 mg
Potassium iodide	0.166 mg

Trace element content per ampoule

Iron	2.0	mg or	35	µmol
Zinc	3.3	mg or	50	µmol
Manganese	550	µg or	10	µmol
Copper	760	µg or	12	µmol
Chromium	10	µg or	0.2	µmol
Molybdenum	10	µg or	0.1	µmol
Selenium	24	µg or	0.3	µmol
Fluorine	570	µg or	30	µmol
Iodine	127	µg or	1	µmol

Tracutil

This trace element solution should be used with caution in case of impaired renal function, as excretion of some trace elements (selenium, fluoride, chromium, mobybdenum and zinc) may be significantly decreased. To prevent iron overload, which is a risk mainly in patients with impaired liver function or those receiving blood transfusions, serum ferritin levels should be monitored at regular intervals.

In patients undergoing medium to long term parenteral nutrition, there is an increased frequency of zinc and selenium deficiency. In such circumstances, especially in the presence of hypercatabolism, e.g. after massive trauma, major surgery, burns etc., when necessary the dosage should be adapted and an extra supply of these elements should be provided.

Chromium deficiency leads to a decrease in glucose tolerance, which improves after chromium supplementation. Then in diabetic patients on insulin medication, relative overdose of insulin and consecutive hypoglycaemia may result. Therefore checks of the blood glucose levels are recommended. Re-adjustment of the insulin doses may become necessary.

Pregnancy and lactation

No safety data for Tracutil are available when it is administered during pregnancy and lactation. Therefore, this product should not be used during pregnancy and lactation except after careful consideration of its expected benefits and potential risks.

Tracutil

Interactions
The degradation of vitamin C in solutions for infusion is accelerated in the presence of trace elements.

The product should not be added to alkaline solutions with marked buffer capacity, e.g. sodium bicarbonate solutions.
Do not add to fat emulsions.

Method of administration
Tracutil, which is a trace element concentrate, should only be administered intravenously after dilution with not less than 250 ml of a suitable solution for infusion, for example:
- glucose solutions (5 %, or 10 % w/v),
- electrolyte solutions (e.g. sodium chloride 0.9%, Ringer's solution).

Dosage
For adults only.

Recommended dosage schedule
The recommended daily dose in patients with basal requirements is 10 ml (1 ampoule).
In patients with moderately increased requirements the daily dose may be up to 20 ml (2 ampoules), accompanied by monitoring of the trace element status.
In cases of significantly increased trace element requirements (such as extensive burns, severe hypercatabolic polytraumatic patients) higher doses may be necessary.

General Considerations for Nutrient Requirements

- Generally, the patient should have satisfactory hydration, electrolyte, and acid-base status prior to initiating PN
- to best achieve nutrition goals with PN, fluid and metabolic abnormalities should be corrected as much as possible before PN initiation
- Because protein intake in an adult is associated with minimal metabolic adverse effects, protein intake of 1–1.5 g/kg/d can be provided on day 1.
- The initial maximum carbohydrate given in an adult is usually 150–200 g/d. (For adult patients with diabetes mellitus or hyperglycemia of stress, 100–150 g)

General Considerations for Nutrient Requirements

- For many adult patients, PN may be increased such that energy and protein goals are achieved within 72–96 hours
- The dextrose content of the PN can be increased if the patient has capillary blood glucose values consistently ≤180 mg/dL.
- The ILE in the PN can be added or increased if the patient has serum triglycerides ≤400 mg/dL.

Optimal glucose control

- we recommend that hyperglycemia (blood sugars > 10 mmol/L) be avoided in all critically ill patients and we recommend a blood glucose target of around 8.0 mmol/L (or 7-9 mmol/L), rather than a more stringent target range (4.4 to 6.1 mmol/L) or a more liberal target range (10 to 11.1 mmol/L). There are insufficient data to recommend the administration of insulin via subcutaneous over IV.
- There are insufficient data to recommend low carbohydrate diets in conjunction with insulin therapy aimed at blood sugar range (<180 mmol/L) vs intensive insulin therapy to maintain blood sugars < 150 mmol/L for critically ill patients.

Table 5-2. Suggested Nutrient Intake for Adult Patients Receiving PN[a,1,13]

PN Component	Patients With Critical Illness	Stable Patients
Protein	1.5–2 g/kg/d	0.8–1 g/kg/d
Carbohydrate	≤4 mg/kg/min	4–5 mg/kg/min
ILE	≤1 g/kg/d	1 g/kg/d
Total energy	25–30 kcal/kg/d	20–30 kcal/kg/d[b]
Fluid	Minimum needed to deliver adequate macronutrients	30–40 mL/kg/d[c]

Table 3
Daily Energy and Substrate Guidelines for Adult PN (5–8)

Nutrient	*Acute Care*	*Critical Care*
Energy	25–30 total kcals/kg/d	25 total kcals/kg/d
• Refeeding	15–25 kcal/kg/d	15–25 kcal/kg/d
• Obesity (≥130% IBW)	15–20 kcal/kg/d adjusted weight *	15–20 kcal/kg/d adjusted weight *
Protein	0.8–1.0 g/kg/d maintenance 1.2–2.0 g/kg/d catabolism	1.5–2.2 g/kg/d
Dextrose	<7 g/kg/d	<5 g/kg/d
Lipid**	<2.5 g/kg/d	0.4–0.75 g/kg/d

*Adjusted weight based on a 50% correction factor ([usual weight – ideal body weight] × 0.50)
**If a patient is to be on PN for greater than 3 weeks, a minimum of 2%–4% of total calories should come from IV fat emulsion (IVFE) including linoleic acid to prevent essential fatty acid deficiency (EFAD) (9)

Macronutrients

- During critical illness, 1.3 g/kg protein equivalents per day can be delivered progressively
- The amount of glucose (PN) or carbohydrates (EN) administered to ICU patients should not exceed 5 mg/kg/min.
- Insulin shall be administered, when glucose levels exceed 10 mmol/L. Avoiding the intravenous infusion of large amounts of glucose (>3-4 mg/kg/min) is probably also recommended.
- The administration of intravenous lipid emulsions should be generally a part of PN.
- Intravenous lipid (including non-nutritional lipid sources) should not exceed 1.5 g lipids/kg/day and should be adapted to individual tolerance.

- carbohydrate could be theoretically eliminated from the diet, but it is probably safe(r) to give 150 g/day: This may be explained by organ preference on glucose such as the brain (100-120 g/day), red\blood cells, immune cells, renal medulla and all the transparent tissues of the eyes
- blend of FAs should be considered, including medium chain triglycerides (MCTs), n-9 monounsaturated FAs, and n-3 polyunsaturated FAs. At this stage, the evidence for n-3 FA-enriched emulsions in non-surgical ICU patients is not sufficient to recommend it as a standalone

Should we use parenteral EPA/DHA?

- Parenteral lipid emulsions enriched with EPA/DHA (Fish oil dose 0.1-0.2 g/kg/d) can be provided in patients receiving PN.
- it is clear that the use of intravenous fat emulsions based solely on a soybean oil rich in 18 carbon omega-6 FA should be avoided due to their likely pro-inflammatory effects.
- we recommend not to delay administration and provide intravenous lipid emulsions daily

Should we use parenteral micronutrients and antioxidants in critically ill patients?

- To enable substrate metabolism, micronutrients (i.e. trace elements and vitamins) should be provided daily with PN.
- Several micronutrients are severely depleted during the inflammatory response, and hence difficult to interpret. Recent evidence tends to show that persistently low zinc concentrations might become an important biomarker in sepsis
- Continuous renal replacement therapy for more than two weeks is a new cause of acute micronutrient deficiencies and particularly of severe copper deficiency
- Antioxidants as high dose monotherapy (exceeding ten times the DRI) should not be administered without proven deficiency.
- 2016 ASPEN guidelines recommend the provision of a combination of antioxidant micronutrients “in safe doses” (i.e. 5-10 times DRI). It is already apparent after five days of administration

Refeeding Syndrome

- The delivery of energy, particularly in the form of carbohydrate (stimulates insulin secretion), may induce refeeding syndrome in a patient with malnutrition.
- metabolic and physiologic intracellular shifts of fluid, electrolytes, and minerals (eg, phosphorus, magnesium, and potassium)
- hypophosphatemia, hypomagnesemia, and hypokalemia.
- characterized by symptoms of generalized fatigue, lethargy, muscle weakness, edema, cardiac arrhythmia, and hemolysis.
- calories should be initiated slowly by providing half of the energy requirements, or approximately 15 kcal/kg/d, on the first day of PN
- The effect of protein on glycolysis is not as concerning as that of dextrose, so some have recommended starting at the goal dose for amounts ≤1.5 g/kg/d.
- Nutrition should be slowly advanced to full nutrition goal over the next 3–5 days as electrolytes are stabilized.

Recognizing Risk for Refeeding Syndrome

- Risk factors: Underweight (BMI < 16 kg/m^2), unintentional weight loss of >15% over the last 3-6 months, little or no nutritional intake for more than 10 days, low levels of phosphate, potassium, or magnesium prior to feeding, severe burns
- Minor risk factors: BMI < 18.5 kg/m2, unintentional weight loss of 10-15% over the last 3-6 months, little or no nutritional intake for more than 5 days, and a history of alcohol abuse or chronic use of diuretics, antacids, chemotherapy or insulin
- Profound hypophosphatemia, the hallmark of refeeding syndrome
- can be life-threatening if not detected and treated promptly.
- Low levels of potassium and magnesium are also typical
- Fluid overload due to sodium retention is another common manifestation that can lead to pulmonary edema, heart failure, and dysrhythmias

Recognizing Risk for Refeeding Syndrome

- correction of existing electrolyte disturbances should take place before PN begins.
  Then, the initial PN should provide a reduced level of energy.
- In patients with refeeding hypophosphatemia energy supply should be restricted for 48 h and then gradually increased.
- Because thiamin deficiency can occur in conjunction with refeeding syndrome, supplementation with this vitamin in the first 3 days of PN is also recommended.
- Vigilant monitoring of serum electrolytes and aggressive correction of deficits are especially critical.
- Electrolyte supplementation is often required in relatively high doses, over several days, before metabolic stability is achieved.

Table 7-4. Laboratory Monitoring During PN (Adult and Pediatric)

	Acute Care PN			Long-term PN			
Parameter	Baseline	Days 1–7	Ongoing, Stable	Initial, Postdischarge	Weeks 1–4 (or until stable)	At 3 mo	Ongoing, Stable
Glucose, BUN, creatinine, electrolytes, calcium, magnesium, phosphorous	√	Daily × 3 or until stable	1–2 times/wk or as clinically indicated	√	√		Monthly
CBC with differential	√	Daily × 3 or until stable	1–2 times/wk	√	√		Monthly

Table 7-4. Laboratory Monitoring During PN (Adult and Pediatric)

	Acute Care PN			Long-term PN	
Total bilirubin, direct bilirubin, AP, AST, ALT,	√		Weekly	√	Monthly
PTT, PT, INR	√		Weekly		Monthly
Triglyceride level	√	Pediatric: daily until stable then weekly	Weekly	√	Monthly
Serum proteins (to monitor inflammation)	√		Weekly	√	Monthly

Table 7-4. Laboratory Monitoring During PN (Adult and Pediatric)

Acute Care PN		Long-term PN		
Iron indices	As clinically indicated		√	Every 3–6 mo
Zinc, selenium, manganese, copper, chromium	As clinically indicated		√	Every 3–6 mo
Vitamin A, 25 (OH)D, vitamin E	As clinically indicated		√	Every 12 mo
Vitamin B12 and folate	As clinically indicated		√	Every 6–12 mo
TSH		As indicated		Every 12 mo
Carnitine	No guideline for adults		√ Pediatric patients	Every 3–12 mo

Table 7-5. Clinical Monitoring During PN: Hospitalized Patients (Adult and Pediatric)

Parameter	Approach	Frequency
Physical examination	Including a nutrition-focused approach: • micronutrient abnormalities • muscle and fat stores • fluid accumulation • functional/developmental status	On initial examination (Physical examination should be done initially, then according to hospital nutrition reassessment policy.)
Adults: evaluate weight and height	Use of stadiometer, knee-height calculations, or arm-span measures Weight scales used in a consistent manner; patients should not wear shoes or heavy garments	On initial examination, then weights daily until stable (2–3 times/wk for stable patient)
Determine energy and macronutrient needs	Use of appropriate predictive equations, indirect calorimetry, or nitrogen balance	On initial examination, then when changes in medical condition or activity level occur

Table 7-5. Clinical Monitoring During PN: Hospitalized Patients (Adult and Pediatric)

Parameter	Approach	Frequency
Evaluate intake and output records	Oral or enteral intake, IV fluids and medications, blood products, urine, stool/ostomy/fistula output, other relevant wound/drain output	On initial examination, then daily until stable
Review vital signs	Blood pressure, respiratory rate, heart rate, temperature	On initial examination, then daily until stable
Blood glucose monitoring	Capillary glucose levels, in addition to correctional-dose insulin program and ancillary orders for appropriate intervention for hypoglycemia	Every 1–24 h, as warranted by clinical status; discontinue once blood glucose values normalize and PN reaches target dextrose dose
Evaluation of micronutrient status	Serum levels of vitamins, minerals, trace elements	When history, physical, and/or clinical evidence suggests an abnormality

Table 7-5. Clinical Monitoring During PN: Hospitalized Patients (Adult and Pediatric)

Parameter	Approach	Frequency
Examination of VAD	Inspection and palpation to assess for redness, tenderness, or rash under dressing or along subcutaneous tunnel Observe for upper extremity edema Review position on chest x-ray	Daily assessment, x-ray confirmation at VAD placement, when admitted with a VAD in place, whenever concern for catheter displacement exists
Reassess continued need for PN therapy	Intake and output records, nutrition adequacy assessment, physical examination, radiological evaluation	Daily, or with signs indicating return of or improvement in bowel function, or with change in pertinent clinical condition
General response to therapy	Wound healing, stamina, functional status, progress toward weight or growth goals	Ongoing throughout the course of therapy

wean or transition from PN

- improvement in bowel function must occur (eg, as seen with adaptation in short bowel syndrome)
- tolerance of PO or EN should be confirmed before reducing the PN
- PN may have a negative effect on **appetite**. If **>25%** of caloric needs are provided as PN, reduced oral intake can be expected
- When oral intake equals **500 kcal/d** in an adult patient, the carbohydrate and protein in the PN should be reduced by an amount equal to the amount consumed orally.
- Subsequent decreases in the PN should continue as PO increases.
- PN is not fully discontinued until the patient consistently consumes at least 50%–75% of energy and protein needs orally or through EN, with signs of continuing improvement

wean or transition from PN

- At times, this process is quite rapid, and PN can be withdrawn in a very short period without significant modification
- may require longer weaning periods:
  - complicated hospital course
  - Malnutrition (should demonstrate higher oral intakes)
  - severe GI disease (may never successfully transition off PN)
- metabolically stable adults can be weaned from long-term PN by reducing the number of infusion days each week. This strategy offers benefits in terms of quality of life.
- Eliminate 1 or 2 nonconsecutive infusions per wk.
- Patients with short bowel syndrome may have ongoing fluid and electrolyte losses despite improved nutrient absorption

Case Study

- Male
- 57 years old
- W: 61, H: 176
- Diagnosis: DVT
- MH: Dialysis, Colon Cancer with liver metastasis, EF=35%, Monoplegia
- Weight loss: 5 kg in 3 months
- Diet: NPO for 3days
- Output: 3000, Input: 3350
- BP: 116/72, RR: 18, T: 37
- Lab: INR:1.1, FBS:92, BUN:47, Cr:2.9, UA:10.1, Na:135, K:4.2, Ca:12.5, Alb:3.9, PTH:1.2, PO2:27.4, PCO2:30.2, HCO3:17.2 vitD:70, mg:2.2, Phos:2.4, K:2.8
- Medicines: Methadone 5mg, Ondansetron 4mg, ceftriaxone 1g BID, sandostatin 30mg monthly, Metronidazole 500mg TDS, Concor 5 mg BID, Allopurinol 100 mg BID, Alb 20% BID
- Drip: Nepinephrin If BP<90, Amiodarone per protocol, Reg Insulin 4 IU If BS:200-250

Step 1

Evaluate malnutrition

- BMI=61/(176*176)=19.6
- Weight loss=(5/66)*100=7.5% (3 months)
- Mild depletion of muscle mass in physical exam (MUAC=21)

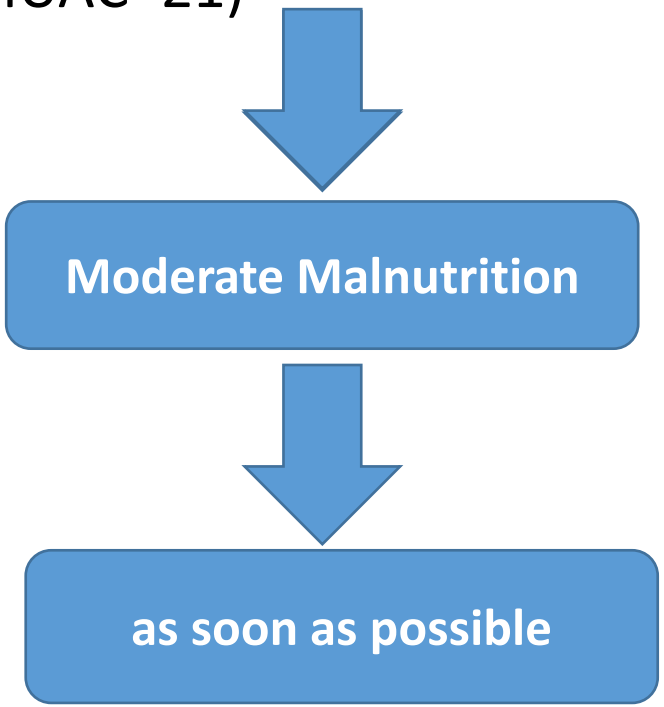


Table 1-6. Characteristics to Diagnose Nonsevere (Moderate) Malnutrition

Characteristic	Acute Illness or Injury	Chronic Disease	Social or Environmental Factors
Weight loss	1%–2%/1 wk	5%/1 mo	5%/1 mo
	5%/1 mo	7.5%/3 mo	7.5%/3 mo
	7.5%/3 mo	10%/6 mo	10%/6 mo
		20%/1 y	20%/1 y
Energy intake	<75% for >7 d	<75% for ≥1 mo	<75% for ≥3 mo
Body fat	Mild depletion	Mild depletion	Mild depletion
Muscle mass	Mild depletion	Mild depletion	Mild depletion
Fluid accumulation	Mild	Mild	Mild
Grip strength	Not applicable	Not applicable	Not applicable

Patients	Insufficient intake	PN initiation
Well-nourished, stable adult	Not received significant (≥50% of estimated requirements) oral or enteral nutrients	After 7 days
Adults who are nutritionally at risk	Not anticipated to reach desired oral or enteral needs	3-5 days
Adults with moderate or severe malnutrition	Oral or enteral intake is not possible or sufficient	as soon as possible

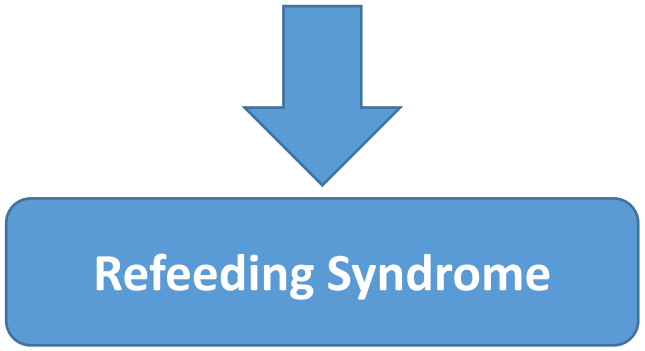
Step 2

Evaluate Refeeding Syndrome

Recognizing Risk for Refeeding Syndrome

- Risk factors: Underweight (BMI < 16 kg/m^2), unintentional weight loss of >15% over the last 3-6 months, little or no nutritional intake for more than 10 days, low levels of phosphate, potassium, or magnesium prior to feeding, severe burns
- Minor risk factors: BMI < 18.5 kg/m2, unintentional weight loss of 10-15% over the last 3-6 months, little or no nutritional intake for more than 5 days, and a history of alcohol abuse or chronic use of diuretics, antacids, chemotherapy or insulin
- Profound hypophosphatemia, the hallmark of refeeding syndrome

- BMI=61/(176*176)=19.6
- Weight loss=(5/66)*100=7.5% (3 months)
- NPO for 3days
- low levels of potassium and Phosphorus



Step 3

Calculate energy and macro
Day 1

- calories should be initiated slowly by providing half of the energy requirements, or approximately 15 kcal/kg/d, on the first day of PN
- The effect of protein on glycolysis is not as concerning as that of dextrose, so some have recommended starting at the goal dose for amounts ≤1.5 g/kg/d.
- Nutrition should be slowly advanced to full nutrition goal over the next 3–5 days as electrolytes are stabilized.

- Energy: 61 * 15kcal/kg/d = 915 Kcal/day
- Prot: 61 * 1g/kg/d = 61g/day --- test: (61 * 4)/915 = 26% --- 100-26 = 74
- Carb: 50% * 915 = 457.5/3.4 = 134.5g/day
- Fat: 24% * 915 = 219.6 Kcal
- Fluids: 61 * (30-40 cc/kg)= 1800-2400

915 Kcal

1800-2400 cc

Output:3000

Step 3

Estimate Serum volumes

- Prot: 61 g/day

aa 10%:

100cc 10g → x= 600 CC

X 60g

- Fat: 24% * 915 = 219.6 KcaL

ILE 10%:

1cc 1.1kcal → x= 200 CC

X 219.6kcal

- CHO: 50% * 915 = 457.5/3.4 = 134.5g/day

Dextrose 50%:

100cc 50g → x= 269 CC

X 134.5g

Step 3

Infusion Rate

Lipid: 200 cc/10h = 20 cc/h * 1.1 = (22kcal/h <61 kcal/h) / (10kcal/g) = 2.2 g/h < 6.7 g/h

The rate should not exceed 0.11 g/kg/h [61 * 0.11 = 6.7 g/h] OR 1 kcal/kg/h [61 kcal/h]

Faster infusion rates are associated with hypertriglyceridemia and infections

Dextrose: 269/3 = 90 cc OR 134.5/3 = 44.8 g * 1000 = 44800 mg / 61 / (6h*60) = 2 mg/kg/min < 4

The rate should not exceed 4 mg/kg/min

Step 4

Order

1. Fix CV line
2. Ser N/S 500cc + 2 vial D/W50% 6h + 1 Amp soluvit + 1 Amp Tracutil + 1 vial Glycophos
3. Ser Intralipid 10% 200cc IV 10h daily if serum TG<400 mg/dL
4. Ser Aminoven 10% 500cc IV 8h daily
5. H/S 500cc + 5cc kcl15% STAT 2h
6. Check Glucose, BUN, creatinine, electrolytes, calcium, magnesium, phosphorous Daily
7. Check Total bilirubin, direct bilirubin, AP, AST, ALT, PTT, PT, INR, TG Weekly