

Parenteral Nutrition - TPN

Typically for infants ≤ 34 weeks GA

ORDERING TPN

1. Order should be placed daily by 1200
2. TF order (mL/kg/day) = all continuous infusions + enteral feeds (even trophic)
3. EPIC TPN volume order = TF minus enteral feeds, lipids, and significant non-nourishment infusions (ex. PAL/UAC fluid, continuous med infusions)
4. Enter as "NEW" with **NEONATAL TPN PANEL** or "REORDER"- 2200 start time for either
5. **DO NOT** modify infusion rate of current order – use **NURSING ORDER** to communicate changes

CALORIES

Goal

- Parenteral 90-110 kcal/kg/day
- Protein to energy ratio of 1g to 25-33Kcal

Energy Density

- IV glucose 3.4 kcal/gm
- Protein 4 kcal/gm
- Fat (SMOF 20%) 10 kcal/gm or 2 kcal/mL

Intravenous Fluid Volume (Day of Birth)

- < 37 weeks = 80 mL/kg/day
- ≥ 37 weeks = 60 mL/kg/day

CARBOHYDRATE (GLUCOSE)

- **Begin Glucose Infusion Rate (GIR) at 4-6 mg/kg/min (no lower than 4 mg/kg/min)**
- Many ways to calculate GIR
Example: (mL/kg/day X % dextrose) \div 144

PROGRESSION OF GIR

- Progress GIR by 1-2 mg/kg/min daily
- Maximum GIR 12-14 mg/kg/min

MAXIMUM DEXTROSE % (BASED ON TYPE OF ACCESS)

PIV: D12.5% (max osmolarity 1000 mOsm/L)

Central (Broviac, PICC, UAC or UVC line): D35%

Midline PICC: D15% (max 1000 mOsm/L)

PROTEIN

- **Begin at total of 3 gm/kg/day**

2.5% AMINO ACID SOLUTION WITH D10W (D10AA)

- For PIV, UVC, PICC, includes heparin
- Continue if TPN can't be ordered by 1200
- See Appendix 1 for total protein/GIR
- Do not order as KVO in infants > 1 kg

3.6% AMINO ACID SOLUTION (ISOTONIC AA/IAA)

- Include Isotonic AA in total daily protein
- Administer via UAC or PAL, includes heparin
- **CONTAINS NO DEXTROSE (glucose source needed)**
- See Appendix 2 for total protein content

PROGRESSION OF PROTEIN

- Progress to goal by day of life 2
 1. If **BW < 1250 g:** goal 3.5 gm/kg/day
 2. If **BW ≥ 1250 g:** goal 3 gm/kg/day
- >1.5 gm/kg/day (from parenteral and/or enteral feeds) meets essential amino acid needs
- May decrease if metabolic/renal concerns

FAT (SMOF 20% EMULSION SOLUTION)

- **Begin at 0.5-1 gm/kg/day**
- Gives essential fatty acids at 2 gm/kg/day

PROGRESSION OF FAT

- Progress by 1 gm/kg/day to final goal 3 gm/kg/day

PREVENT AND MANAGE HYPERGLYCEMIA IN ELBW

- Consider increasing by 0.5 gm/kg/day
- Check TG level every 48 hrs thru DOL 7 and PRN - if >200 mg/dL stop lipids for 24 hrs then restart at lower dose (see [ELBW GUIDELINES](#) for reference)

ELECTROLYTES AND MINERALS

SODIUM

- **Maintenance: 2-4 mEq/kg/day**
- Influenced by total body fluid status
- Typically not added until 48 hrs if BW < 1.5 kg
- Start sodium acetate if BW < 1.5 kg; transition to sodium chloride with age
- May also be given as sodium phosphate

POTASSIUM

- **Maintenance: 1-3 mEq/kg/day**
- Begin when renal function is established
- Begin with potassium phosphate, then advance to potassium acetate and potassium chloride
- 1 mMol of potassium phosphate = 1.47 mEq of potassium in the TPN

MAGNESIUM:

- **Maintenance: 0.25- 0.5mEq/kg/day**
- Elevated if magnesium given prenatally
- Begin when serum magnesium is < 2.0 mg/dL
- Must correct hypomagnesemia to correct hypocalcemia

CALCIUM

- **Maintenance: 2-4 mEq/kg/day**
- 200 mg of Calcium Gluconate = 1 mEq Ca^{2+}
- Add 1 mEq/kg/day to TPN on day of birth
- Optimal ratio of Ca to Phos should be 2:1
- Initially ratio of Ca to Phos may need to be lower, especially in ELBW

PHOSPHORUS

- **Maintenance: 1-2 mmol/kg/day**
- Potassium phosphate or sodium phosphate
- Works with calcium for bone formation

ACETATE

- Will assist in correcting acidosis
- Anion for sodium and potassium
- Adjust ratio of chloride & acetate based on clinical status and serum electrolytes

CHLORIDE

- Anion for sodium and potassium
- Add once the infant is older and/or initial metabolic acidosis is resolved

OTHER TPN COMPONENTS

Heparin: 0.5 units/mL

Cysteine: recommend 20-40 mg/g protein

- Increase to 40 mg/g to improve Ca:P solubility

MVI: 2 mL/kg; max is 5 mL

Trace elements: To be added soon after birth

OTHER CONSIDERATIONS

- Monitor electrolytes when substrates are manipulated in the TPN
- **Prolonged TPN:** monitor electrolytes weekly; monitor liver function, phosphorus, and alkaline phosphatase every 2 weeks
- **Cholestasis or renal dysfunction:** discuss with pharmacist/RD adjusting TPN additives
- **For questions:** Consult pharmacist/RD

Parenteral Nutrition - Clear Fluids

- **Epic order: NEONATAL CUSTOM IV FLUID BUILDER**
- D10 with 10 mEq NaCl and 10 mEq KCl at 120 ml/kg/d gives GIR 8.3 mg/kg/min + 2.4 meq/kg/d of NaCl and KCl
- May add Calcium Gluconate (in mg); no Phos
- *Add heparin if central line*
- Note: D10AA is a clear fluid

Enteral Nutrition Guidelines

- See [FEEDING PATHWAYS](#) for details
- Feeds routinely administered every 3 hours
- Non-nutritive, trophic feeds are 10-20 mL/kg/day

GOALS

CALORIES

- 110-130 kcal/kg/day

PROTEIN

- **PRETERM** > 3.5 g/kg/day
- **TERM** ≥ 1.5 g/kg/day

WHAT TO FEED

MATERNAL HUMAN MILK (MHM) PREFERRED

- Colostrum (Oral Immune Therapy) is given to all NCCC infants for the first 5 days of life
- Donor human milk (DHM) is available

EXCLUSIVE HM (FORTIFICATION WITH PROLACTA)

- Indicated for BW < 1 kg or GA < 29 weeks
- Increases protein and calories (28 kcal/oz)
- Cream HM can add additional 2 kcal/oz
- No bovine additives while using Prolacta
- At 32 weeks CGA, [transition to LHMF fortification](#) (24 kcal/oz) if MHM or SSC 24 kcal/oz if DHM

LIQUID HUMAN MILK FORTIFIER

- Bovine base fortifier (hydrolyzed protein)
- Increases calories, protein, Ca, P, Na, and other mineral content when added to HM
- Typically used to fortify HM to 24 kcal/oz

FORMULA CONSIDERATIONS

UNC Formulary = Abbott products

PRETERM FORMULA

Similac Special Care (SSC)

- Standard caloric density is 24 kcal/oz, may be fortified with SSC 30 kcal/oz to achieve higher caloric density

PRETERM DISCHARGE FORMULA

Similac Neosure

- Standard caloric density is 22 kcal/oz
- Typically used once infant is 2 kg and/or ready for discharge

TERM FORMULA

Similac Total 360 / Similac Advance

- Standard caloric density is 20 kcal/oz

PEPTIDE BASED / SEMI-ELEMENTAL FORMULA

- Used for suspected malabsorption, formula intolerance (Pregestimil (55%MCT), Alimentum)

ELEMENTAL FORMULA

- Used for infants with GI impairment like protein intolerance, short-gut syndrome (Elecare)

SIMILAC PM 60/40 FORMULA

- Lower minerals (like phosphorus, iron, calcium) usually used in infants with a renal impairment.

ENFAPORT FORMULA

- Used for lymphatic and fatty acid oxidation disorders.

SOY BASED FORMULA

- Not recommended for preterm infants

MODULAR ADDITIVES

- To increase **CALORIES**: MCT oil
- To increase **PROTEIN**: liquid hydrolyzed protein

MICRONUTRIENT CONSIDERATIONS

MULTIVITAMINS (MVI)

- If < 2.5 kg: MVI 0.25 mL twice daily without iron
- If on **PROLACTA**: MVI 0.5 mL twice daily
- If ≥ 2.5 kg: may use multivitamin with iron (0.5 mL twice daily)

FERROUS SULFATE (AS ELEMENTAL IRON)

- Supplement with 3 mg/kg/day divided BID
- If infant is on Epogen, total daily Fe should be 6 mg/kg/day

WEIGHT GAIN GOALS

- Related to GA, birth and current weight and length
- Follow infant growth charts closely

GROWTH CHARTS *(available as activity in Epic)*

- Use [FENTON](#) growth chart for **PRETERM** infants
- Use [WHO](#) growth chart for **TERM** infants

NUTRIENT CONTENT PER 100 ML

FEEDINGS	kcal	Pro gm	Na mEq	K mEq	Ca mg	Phos mg	Vit D IU	Fe mg
HM (20 kcal/oz)	66	1	0.8	1.4	28	14.2	2	0
HM* (24 kcal/oz)	80	2.5	1.4	2.9	123	68.5	116	0.4
HM* (26 kcal/oz)	87	2.7	1.5	2.9	140	78	127	0.9
HM+Prolacta (28 kcal/oz)	97	3.0	2.3	2.4	125	65	53	0.2
HM+Neosure (24 kcal/oz)	80	1.4	1	1.85	42	22.5	12	0.2
SSC (HP) (24 kcal/oz)	80	2.7	1.5	2.6	145	80	120	1.5
Neosure (22 kcal/oz)	73	2.1	1.0	2.7	78	46	52	1.3
Neosure (24 kcal/oz)	80	2.3	1.1	2.9	84	49.6	56	1.4
SSC (30 kcal/oz)	100	3	1.9	3.3	180	100	150	1.8

HM = Human Milk SSC = Similac Special Care HP = High Protein

* **To fortify HM**: liquid human milk fortifier (LHMF) to 24 kcal/oz; SSC 30 kcal/oz can be added to increase calories

PRETERM DISCHARGE

To avoid nutritional deficit ALL preterm infants should at least receive nutrients for their respective CGA (see [Post Discharge Nutrition Guidelines](#))

FORTIFICATION STRATEGIES

Breastfeeding

- Feed 2-3 bottles per day of HM fortified to 24 kcal/oz using preterm discharge formula powder **OR** preterm discharge formula 22/24 kcal/oz

Human Milk (Bottle Feeding)

- Fortify all HM with preterm discharge formula powder to 24 kcal/oz
- Feed 2-3 bottles per day of preterm discharge formula 22/24 kcal/oz

Formula (Bottle Feeding): Similac Neosure 22 kcal/oz

DISCHARGE CONSIDERATIONS

- Individualized approach to optimize growth
- Pre-discharge discussion with parents and team
- Post discharge intervention
 1. Until growth indices are all > -2 SD (WHO chart)
 2. Minimum of 12 weeks after discharge if BW < 1.25 kg or if < 2 kg at discharge