وزارة الصحة
Ministry of Health

ADULT PARENTERAL NUTRITION

CLINICAL PRACTICE GUIDELINES

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1. STATEMENT OF PURPOSE

1.1 To provide essential information for healthcare professionals involved in the provision and administration of parenteral nutrition (PN) in adult.

1.2 To improve the management of adult patients requiring PN support.

2. RELATED DOCUMENTS

2.1 **1431-201 CPP** High Alert Medication

2.2 **1431-290 CPP** Parental Nutrition

3. RELATED ACCREDITATION STANDARDS

3.1 **CBAHI 3rd edition:** MM.5, MM.27, & MM.32.6

3.2 **JCI standards 7th edition: MMU.5**

4. ABBREVIATIONS AND DEFINITIONS

4.1 **PN:** Parenteral Nutrition is the provision of nutrients via the intravenous route. PN is used for neonates who cannot receive their full nutritional requirements via enteral nutrition.

4.2 **EN:** Enteral nutrition

4.3 **GI**: Gastrointestinal

4.4 **PPN:** Peripheral Parenteral Nutrition

4.5 **CPN:** Central Parenteral Nutrition

4.6 **CVADs**: Central venous catheter devices

4.7 **AA:** Amino acid

4.8 **GIR:** Glucose infusion rate

4.9 **ILE:** Intravenous lipid emulsion

4.10 **EFAs:** Essential fatty acids

4.11 **NEC:** Necrotizing enterocolitis

4.12 **IUGR:** Intrauterine growth restriction

4.13 **ASPEN:** American Society for Parenteral and Enteral Nutrition

4.14 **TNAs:** Total nutrition admixtures

4.15 **CRBSI:** Catheter-related bloodstream infection

4.16 **SBS:** Short bowel syndrome

4.17 **EFAD:** Essential fatty acid deficiency

5. GUIDELINES/ PROTOCOL/PATHWAY

5.1 Introduction

5.1.1 Adult Total Parenteral Nutrition (TPN) is a specialized medical intervention providing essential nutrients directly into the bloodstream for individuals unable to consume food orally or via enteral feeding tubes. TPN is tailored to meet the unique nutritional needs of each patient, comprising a balanced combination of macronutrients, micronutrients, electrolytes, and vitamins to sustain bodily functions and promote healing. Administered under strict medical supervision, TPN plays a crucial role in managing conditions such as severe malnutrition, gastrointestinal disorders, and during recovery from surgeries where oral intake is limited or contraindicated.

5.1.2 All Physicians, Pharmacist, And Nursing Staff shall follow and adhere to this guideline.

5.1.3 All the Parenteral Nutrition plans, orders, and monitoring must document in the patient's medical record, and manual incase system in down.

5.2 Indications of PN:

5.2.1 Absolute indications:

5.2.2 Impaired absorption or loss of nutrients via the GI tract because of one or more of the following:

5.2.2.1 Massive small bowel resection: Adult patients with less than 120 cm of s mall bowel distal to the ligament of Treitz without a colon or less than 6 ocm of small bowel with an intact colon.

5.2.2.2 High output GI fistulae: Greater than 500 mL/day; location precludes ent eral access

5.2.2.3 High volume fistula output with EN

5.2.2.4 Neutropenic colitis: Typhlitis or opportunistic infection in an immunoco mpromised patient

5.2.2.5 Small bowel mucosal disease: Radiation or chemotherapy-related enterit is, autoimmune enteropathy, intractable diarrhea of infancy

5.2.2.6 Intestinal atresia

5.2.2.7 Gastroschisis

5.2.2.8 Volvulus

5.2.2.9 Meconium ileus

5.2.2.10 Necrotizing enterocolitis

5.2.2.11 Mesenteric thrombosis

5.2.3 Mechanical bowel obstruction:

5.2.3.1 Intrinsic or extrinsic blockage of intestinal lumen

5.2.3.2 Stenosis or stricture

5.2.3.3 Inflammatory disease

5.2.3.4 Peritoneal carcinomatosis

5.2.3.5 Severe adhesive disease

5.2.3.6 Severe superior mesenteric artery syndrome

5.2.4 Restricted oral intake or EN necessary for bowel rest:

5.2.4.1 Ischemic bowel

5.2.4.2 Severe pancreatitis

5.2.4.3 Chylous fistula

Preoperative status: Severely malnourished patient with non-functional GI tract for 7

to 10 days prior to surgery

5.2.5 Motility disorders:

5.2.5.1 Prolonged ileus

5.2.5.2 Pseudo-obstruction

5.2.5.3 Scleroderma

5.2.5.4 Visceral organ myopathy

5.2.5.5 Very long segment Hirschsprung's disease

5.2.5.6 Severe adhesive disease

5.2.6 Inability to achieve or maintain enteral access or EN:

5.2.6.1 Hemodynamic instability

5.2.6.2 Active GI bleeding

5.2.6.3 Severe neutropenic fever

5.3 Time frame for initiating PN in Adults:

5.3.1 Previously well-nourished patients: Initiate PN after 7 days of oral intake or EN less th an 50% of estimated requirements.

5.3.2 Nutritionally at-risk patients (i.e., involuntary loss of 10% or more of usual body weight within 6 months; involuntary loss of greater than or 5% or more of usual body weight in 1 month; involuntary loss or gain of 10 pounds within 6 months; BMI less than 18.5 kg/m2; inadequate nutrition intake, including inadequate food or nutrition

products for greater than 7 days): **Initiate PN after 3 to 5 days of oral intake or EN less than 50% of estimated requirements.**

5.3.3 Moderate or severely malnourished patients: Initiate PN as soon as feasible for those i n whom oral intake or EN is not possible or sufficient.

5.3.4 Delay PN in metabolically unstable patients until improvement in clinical condition.

5.4 Energy requirements (Appendix 1)

5.5 Fluid Requirement (Appendix 1)

5.6 Constituents of Parenteral Nutrition (Appendix 1)

PN solutions contain some or all of the following constituents.

5.6.1 **Amino Acids (Protein / Nitrogen)**

5.6.1.1 Proteins are the major structural and functional components of all cells in the body and are made up of chains of amino acids.

5.6.1.2 In the amino acid (AA) solutions currently used, each gram of AA contains approximately 4 kcals.

5.6.2 **Carbohydrate**

5.6.2.1 Carbohydrate is the main source of energy in PN, it is recommended that approximately 60 - 75% of non-protein energy comes from carbohydrate.

5.6.2.2 Each gram of dextrose contains 3.4 kcal.

5.6.2.3 Glucose provision can be calculated as the glucose infusion rate (GIR), expressed as mg/kg/minute. GIR= (% of Dextrose X ml/kg/day) / 144

5.6.3 **Intravenous Lipid Emulsion (ILE)**

5.6.3.1 ILEs are used in neonatal PN as a non-carbohydrate source of energy, to provide a source of essential fatty acids (EFAs)

5.6.3.2 It is recommended that approximately 25 - 40% of non-protein energy comes from lipids in patients receiving PN as a sole source of nutrition.

5.6.3.3 The energy provided per gram of lipid in PN is approximately 10 kcal.

5.6.4 **Electrolytes** (Appendix 1)

5.6.4.1 The main electrolytes included in PN necessary for the maintenance of many cellular functions are:

5.6.4.1.1 Sodium (Na)

5.6.4.1.2 Potassium (K)

5.6.4.1.3 Calcium (Ca)

5.6.4.1.4 Magnesium (Mg)

5.6.4.1.5 Phosphate (P)

5.6.4.2 Electrolytes may be given to maintain normal serum concentrations or to correct deficits.

5.6.4.3 Consider other sources of electrolytes such as intravenous fluids and medications when ordering PN.

5.6.4.4 Adequate calcium, phosphate, and magnesium, together with vitamin D essential for bone mineralization.

5.6.4.5 Electrolytes should be prescribed in the form of complete salts rather than individual ions to minimize the risk of dosing errors and ensure accurate preparation and administration

5.6.5 Calcium and Phosphate

5.6.5.1 The precipitation of calcium and phosphorus is a common interaction that is potentially life-threatening.

5.6.5.2 The risk of precipitate formation is greater with:

5.6.5.2.1 Increased solution temperature and pH

5.6.5.2.2 Higher concentrations of calcium and phosphorus

5.6.5.2.3 Lower concentrations of amino acids and dextrose

5.6.5.2.4 Use of the chloride salt of calcium

5.6.5.2.5 Improper mixing sequence when adding calcium and phosphorus salts.

5.6.5.2.6 The presence of other additives (including ILEs)

5.6.5.3 Steps to minimize the risk of calcium and phosphate precipitation in PN admixtures include:

5.6.5.3.1 The use of calcium gluconate instead of calcium chloride because it is less reactive.

5.6.5.3.2 Use organic phosphate salt.

5.6.5.3.3 Adding phosphate salts early in the mixing sequence, adding calcium last or nearly last, and agitating the mixture throughout the admixture process to achieve homogeneity.

5.6.5.3.4 PN admixtures with a lower final pH should be used when clinically appropriate.

5.6.5.3.5 Higher final concentrations of dextrose and AA and lower final concentrations of lipids favor a lower admixture pH.

5.6.5.4 AA product-specific solubility curves that are available from the manufacturer or primary literature should be consulted for calcium and phosphorous solubility.

5.6.6 **Chloride and Acetate**

5.6.6.1 Amount of chloride and acetate based on acid-base balance.

5.6.6.2 Because the addition of bicarbonate to acidic PN admixtures may result in the formation of carbon dioxide gas and insoluble calcium and magnesium carbonates, sodium bicarbonate used in PN admixtures is not recommended. Use of a bicarbonate precursor salt such as acetate usually is preferred.

5.6.6.3 Acetate is metabolized in the liver to produce bicarbonate on a 1:1 molar ratio.

5.6.6.4 Chloride in PN (as sodium chloride or potassium chloride) can be partly replaced by acetate (as sodium acetate or potassium acetate) to reduce metabolic acidosis and/or hyperchloremia.

5.6.7 **Trace Elements** (Appendix 1)

5.6.7.1 Many trace elements are an important part of metalloenzymes and function as cofactors in a variety of regulatory metabolic pathways.

5.6.7.2 Injectable trace elements are available as single trace element solutions and as multiple trace element combinations.

5.6.7.3 Requirements for trace elements also vary on the basis of the patient's clinical condition.

5.6.7.4 Higher doses of supplemental zinc likely are necessary for patients with high-output ostomies or diarrhea because the GI tract is the predominant excretion route for zinc.

5.6.7.5 Manganese and copper are excreted through the biliary tract, chromium, molybdenum, and selenium are excreted renally.

5.6.7.6 Multi-trace dosage may require alteration in patients with increased gastrointestinal or skin losses or with hepatic or renal dysfunction.

5.6.8 **Vitamins** (Appendix 1)

5.6.8.1 Both water-soluble and fat-soluble vitamins are added to PN

5.6.8.2 Water-soluble vitamins are the B group of vitamins and vitamin C; and fat-soluble vitamins are vitamins A, D, E, and K

5.6.9 **Other**

5.6.9.1 **Carnitine**

5.6.9.1.1 Carnitine facilitates the transport of long-chain fatty acids across the mitochondrial membrane, improving the possibility of oxidation.

5.7 Routes of PN administration

Peripheral route

5.7.1 Peripheral parenteral nutrition (PPN) is an option for mild to moderate stressed patients in whom adequate GI tract function is expected to return within 10-14 days.

5.7.2 Potential PPN candidates should not be fluid-restricted or require large nutrient amounts.

5.7.3 Lower concentration of dextrose (10-12.5% final concentration), and micronutrients must be used for peripheral route administration.

5.7.4 The primary advantages of PPN include a potentially lower risk of infectious and technical complications associated with CVC access.

5.7.5 Most PPN formulations are between 750 and <900 mOsm/L.

Central route

1.1.1 Central Parenteral Nutrition (CPN) is the preferred route for PN delivery and is used predominantly for patients who require PN for a period of more than 7 to 14 days.

1.1.2 CPN is the preferred route for patients who have large nutrient requirements, poor peripheral venous access, or fluctuating fluid requirements.

1.1.3 Unlike peripheral veins, central veins have a higher blood flow, which quickly dilutes the hypertonic solution, PN can with higher osmolarities.

1.1.4 The most common insertion sites include, subclavian, internal jugular , femoral , cephalic and basilic veins.

5.8 Ordering and Prescribing Parenteral Nutrition

5.8.1 In all cases, the following should be included on the PN prescription/order:

- PN volume (ml/day)

- Central/peripheral access (if glucose concentration is greater than 10 %, a central access must be used)
- Working weight / dosing weight (kg)
- Amino acid (g/day)
- Glucose (mg/kg/min) or (%)
- Lipid (g/day)
- Electrolytes as salt (mmol/day)
- Multi-vitamins
- Trace elements
- Other requirements (as necessary), e.g. carnitine, thiamine

5.8.2 PN volume should be determined after subtracting all other patient's fluids from total fluid intake, up to 10% may be added as extra PN volume if needed.

5.8.3 PN is a 7-day service, all PN should be ordered before 1 PM, any patient need PN after working hours can be given starter PN or IV fluids.

5.8.4 PN prescriptions must be reviewed and verified by a PN pharmacist prior to transmitting to the PN compounding process.

5.9 Delivery and Storage of Parenteral Nutrition

5.9.1 PN should be collected by the nurse from the pharmacy before 5 PM

5.9.2 All PN should be stored in a designated medication refrigerator 2 to 8°C.

5.9.3 The aqueous solution and lipid solution should be removed from the fridge in advance, approximately one hour prior to commencing the infusion. This allows it to come to a suitable temperature for infusion.

5.9.4 PN solutions (solution, and lines) should be protected from light to prevent peroxidation and degradation of light-sensitive vitamins.

5.10 Administration of Parenteral Nutrition by Nurse

5.10.1 PN solutions should be administered using volumetric pumps which are capable of accurately delivering low flow rates and have occlusive and air-in-line alarms to minimize infusion-related complications.

5.10.2 PN can be infused via a peripheral (short-term use only) or central venous access device (CVAD).

5.10.3 Ideally, the venous line used for PN should not be interrupted for giving antibiotics or medications; a separate IV line should be used.

5.10.4 If co-infusion is unavoidable through the same line, medication stability and compatibility with the PN must be established and verified before administration.

5.10.5 The infusion set and lipid infusion line should be changed every 24 hours.

5.10.6 Use a 0.2-micron filter for aqueous PN solution and a 1.2 micron filter for lipid-containing PN.

5.10.7 ASPEN recommended using a 1.2 micron in-line filter for the administration of total nutrients admixture (TNAs), dextrose- amnio acid admixtures, and ILE. For TNAs, place the filter as close to the catheter hub as possible. For dextrose-amino acid admixtures below the Y-site where the dextrose-amino acid admixture and ILE co-infuse.

5.11 Transitioning from Parenteral Nutrition to Enteral Nutrition

5.11.1 There should be a gradual transition from PN once a clinical decision has been made to commence enteral nutrition.

5.11.2 Full PN volumes should continue until at least 25% of nutritional requirements are met from enteral or oral nutrition.

5.12 Monitoring of Parenteral Nutrition by prescriber (Appendix 1)

5.12.1 Consistent monitoring of patients who are receiving PN is necessary to ensure that the desired nutritional outcomes are achieved and to prevent the occurrence of adverse effects or complications.

5.12.2 Special attention is required when PN is being increased or adjusted especially if the patient is clinically unstable, or if PN is to be provided long term.

5.12.3 Serum concentrations of electrolytes, hematologic indices, and biochemical markers for kidney and liver function, and nutrition status should be measured before PN initiation and periodically thereafter depending on the patient's age, nutrition status, and clinical condition (more details are mentioned in the appendix).

5.12.4 Fluid balance, including input and output from all sources, must be monitored daily and provision of fluid and electrolytes adjusted as required.

5.13 Complication of Parenteral Nutrition

5.13.1 **Infectious Complications**

5.13.1.1 Infection is one of the most common and potentially fatal complications of Central venous access devices (**CVADs**).

5.13.1.2 **Catheter related bloodstream infections (CRBSIs),** defined as the presence of clinical manifestations of infection (eg, fever, chills,

hypotension) associated with bacteremia or fungemia resulting from no apparent source other than the catheter, are common sources of systemic infection.

5.13.1.3 The source of a CVC infection may be skin organisms from the catheter insertion site, contamination of the catheter hub, or hematogenous seeding of the catheter from a distant site.

5.13.1.4 When Infection is suspected PN **should be stopped** and central blood cultures obtained, ideally a peripheral blood culture should be obtained at the same time.

5.13.1.5 Before this diagnosis can be made, there should be evidence of more than one positive blood culture result obtained from the peripheral vein with growth of the same organism from a blood culture obtained from the catheter or catheter segment.

5.13.1.6 When a CRBSI is suspected or confirmed, appropriate antimicrobial therapy should be initiated. Retention or removal of the CVC depends on the patient's severity of illness, the suspected or identified pathogen, and the type of catheter involved.

5.13.1.7 Filling the catheter with antimicrobials such as vancomycin or antiseptics such as 70% alcohol and allowing the solution to dwell for a period of time while the catheter is not in use is referred to as a **catheter lock therapy.**

5.13.1.8 The duration of antibiotics is guided by the identified organism.

5.13.2 Refeeding Syndrome

5.13.2.1 Refeeding syndrome can be defined as the potentially fatal shifts in fluids and electrolytes that may occur in malnourished patients receiving artificial refeeding (whether enterally or parenterally).

5.13.2.2 Refeeding syndrome is characterized by acute electrolyte imbalances, most notable hypophosphatasemia, hypokalemia, hypomagnesaemia, and hypoglycemia.

5.13.2.3 **Individuals at greatest risk :**

5.13.2.3.1 Severely malnourished patients with considerable weight loss who receive aggressive nutritional supplementation.

5.13.2.3.2 Those who are unfed for 7 to 10 days with evidence of stress or nutritional depletion.

5.13.2.3.3 Those with chronic diseases causing undernutrition such as cancer, cardiac cachexia, chronic obstructive pulmonary disease, or cirrhosis.

5.13.2.3.4 Individuals who were previously morbidly obese and have experienced massive weight loss.

5.13.2.4 **To reduce risks of refeeding syndrome:**

5.13.2.4.1 Recommendations for initiating PN in adults at risk for refeeding syndrome include providing 100 to 150 g of dextrose or 10 to 20 kcal/kg (4284 kJ/kg) for the first 24 hours and advancing calories by 33% of goal every 1 to 2 days.

5.13.2.4.2 Check serum potassium, magnesium, and phosphorus before initiation of nutrition.

5.13.2.4.3 Monitor every 12 hours for the first 3 days in high-risk patients. May be more frequent based on clinical picture and replace low electrolyte.

5.13.2.4.4 Patients may be at risk of thiamine deficiency, therefore supplementation with thiamine and a multivitamin is essential.

5.13.2.4.5 Maintenance requirement of thiamine for PN: 200-300 mg daily orally. (ASPEN's proposed guidelines also recommend 100 mg of thiamine supplementation before the use of dextrose-based solutions or feeding).

5.13.3 **Metabolic Bone Disease**

5.13.3.1 PN-related metabolic bone disease has been described in patients on long-term PN. It's characterized by osteomalacia with or without osteoporosis that may present without associated clinical, radiologic, or biochemical abnormalities.

5.13.3.2 Regular measurements of urinary calcium, plasma calcium, phosphorus, alkaline phosphatase, parathyroid hormone, and vitamin D concentrations are advised.

5.13.3.3 Regular assessment of bone mineralization should be undertaken in adults on long-term or home PN.

5.13.3.4 Treatment options include pharmacologic intervention, calcium and vitamin D supplementation.

5.13.4 Hepatobiliary Complications

5.13.4.1 Patients requiring long-term PN are at high risk of developing PN-associated liver disease PNALD and in most cases it is moderate and reversible.

5.13.4.2 Parenteral nutrition (PN)-associated liver disease (PNALD) refers to liver dysfunction caused by intestinal failure, or inability to digest and absorb nutrients, that occurs in the setting of PN use. There are three primary types of PNALD: steatosis, cholestasis, and gallbladder sludge/ stones. Patients may have one of these disorders or a combination of the three.

5.13.4.3 **Risk factors include:**

5.13.4.3.1 Absence of enteral nutrition

5.13.4.3.2 Short bowel syndrome (SBS) which may be associated with disruption of bile acid enterohepatic circulation, and bacterial overgrowth.

5.13.4.3.3 Recurrent septic episodes

5.13.4.3.4 Excessive carbohydrate intake and/or continuous PN infusion leading to hyperinsulinism and subsequently to steatosis.

5.13.4.4 **Prevention and treatment of cholestasis:**

5.13.4.4.1 Introduce enteral nutrition as soon as possible, even if only minimal amount.

5.13.4.4.2 Consider decreasing lipid infusions if unexplained and sustained rise of conjugated bilirubin occurs (> 2 mg/dl).

5.13.4.4.3 Consider Cycled infusions (PN infusion less than 24 hours, generally 8-12 hours).

5.14 PN product shortage consideration

5.14.1 Assess each patient as to the indication for PN and provide nutrition via the oral or enteral route when possible.

5.14.2 PN Amino Acids product shortage considerations

5.14.2.1 Different brands of amino acids products are not always directly substitutable, they may have different pHs, different calcium-phosphorus solubilities, different amounts of phosphorus, as well as other characteristics that should be considered.

5.14.3 PN Lipid Injectable Emulsion product shortage considerations

5.14.3.1 Prioritize supply of soybean oil-based ILE as follows:

5.14.3.2 Adult, hospitalized patients receiving PN greater than 2 weeks should receive a total of 100 g of a soybean oil-based ILE weekly for EFAD prevention, which should be provided by the safest and most efficient method that minimizes waste.

5.14.3.3 Adult, hospitalized, critically ill patients receiving propofol should not require additional ILE for EFAD prevention since the soybean oil in the medication will supply needed essential fatty acids (EFAs).

5.14.3.4 Home or long-term care patients receiving PN should continue to receive the same ILE therapy as before the shortage. However, ILE should be minimized when clinically feasible. At a minimum, patients should receive a total of 100 g of a soybean oil-based ILE weekly for EFAD prevention which should be provided by the safest and most efficient method that minimizes waste.

5.14.3.5 Monitor closely patients receiving PN for developing EFAD during shortages. Increase awareness and assessment for signs and symptoms of EFAD. Signs and symptoms of EFAD include, but are not limited to, diffuse dry, scaly rash, alopecia, thrombocytopenia, anemia, and impaired wound healing. Biochemical evidence of EFAD is confirmed by a triene-to-tetraene ratio greater than 0.2. Using topical oils for prevention and treatment of EFAD has produced mixed results. Safflower and sunflower seed oils had beneficial results whereas vegetable oil (corn oil) did not.

5.14.3.6 In the event of a four-oil (soybean oil, medium chain triglycerides, olive oil and fish oil) ILE shortage use standard soybean oil-based ILE dosing and frequency to meet patients' EFAs needs.

5.14.4 PN Multivitamin product shortage considerations

5.14.4.1 The use of pediatric intravenous multivitamins for adults is not recommended. Using pediatric intravenous multivitamins for adults may contribute to a shortage of pediatric products. A shortage of pediatric intravenous multivitamins could create a potential risk of vitamin deficiencies in neonatal and pediatric patients that may have an even greater need for vitamins.

5.14.4.2 Consider switching to oral or enterally administered multivitamins when oral/enteral intake is greater than 50% of needs (excluding patients with malabsorption syndromes).

5.14.4.3 When all options to obtain intravenous multivitamins have been exhausted, ration intravenous multivitamins in PN, such as reducing the daily dose by 50% or giving one multivitamin infusion dose three times a week.

5.14.4.4 In complete shortages , administer individual parenteral vitamin entities in doses that are appropriate for the patient's age and weight. Thiamine, ascorbic acid, pyridoxine, and folic acid should be given daily

5.14.5 PN Trace Elements product shortage considerations

5.14.5.1 Consider switching to oral or enterally administered multi-trace element supplement products when oral/enteral intake is initiated

5.14.5.2 Reserve intravenous trace elements for those patients receiving solely PN-dependent or those with a therapeutic medical need for intravenous trace elements.

5.14.5.3 If intravenous multi-trace element products are no longer available, administer individual parenteral trace element entities.

5.14.5.4 The use of intravenous PEDIATRIC or NEONATAL intravenous (IV) multi-trace element products for adults is not recommended. Using pediatric or neonatal IV multi-trace elements for adults may contribute to a shortage of pediatric and/or neonatal products.

6 APPENDICES

Appendix 1

7. REFERENCES

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Appendix 1:

- **Table 1. Fluids Requirements**

Methods to Estimate Maintenance Fluid Needs	Weight	Formula
Holliday Segar equations (Daily requirement)	0 – 10 kg	100 ml/kg/day
	> 10 Kg to ≤ 20 Kg	1000 ml + (50 ml x each kg > 10 kg) / day
	> 20 Kg	1500 ml + (20 ml x each kg > 20 kg) / day
4 – 2 – 1 (Hourly Requirement)	0 – 10 kg	4 ml/Kg/hr
	> 10 Kg to ≤ 20 Kg	40 ml/hr + (2 ml/hr x each kg > 10 kg)
	> 20 Kg	60 ml/hr + (1 ml/hr x each kg > 20 kg)

- **Table 2. Initiation and Advancement of PN Macronutrients**

Adult	Initiation	Advance By		Goals
Protein (g/kg/d)	0.8–1	0.3–0.5	Protein (g/kg/d)	2
Dextrose (mg/kg/min)	1 – 2	1–2	Dextrose (mg/kg/min)	5
ILE (g/kg/d)	0.5	0.5	ILE (g/kg/d)	1 (max lipid infusion 0.11 g/kg/hr)

- **Table 3. Macronutrients & Specific population considerations**

Disease/Clinical Condition	Protein/Amino Acids (g/kg/d)	Total Energy (kcal/kg/d)	PN	Component	Fluid (mL/kg/d)
			Dextrose (mg/kg/min)	ILE (g/kg/d)	
Stable	0.8-1.5	20-30	4-5	1	30-40
Critically ill, trauma, sepsis	1.2-2.5	20-30	<4	<1	Minimal to provide adequate macronutrients
Different Amino Acid Requirements than Above	Protein Amino Acids (g/kg/d)	Total Energy (kcal/kg/d)			
Traumatic brain injury	1.5-2.5				
Burns	1.5-2				
Open abdomen	Additional 15-30 g/L exudate				
Acute kidney injury	0.8-2.0				
Continuous renal replacement therapy	Additional 0.2 g/kg/d not to exceed 2.5 g/kg/d)				
Chronic kidney failure with maintenance hemodialysis	1.2				
Hepatic failure	1.2-2 (based on "dry" weight and tolerance)				
Obese	2-2.5* (based on IBW)	22-25 (based on IBW)			

* For patient BMI > 30 use 2 g/kg and for patient BMI > 40 use 2.5 g / kg of protein

- **Table 4. PN Electrolyte Daily Dosing**

Nutrient	Standard Daily Requirement	Factors That Increase Needs
Calcium*	4-10 mmol	High protein intake
Magnesium	8-20 mmol	GI losses, medications, refeeding
Phosphorus*	20-40 mmol	High dextrose intake, refeeding
Sodium	1-2 mmol/kg	Diarrhea, vomiting, NG suction, GI losses
Potassium	1-2 mmol/kg	Diarrhea, vomiting, NG suction, GI losses, medications, refeeding
Acetate	As needed to maintain acid-base balance	Renal insufficiency, metabolic acidosis, GI losses of bicarbonate
Chloride	As needed to maintain acid-base balance	Metabolic alkalosis, volume depletion

* Use caution in prescribing calcium and phosphorus related to compatibility

- **Table 5. Daily Requirements For Adult Parenteral Trace Elements***

Trace Element	Standard Daily Requirement
Chromium	<10 mcg
Copper	0.3-0.5 mg
Manganese	55 mcg
Selenium	60-100 mcg
Zinc	3-5 mg
Iron	-
Molybdenum	-
Iodine	-
Fluorine	-

* Prescribe full daily dose unless patient able to ingest or absorb orally/enterally.

- **Table 6. Additives dosing recommendation**

Medication	Dose
Thiamine	100 mg
Carnitine	5-20 mg/kg/day
Copper	20 mcg/kg/day

- **Table 7. Daily Requirements for Adult Parenteral Vitamins***

Vitamin	Standard Daily Requirement
Thiamin (B1)	6 mg
Riboflavin (B2)	3.6 mg
Niacin (B3)	40 mg
Folic acid	600 mcg
Pantothenic acid	15 mg
Pyridoxine (B6)	6 mg
Cyanocobalamin (B12)	5 mcg
Biotin	60 mcg
Ascorbic acid	200 mg
Vitamin A	990 mcg
Vitamin D	5 mcg
Vitamin E	10 mg
Vitamin K	150 mcg

* Prescribe full daily dose unless patient able to ingest and/or absorb orally/enterally.

* Multivitamin dosing in healthy adult 5ml

* Multivitamin dosing in Bariatric patient 10 ml

- **Table 8. Recommended Monitoring Parameters While Patient on PN**

Parameter	Baseline	Initiation	Critically ill patient	Stable patient
Weight	Yes	Daily	Daily	2-3 X per week
Intake and output	Yes	Daily	Daily	Daily unless fluid status is assessed by physical exam
CBC with differential	Yes	-	Weekly	Weekly
INR, PT, PTT	Yes	-	Weekly	Weekly
Electrolytes: Na, K, Cl, CO_2, Mg, Ca, Phosphorus, BUN, Cr	Yes	Daily X 3	Daily	1-2 X per week
Serum triglyceride	Yes	Day 1	Weekly	Weekly
Serum glucose	Yes	Daily X 3-4	Daily	1-2 X per week
Capillary glucose	-	As needed	Twice daily	As needed
ALT, AST, ALP, total bilirubin	Yes	Day 1	Weekly	Weekly
Nitrogen balance	As needed		As needed	As needed

- **Table 9. Macronutrients Control**

Component	Targets	Additional Considerations
Glycemic Control	140–180 mg/dL (7.8-10 mmol/L).	Blood glucose measurements above the goal range should be treated with short acting insulin administered subcutaneously according to an appropriate sliding scale.
Lipid Control	-	Withhold IVFE doses for triglyceride levels > 5.65 mmol/L. If level (3.39 to 4.52 mmol/L) then restrict lipids (once or twice a week). IVFE containing fish oil and MCT might reduce the risk of hypertriglyceridemia by accelerating lipid clearance whilst still maintaining energy intake.
Protein Control	-	Azotemia : BUN (>10.7 mmol/L) , Hyperammonemia: Ammonia (>250g/dL). In case the development of any of the following Decrease the requirement. Limit protein intake to 2.5 gm per kg.