IREDELL HEALTH SYSTEM

Parenteral Nutrition for Adults	
Approved by: Jamie Basham, PharmD, BCPS Laura Rollings, PharmD, BCPS, BCGP	Last Revised/Reviewed Date:
Critical Care Committee Department of Surgery Department of Medicine P&T Committee	Date: 1/2024 Date: 1/2024 Date: 1/2024 Date: 02/2024
Summary of Revisions: N/A	

Purpose: To provide guidelines and a standardized approach to safely administer patients Parenteral Nutrition/intravenous fat emulsion through a central line or peripheral line and to prevent potential complications of Parenteral Nutrition. To prevent potential complications of PN, such as infection, hyperglycemia, hypoglycemia and occlusion of catheter. For Central Parenteral Nutrition, to maintain sterility and dryness at catheter skin site and to prevent catheter related sepsis.

Statement: The Pharmacy Department shall be responsible for initiating and monitoring parenteral nutrition (PN) in adult patients when consulted by providers. The pharmacist will assist providers in providing optimal nutrition therapy to patients unable to receive nutrition via the oral or enteral route (EN).

Definitions:

- PN – Parenteral Nutrition
- CPN – Central Parenteral Nutrition
- PPN – Peripheral Parenteral Nutrition
- EN – Enteral Nutrition
- EEE – Estimated Energy Expenditure
- REE – Resting Energy Expenditure
- Kcal(s) – Kilocalorie(s)
- ABW – Actual Body Weight
- IBW – Ideal Body Weight
- BMI – Body Mass Index
- CRRT – Continuous Renal Replacement Therapy
- SCr – Serum Creatinine
- NS – Normal Saline
- EMR – Electronic Medical Record
- IV – Intravenous
- TG – Triglycerides
- BUN – Blood Urea Nitrogen
- CLABSI – Central Line-Associated Blood Stream Infection
- EFAD – Essential Fatty Acid Deficiency
- Na – Sodium
- K – Potassium
- Mg – Magnesium
- Ca – Calcium
- Phos – Phosphorus
- GI – Gastrointestinal
- EDTA – ethylenediaminetetraacetic acid

Procedures:

Consults and/or initial orders must be entered in the EMR or phoned to the central pharmacy by the designated cutoff time of 1400. New consults may be triaged until the following day on weekends and holidays, based on demand/workflow.

General Instructions:

- A signed set of electronic CPN or PPN orders and confirmed access is required prior to the initiation of PN.
- Central Parenteral Nutrition therapy is a hypertonic solution of amino acids, dextrose, and/or lipids designed to provide long term nutrition support and is referred to in this policy as CPN. CPN is only to be administered via confirmed central line access.
- Peripheral parenteral nutrition is a solution of amino acids, dextrose, and/or lipids with an osmolarity less than or equal to 900 mOsm/L and is referred to in this policy as PPN. PPN may be administered via peripheral or confirmed central access.
- Intravenous (IV) fat emulsion (lipids) are utilized to provide an additional source of calories or a source of essential fatty acids in patients via central or peripheral IV access. Lipids can be administered alone or with CPN or PPN.

Preparation:

- All solutions shall remain in original packaging until an order is placed.
- All additives must be added in the pharmacy under a sterile environment – additives shall not be added to CPN or PPN on a nursing unit.
- Orders for formulation changes will begin with the next bag, unless the continuation of the current formulation is not acutely clinically indicated. If additional TPN components, such as electrolytes or insulin, are needed prior to the next bag, the provider should order these to be given separately from the TPN solution.

Administration:

- A designated IV line is to be used only for administration of PN/fat emulsions. Do not aspirate or infuse blood, medications or other solutions through the designated PN/fat emulsions line including no piggyback of a second IV fluid and no irrigation.
- It is recommended if existing central line is present prior to initiation of PN, that patient have a new central line access inserted for minimization of CLABSI risks.
- Nursing shall:
    - Notify pharmacy if the rate of infusion is changed by the provider.
    - Notify the provider if the patient experiences an adverse reaction. The PN shall be stopped immediately.
    - Confirm and maintain peripheral or central IV access per Nursing policy and Procedure.
    - Prior to hanging PN, verify the correct PN solution by checking the bag label against what is in the EMR. Ensure the compounded product reflects any changes ordered that day. If there is a discrepancy, call the central pharmacy for further instructions.
    - Use 0.22 micron filter for administration of the PN and change CPN/PPN tubing, administration set and filter every 24 hours.
    - For lipids infused separately, change tubing, administration set and filter with each new bag. Use 1.2 micron filter for administration of lipids. Lipids may be piggybacked with PN.
- CPN specifics:

    - At the time of line insertion, one port of the central line is dedicated and labeled for the delivery of CPN infusion only.
    - With a provider order, the designated lumen may be used temporarily for compatible medications to be piggybacked into the CPN line in cases without alternative access.
    - If CPN is interrupted for any reason, nursing shall hang Dextrose 10% in Water at the same rate until PN resumes.
    - If the CPN is ordered to be discontinued, taper by decreasing the rate by 50% for 2 hours then decrease by another 50% for the final 2 hours.
    - Change dressing every 7 days and PRN using appropriate PPE.
    - Clamp catheter when changing IV tubing due to the negative pressure in the vena cava and danger of air embolism. Due to negative pressure in the vena cava, a disconnection allows the negative pressure to suck air into the blood stream. If air embolism is suspected, place the patient on their left side with their head down.
- PPN specifics:
    - Incompatible medications may be given via the peripheral line if the PPN solution is stopped and the line flushed before and after medication delivery with 10 mL of normal saline.
    - If PPN is interrupted for any reason, nurses should hang Dextrose 5% in Water for PPN at the same rate until parenteral nutrition resumes.
- Fat Emulsions (Lipid) specifics:
    - For the first dose of IV lipids, administer a test dose prior to the initial dose if the patient has never had it before and has risk factors for possible allergic reaction.
        - Regulate test dose at 0.5 mL/min for 15-30 minutes.
        - Observe for and document any reactions. Symptoms include, but not limited to:
            - Dyspnea
            - Allergic reactions
            - Nausea/vomiting
            - Elevated temperature
            - Headache
            - Pain in chest/back
        - Notify provider and stop infusion if patient develops a reaction.
        - If no reaction noted, can infuse fat emulsion at standard rate of 63 mL/hr.
    - Should be used within 24 hours once over-wrap is removed. Discard any partially used volume.
    - Should NOT be mixed with other additives.
    - If lipid emulsions solution separates, the infusion shall be stopped and Pharmacy shall be notified.

<u>Monitoring:</u>

- Patients receiving PN should be weighed a minimum of three times weekly (every Monday, Wednesday, and Friday) unless this is contraindicated or there is a provider order to omit weights.
- Patients receiving CPN should have at least one documented blood glucose level daily either by lab or Point-of-Care (POC) unless the order has been discontinued by the provider.
- Vital signs should be obtained at least twice a day on patients receiving CPN. Nursing shall notify the provider if the patient's temperature is >101 F to institute a complete fever work-up if indicated. Providers should consider a fever work-up that includes: blood cultures peripheral and from central line, catheter site inspection and culture, if any drainage visible.

- A comprehensive metabolic panel, phosphorus, and magnesium will be ordered for two consecutive days after initiation of PN then at least three times weekly thereafter. Long-term stable patients may be decreased to once weekly labs when appropriate.
- A serum triglyceride (TG) level should be obtained on each patient after initial infusion is complete to assure adequate clearance of lipids and prevent hyperlipidemia. Serum TG concentrations should be checked in any patient with a known history of hyperlipidemia prior to lipid administration.
    - PN formulas will be adjusted if TG > 300mg/dL
- Additional nutrition related labs may be ordered on a case by case basis, per pharmacist's clinical judgement.
- Pharmacists will review all PN orders and labs, if available, on a daily basis.

Documentation:

- All PN solutions and lipids should be documented in the EMR including the IV site, appearance of IV site, date/time hung, date/time of fluid or tubing changes, and the rate of flow.
- All patients on PN should have intake and outputs documented every shift.
- Pharmacists will document in the EMR when a) PN is being initiated, when b) PN formula is changed or modified or when c) every 72 hours in the absence of a or b.

Pharmacists' Role:

- Upon a **Pharmacy to Dose – Parenteral Nutrition Consult**, pharmacists shall:
    - Write orders for macronutrients and micronutrients per the guidelines listed in **Table 1**.
    - Order labs per "Monitoring" section of the protocol
    - Sign PN and lab orders, with the name of the provider who placed the original consult order in the Physician field and "protocol/standing order" in the communication type field.
    - Evaluate appropriateness of initiation of PN and patient's level of nutritional intake.
- Competency Standard: Pharmacists must successfully complete upon hire and annually a parenteral nutrition competency.

Table 1: Ordering/Dosing guidelines

Category:	Procedure:

Estimate Energy Requirements	• Determine patient's weight
	  o Actual body weight in kg (ABW) – the patient's ABW at hospital admission will be used for all energy requirement and protein requirement calculations except where specifically stated.
	  o Ideal body weight in kg (IBW) – the patient's IBW will be used in specific circumstances such as obesity, pregnancy, or as outlined in **Appendix B**.
	• Calculate estimated energy expenditure (EEE) per 24 hours using validated energy requirement calculation methods. See **Appendix A**.
	• Estimate stress factor where applicable.

Fluid Volume	• PN should not be used to completely satisfy fluid requirements. If additional fluid is required, providers should order a maintenance fluid in addition to PN. • Assess need for fluid restriction (ex. congestive heart failure, renal failure)
Administration rate	• If patients are at risk for refeeding syndrome, the PN will be initiated at a maximum of ½ goal rate for a minimum of 24 hours and then increased to goal rate per pharmacist's discretion. o Risks for refeeding syndrome include: chronic starvation (no intake for 10 + days), significant unintentional weight loss within 3-6 months, BMI < 16mg/m2, chronic alcoholism, anorexia, morbid obesity with rapid weight loss, malabsorption syndrome • If PN is to be discontinued, decrease rate by 50% for 2 hours then decrease by another 50% for the final 2 hours. Lipids do not need to be tapered when discontinuing.
Protein Requirements (4 kcal/g)	• See **Appendix B** for estimated protein requirements in various disease states and patient populations. • Monitor BUN and SCr. • Consider limiting protein when risk of nephrotoxicity is high.

Lipid Requirements (10 kcal/g)	• Optimal dose: 25-30% of total calories
	  o Required minimum: 4-10% of total calories to prevent essential fatty acid deficiency (EFAD).
	• Baseline and weekly TG level shall be monitored and should remain < 300 in order for lipids to be infused.
	  o When TG >300, give lipids 250 mL once a week to prevent EFAD.
	• For patients receiving propofol (1.1 kcal/mL), lipids may be held or adjusted to meet appropriate caloric requirements.

Carbohydrate Requirements (3.4 kcal/g)	• Dextrose should provide the balance of required calories not provided by protein and lipids.
	  o Should provide approximately 50-60% of total calories (2-5 mg/kg/min)
	• At the time of PN initiation, if the patient is not currently on corrective dose insulin, low dose insulin Regular SubQ 4x/day sliding scale will be initiated.
	  o Further adjustments can be made to medium or high dose sliding scale per nursing protocol

	○ If additional adjustments are needed, insulin orders must be made by a provider. • If two consecutive blood glucose levels are greater than 250 mg/dL, notify the provider to receive additional orders.
Sodium (Na) Normal serum value: 136 – 145 mEq/L	• Standard amount in electrolyte formulation is 35 mEq/L. • Hyponatremia ○ Consider fluid status and disease states in patients with mild to moderate hyponatremia (125-135 mEq/L). If patient is fluid overloaded, no adjustments shall be made. ○ If patient is determined to be normal fluid balance, with two consecutive low Na levels, consider increasing Na in the next PN. • Hypernatremia ○ Consider fluid status of the patient and change to a non-electrolyte formulation, if appropriate.
Potassium (K) Normal serum value: 3.6 – 5.0 mEq/L	• Standard amount in electrolyte formulation is 30 mEq/L. • Hypokalemia ○ Potassium in PN shall be increased per pharmacist discretion based on lab vale, diuretic use, other IV fluids and total potassium replaced outside of the PN. • Hyperkalemia ○ For potassium greater than 5.5 or symptomatic hyperkalemia, PN rate shall be reduced or stopped if it contains potassium and amount will be adjusted in the next PN bag.
Magnesium (Mg) Normal serum value: 1.6 - 2.6 mEq/L	• Standard amount in electrolyte formulation is 5mEq/L. • Hypomagnesemia ○ Magnesium in PN shall be increased per pharmacist discretion based on lab value and if magnesium was replaced outside of the PN. • Hypermagnesemia ○ If patient experiences symptomatic hypermagnesemia, PN rate shall be adjusted or stopped if it contains magnesium and amount will be adjusted in the next PN bag.
Calcium (Ca) Normal serum value: 8.3 – 10.6 mEq/L	• Standard amount in electrolyte formulation is 4.5 mEq/L. • To minimize the risk of precipitate formation in PN solution [Ca (mEq/L) + Phos (mMol/L) less than or equal to 45] • Hypocalcemia ○ Consider patient's albumin and calculate corrected calcium prior to increasing Ca in PN bag. ○ Calcium in PN will be increased per pharmacist discretion based on lab value and if any calcium was replaced outside of the PN. • Hypercalcemia ○ If patient experiences symptomatic hypercalcemia, PN rate will be adjusted or stopped if it contains calcium and amount will be adjusted in the next PN bag.
Phosphorus (Phos) Normal serum value: 2.4 – 5.1 mMol/L	• Standard amount in electrolyte formulation is 15 mMol/L. • To minimize the risk of precipitate formation in PN solution [Ca (mEq/L) + Phos (mMol/L) less than or equal to 45] • Hypophosphatemia

	○ Phosphorus in PN will be increased per pharmacist's discretion based on lab value and if any phosphorus was replaced outside of PN. • Hyperphosphatemia ○ PN rate will be adjusted or stopped if it contains phosphorus and amount will be adjusted in the next PN ○ Note: Lipid formulations contain phosphorus, so patient may continue to receive some phosphorus even if it is removed from PN. ▪ 1.5 mMol of phosphorus per 100 mL
Chloride & acetate (bicarbonate) Normal serum value: Cl: 98 – 107 mEq/L Bicarbonate: 20-31 mEq/L	• Chloride:acetate ratio varies in each premade PN formulation. • Metabolic acidosis ○ If severe, pharmacist will switch formulations to minimize chloride in PN. • Metabolic alkalosis ○ If severe, pharmacist will switch formulations minimize acetate in PN.
Multivitamin	• Pharmacists shall order standard multivitamin with each initiation of PN unless otherwise specified by provider. • See **Appendix C** for ingredients

Additional Supplementation:	
No additional additives other than the multivitamin as stated in this protocol will be added unless patient meets criteria to have one of the additives as stated in this section. Pharmacy shall prepare these additives within the	Ascorbic Acid (Vitamin C) • Patient population: wound healing of surgical incisions or stage 2 or greater pressure ulcers may benefit from vitamin C supplementation ○ Pharmacist may add 500-1000 mg/day to PN ○ Patients with renal insufficiency who are not receiving dialysis will receive a maximum of 500 mg/day ○ Patients with a history of or at high risk for nephrolithiasis will not receive any additional ascorbic acid.
	Zinc • Patient population: wound healing of surgical incisions or pressure ulcers may benefit from zinc supplementation. ○ Pharmacist may add zinc 5-10 mg/day to PN • Patient population: patients with significant stool and/or GI fluid loss from diarrhea, ostomies, fistula, etc are at risk of deficiency and may benefit from supplementation. ○ Pharmacist may add zinc 5-10 mg/day to PN

PN to be administered per 24 hours.	• Patient population: patients who receive propofol infusion for > 5 days are at risk of deficiency due to the chelating effects of ethylenediaminetetraacetic acid (EDTA). ○ Pharmacist may add zinc 5 mg/day to PN • If a patient has more than one of the above indications for zinc supplementation, a maximum of zinc 10 mg/day will be added to PN.

	Thiamine
	• Patient population: chronic alcoholism
	  ○ Pharmacist may add thiamine 100 mg/day to PN
	• Patient population: those at risk for refeeding syndrome
	  ○ Pharmacist may add thiamine 100 mg/day to PN

	Folic Acid
	• Patient population: chronic alcoholism
	  ○ Pharmacist may add folic acid 1 mg to PN
	• Patient population: those at risk for refeeding syndrome
	  ○ Pharmacist may add folic acid 1 mg to PN

	Trace elements
	• Patient population: patients who will likely be long-term PN (10 + days)
	  ○ Pharmacist shall order standard trace elements.
	  ○ Not to be ordered for patients with renal insufficiency (SCr > 2-3) or with hyperbilirubinemia (tbili >3-4) due to risk for accumulation.
	• See **Appendix C** for ingredients.

	Insulin Regular • Insulin Regular may be added to the PN bag at the provider's discretion after the PN has been at goal rate for 24 hours. • When any PN containing insulin is discontinued, the pharmacist shall contact the provider for new insulin orders if not already addressed.

INITIAL EFFECTIVE DATE: 04/2024;
DATES REVISIONS EFFECTIVE:
DATES REVIEWED (no changes):

Appendix A – Calculations for Estimation of Energy Expenditure

For all equations:

A = age in years
W = actual body weight in kg regardless of BMI
H = height in cm
S = sex (male = 1, female = 0)

T = trauma (present = 1, absent = 0)
B = burns (present = 1, absent = 0)
O = obesity = BMI > 27kg/m2 (present = 1, absent = 0)

Non-ventilator dependent, BMI <30:
Mifflin-St. Jeor Equation
Men: REE = 10(W) + 6.25(H) – 5A +5
Women: REE = 10(W) + 6.25(H) – 5(A) – 161

EEE = REE + stress factor

Stress factor:

Weight maintenance or mildly stressed	1.1 – 1.3
Cancer	1.1 – 1.5
Minor infection or moderately stressed	1.2 – 1.3
Severely stressed	1.3 – 1.5
Acute renal failure	1.5 – 2
Chronic renal failure	1 – 1.5
Burns	2

Ventilator dependent, BMI < 30
Ireton-Jones Equation (1992 version)
EEE = 1925 – 10A + 5(W) + 281(S) + 292(T) + 851(B)
Do not use a stress factor with this equation

BMI >30; non-ventilator and ventilator dependent
22 kcal/kg (IBW)

Non-ventilator dependent, pregnant
36-40 kcal/kg (IBW)

Appendix B – Estimated Daily Protein Requirements

All weights are in kilograms of ABW unless otherwise indicated

	Protein Requirements
Maintenance, healthy, no stress	0.8 – 1 g/kg
Mild stress	1 – 1.2 g/kg
Moderate stress, protein repletion, elderly	1.3 – 1.5 g/kg

Severe stress, extensive repletion, burns	1.5 – 2.5 g/kg

Protein needs in specific disease states:

Disease States	**Protein Requirements**
Hepatic failure	0.8 – 1 g/kg
Acute renal failure	0.8 – 1.2 g/kg
Chronic renal failure (non-dialysis)	0.6 – 0.8 g/kg
Hemodialysis	1.2 – 1.5 g/kg
CRRT	1.5 – 2.5 g/kg
Obesity (BMI 30-40)	2 g/kg/IBW; adjust for organ dysfunction
Obesity (BMI > 40)	2.5/kg/IBW; adjust for organ dysfunction
Pancreatitis	1 – 1.5 g/kg
Respiratory failure or diabetes	1 – 1.5 g/kg
Sepsis	1.5 – 2.5 g/kg
Short bowel syndrome, IBD	1 – 2 g/kg
Hyperemesis gravidarum	1.2 – 1.7 g/kg

Appendix C – PN Standard Product Formulations:

Amino acid/Dextrose formulations (1000 mL):

Clinimix E 5/20	**Clinimix 5/20**	**Clinimix E 8/14**	**Clinimix 8/14**	**Clinimix E 2.75/5**
Amino acids 5% Dextrose 20% Sodium 35 mEq Potassium 30 mEq	Amino acids 5% Dextrose 20% Chloride 20 mEq Acetate 42 mEq	Amino acids 8% Dextrose 14% Sodium 35 mEq Potassium 30 mEq	Amino acids 8% Dextrose 14% Chloride 32 mEq Acetate 71 mEq	Amino acids 2.75% Dextrose 5% Sodium 35 mEq Potassium 30 mEq

Magnesium 5 mEq Calcium 4.5 mEq Phosphate 15 mMol Chloride 39 mEq Acetate 80 mEq		Magnesium 5 mEq Calcium 4.5 mEq Phosphate 15 mMol Chloride 76 mEq Acetate 83 mEq		Magnesium 5 mEq Calcium 4.5 mEq Phosphate 15 mMol Chloride 39 mEq Acetate 51 mEq

Lipids: Intralipid 20 %

Multivitamin: Infuvite Adult (per 10 mL added to each PN bag)

Vitamin C (ascorbic acid)	200 mg
Vitamin A	3,300 IU
Vitamin D3 (cholecalciferol)	200 IU
Vitamin B1 (thiamine)	6 mg
Vitamin B2 (riboflavin)	3.6 mg
Vitamin B6 (pyridoxine)	6 mg
Vitamin B3 (niacin)	40 mg
Pantothenic acid	15 mg
Vitamin E	10 IU
Vitamin K	150 mcg
Folic acid	600 mcg
Biotin	60 mcg
Vitamin B12 (cyanocobalamin)	5 mcg

Trace elements: Refer to Package Insert of supply on hand