

# Parenteral Nutrition: An Evidence Based Practice Review



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# Learning Objectives



- To identify appropriate use for TPN
- To determine correct TPN composition for different patient populations
- To recognize side effects and possible contraindications for TPN use

# TPN: Indications for Use



- Non functional gastrointestinal tract/Unsuccessful EN attempt
- GI tract cannot be accessed
- NPO status for greater than 7 days in the healthy patient
- In critically ill, if EN is not possible and hypermetabolism is expected to last more than 4-5 days
- Neonates and Infants, if expected to be NPO for more than 2-3 days
- Premature Infants, within the first 24-48 hours of life

# TPN: Indications for Use



- Disease State
  - Congenital Heart Disease
  - GI Disease
- Critically Ill
- ECMO – Extracorporeal Membrane Oxygenation
- Cancer – GVHD, radiation enteritis, cachexia
- High output fistulas
- Organ Transplant

# TPN: Contraindications for Use

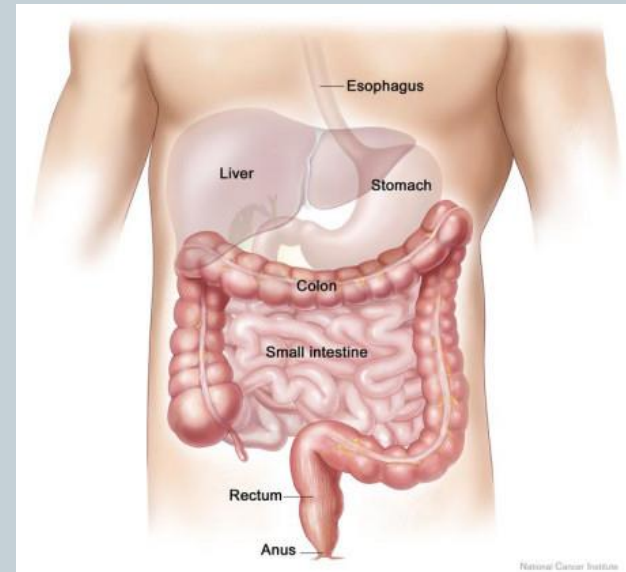


- Functioning GI tract
- Anticipated administration of TPN for < 5 days in adequately nourished patient
- No safe venous access
- No aggressive support desired
- Severe electrolyte imbalance

# TPN considerations



- When possible, allow provision of oral diet or trophic enteral feedings or combined EN/PN
- If the gut works, use it!



# TPN: Indications to Discontinue

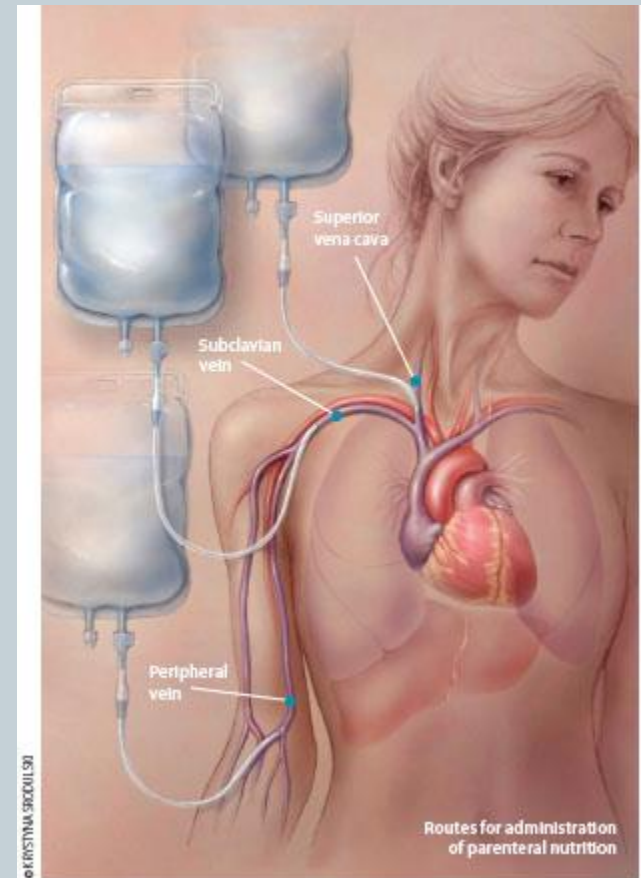
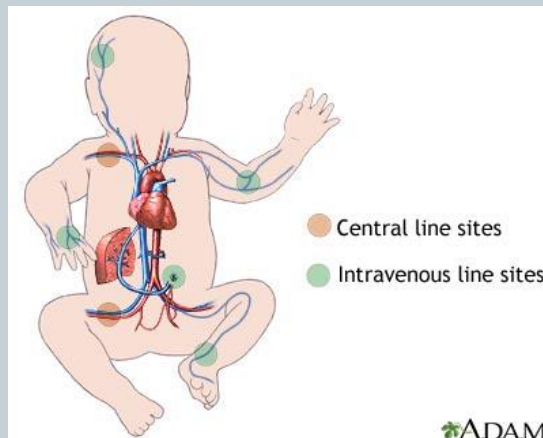


- When patient is able to tolerate enteral nutrition/solid foods by mouth, greater than 60% of needs
- NICU: Decrease PN as EN/PO increases keeping total volume between 150-170 mL/kg. D/C when EN/PO is at 125 mL/kg/day
- Individualized per patient and situation

# Parenteral Nutrition Access



- Peripheral  
-PIV
- Central (CVAD's)  
-PICC  
-Broviac, Hickman, Hohn  
-Port





# TPN Basic Components



- Amino Acids (protein)
- Dextrose (carbohydrate)
- Lipid emulsion (fat)
- Vitamins
- Trace minerals
- Water
- Other additives
- Electrolytes



# Peripheral PN



- 900 mOsm/L
- Dextrose: 150-300g/d (5%-10%) in adults and 10-12.5% dextrose concentration in pediatrics
- Limited nutrition if fluid restriction
- Duration: 5 days to 2 weeks
- Adult Criteria: (1) good peripheral access & (2) tolerate large volumes (2.5-3L)

# Macronutrients



- **Protein**

Crystalline amino acids – Essential and Non-Essential

- Trophamine, Aminosyn, Premasol (Peds)  
Travasol (Adults)

- 4 kcal/g

- Adults: 0.8-2 g/kg

- Pediatrics: 2-4 g/kg

- ~20% total kcals



# Macronutrients



- Carbohydrates – Dextrose
- 3.4 kcal/g
- Needs:  
50-70% of total kcals
- Maximum glucose oxidation rate (mg/kg/min)  
GIR:  $[\text{dextrose (g/day)} \times 1000] / [24 \text{ (h/day)} \times 60 \text{ (min/h)} \times \text{weight (kg)}]$ .

# Macronutrients



- Fat – IV Fat Emulsion (IVFE) or Lipids  
Intralipid, Liposyn III, Nutrilipid
- 10% (1.1 kcal/mL); 20% (2.0 kcal/mL) or 30% (3.0 kcal/mL)
- ~10 kcal/g
- 12 hour hang time
- Usually ~30% of kcal

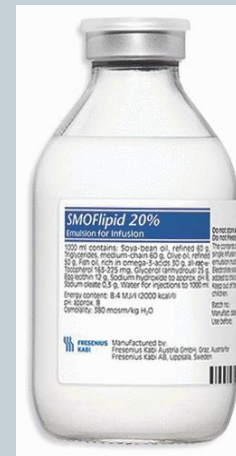


# Macronutrients



## Fat continued:

- 0.5-1g/kg/day to prevent EFAD
- Omega-3 and Omega-9 Fat Emulsions
- SMOF



# Initiation and Advancement of Macronutrients



Infants (<1 y)	INITIATION		ADVANCE BY		GOALS	
	Preterm	Term	Preterm	Term	Preterm	Term
Protein (g/kg/day)	3-4	2.5-3	-	-	3-4	2.5-3
Dextrose (mg/kg/min)	6-8	6-8	1.4-1.7	3.5	10-14 (max 14-18)	10-14 (max 14-18)
Fat (g/kg/day)	0.5-1	0.5-1	0.5-1	0.5-1	3 (max 0.15 g/kg/h)	2.5-3 (max 0.15 g/kg/h)

CHILDREN (1-10 y)			
Protein (g/kg/day)	1.5-2.5	-	1.5-2.5
Dextrose (mg/kg/min)	3-6	2-3	8-10
Fat (g/kg/day)	1-2	0.5-1	2-2.5
ADOLESCENTS			
Protein (g/kg/day)	0.8-2	-	0.8-2
Dextrose (mg/kg/min)	2.5-3	1.2	5-6
Fat (g/kg/day)	1	1	1-2

\*The A.S.P.E.N Pediatric Nutrition Support Core Curriculum, 2<sup>nd</sup> Edition

# Initiation and Advancement of Macronutrients



Adult Patient – individualized per assessment

- 30% of calories from fat
- 70% from dextrose and amino acid solution
- Maximum GIR: 5 mg/kg/min
- Lipids: 1-2.5g/kg
- Protein: individualized per need
- Initiate dextrose with  $\text{GIR} \leq 3 \text{ mg/kg/min}$



# Calculations of Total Calories from PN



- PN volume = PN rate (ml/hr) x hours TPN ordered
- a.) Dextrose Calories: PN volume x % dextrose x 3.4 kcal/g
- b.) Protein Calories: total grams protein/day x 4 kcal/g  
Or grams/kg protein x weight x 4 kcal/g
- c.) Fat Calories: Intralipid volume x 1.1 kcal/mL (10%)  
Intralipid volume x 2.0 kcal/mL (20%)
- d.) Total calories = a+b+c
- Calories per kg = d/weight

# Micronutrients



- Electrolytes
- Vitamins
- Trace Elements – Zinc, Copper, Chromium, Manganese and Selenium



# Parenteral Trace Elements Solutions



<b>Ingredient</b>	<b>Adult Trace/mL<sup>a</sup></b>	<b>Pediatric Trace/mL<sup>b</sup></b>
Zinc	5 mg	1.0 mg
Copper	1.0 mg	0.1 mg
Manganese	0.5 mg	25 µg
Chromium	10 µg	1 µg
Selenium	60 µg	NA

<sup>a</sup>Multitrac-5 Concentrate

<sup>b</sup>Multitrac-4 Pediatric Trace Elements Injection

# Parenteral Vitamin Solutions



Ingredient	Adult MVI/5mL <sup>a</sup>	Pediatric MVI/4 mL <sup>b</sup>
Vitamin A	1 mg 3300 IU	0.7 mg 2300 IU
Vitamin D	5 µg 200 IU	10 µg 400 IU
Vitamin E	10 mg 10 IU	7 mg 7 IU
Vitamin B <sub>1</sub>	6 mg	1.2 mg
Vitamin B <sub>2</sub>	3.6 mg	1.4 mg
Vitamin B <sub>6</sub>	6 mg	1 mg
Niacin	40 mg	17 mg
Dexpanthenol	15 mg	5 mg
Folic acid (per mL)	600 µg	140 µg
Vitamin B <sub>12</sub> (per mL)	5 µg	1 µg
Biotin (per mL)	60 µg	20 µg
Ascorbic Acid	200 mg	80 mg
Vitamin K <sub>1</sub>	150 µg	200 µg

# Electrolytes - Adult



## Daily Electrolyte Requirements

Electrolyte	Parenteral
Sodium	1-2 mEq/kg
Potassium	1-2 mEq/kg
Chloride	As needed to maintain acid-base balance
Acetate	As needed to maintain acid-base balance
Calcium	10-15 mEq
Magnesium	8-20 mEq
Phosphate	20-40 mmol

# Electrolytes - Pediatrics



Electrolyte	Preterm Neonates	Infants/Children	Adolescents and Children > 50kg
Sodium	2-5 mEq/kg	2-5 mEq/kg	1-2 mEq/kg
Potassium	2-4 mEq/kg	2-4 mEq/kg	1-2 mEq/kg
Calcium	2-4 mEq/kg	0.5-4 mEq/kg	10-20 mEq/day
Phosphorus	1-2 mmol/kg	0.5-2 mmol/kg	10-40 mmol/day
Magnesium	0.3-0.5 mEq/kg	0.3-0.5 mEq/kg	10-30 mEq/day
Acetate	As needed to maintain acid base-balance		
Chloride	As needed to maintain acid base-balance		

- Mirtallo J, Cananda T, Johnson D, et al. Safe practices for parenteral nutrition. JPEN J Parenter Enteral Nutr. 2004;28(6):S39-S70.

# TPN- Additives



- Medications
- Carnitine
- Cysteine



# TPN Solutions

- 2-in-1 Solution  
Dextrose and Amino Acids  
Lipids administered separately
- Total Nutrient Admixture (TNA)  
Also called 3-in-1 or all-in-one  
Contains dextrose, amino acids and lipids together
- Premixed Formulations





# Cycling TPN



- Prevent hypoglycemia, hepatotoxicity and PNALD
- 20 to 8 hours depending on patient needs
- Taper 1-2 hours on and off

## **Calculation:**

A.) Total TPN volume per day

B.) Total cyclic infusion time minus 1 hour (if using 1 hr on and off taper)

C.) rate of taper

total volume (A) divided by infusion time in hours (B) = full rate of non taper time.

To obtain taper rate, divide full rate (B) by 2 = rate of taper up and down for 1 hour.

## **Example:**

1. 600 mL total volume/15 hours = 40 mL/hr

2. 40 mL/2 = 20 mL/hr

TPN order: total volume 600 mL cycled over 16 hours at 40 mL/hr with 1 hour taper on and off at 20 mL/hr

# TPN Monitoring



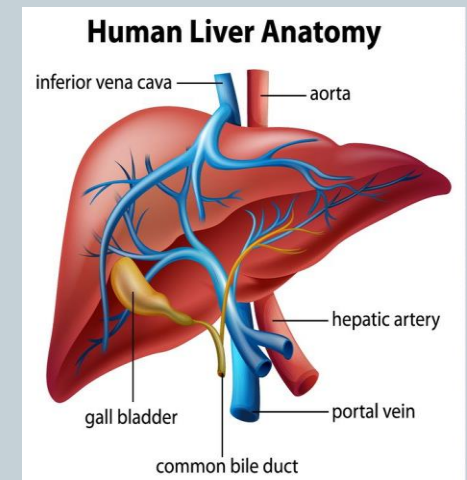
- Anthropometrics and Growth
- I's/O's
- Electrolytes – daily then twice per week if stable
- LFT's, Triglycerides – weekly if stable
- Glucose – individualized as needed
- Vitamins – baseline then every ~3-6 months



# TPN Complications - Adults



- Refeeding Syndrome
- PNALD
- PN Associated Cholestasis (PNAC) & Gallbladder stasis
- Trace element deficiencies or toxicities



# TPN Complications – Pediatrics



- Central Line-Associate Bloodstream Infections
- Aluminum Toxicity
- Iron Deficiency
- Metabolic Bones Disease
- Parenteral Nutrition Associated Liver Disease (PNALD)

# TPN- Safety



- High Alert medication
- Policies, Procedures and Protocols
- PN product shortages
- A.S.P.E.N. PN safety toolkit

<http://www.nutritioncare.org/pnsafety/>



# TPN shortages



- A.S.P.E.N. product-shortages  
<https://www.nutritioncare.org/public-policy/product-shortages/>
- FDA Drug Shortages mobile app
- A.S.P.E.N. Safety Consensus Recommendations, 2014

# Home TPN



- Stable
- Cyclic TPN
- Discharge planning – home health care company, patient/caregiver education, home assessment
- Outpatient follow up with interprofessional team (MD, RD, PA/NP, RN, Pharmacist)
- Monitor lab trends
- Daily administration of vitamins and other additives



# References



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# Questions

