Parenteral Nutrition Guidelines

Typically for infants ≤34 weeks GA

ORDERING TPN: "Neonatal TPN Panel"

1. Order should be placed daily by 12:00pm
2. Infant's total fluids order = All IV fluids including continuous infusions & enteral feeds
3. EPIC TPN volume order = total fluid minus enteral feeds, lipids, and significant non-nourishment drips. (ex PAL/UAC fluid)
4. Enter as "new" or "reorder"; Hang time will be 22:00 daily
5. Start TPN order: "NCCC neonatal TPN panel"

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)

- Initiate Glucose Infusion Rate (GIR) at 5-7mg/kg/min but not lower than 4mg/kg/min
- Many ways to calculate GIR
  Example: (mL/kg/day X % dextrose) ÷ 144

Progression of GIR

- Progress GIR by 1-2 mg/kg/min daily
- Maximum GIR: 12-14 mg/kg/min
- **Depends on serum glucose results**

Maximum Dextrose % (base on access sites):

PIV: D12.5% (max osmolarity: 1000 mOsm/L)
Central (Broviac, PICC, UAC or UVC line): D35%
Midline PICC: D15%

PROTEIN

- On admission start at total of 3gm/kg/day

2.5% AMINO ACID SOLUTION with D10W (D10AA)

- Use PIV, UVC, PICC, includes heparin
- Continue if TPN can't be ordered by 1200
- See appendix 1 for total protein/GIR

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

By day of life 2 progress to goal:

- GA ≤ 32 weeks: goal 4 gm/kg/day
- GA 33-37 weeks: goal 3.5 gm/kg/day
- GA ≥ 38 weeks: goal 3 gm/kg/day
- Remain >1.5gm/Kg/day to meet essential amino acid needs
- Consider less protein if metabolic/renal concerns

FAT (SMOF 20% Emulsion Solution)

- Begin at 1 gm/kg/day
- Provides calories
- Provide essential Fatty Acids at **2** gm/kg/day

Progression of fat

- Progress by 1 gm/kg/day to goal of 3 gm/kg/day
- Consider increasing by 0.5 gm/kg/day in ELBW with hyperglycemia
- check TG level as needed; if >200 mg/dL stop lipid for 24 hrs and restart at lower dose.

ELECTROLYTES and MINERALS

SODIUM

- **Maintenance: 2-4 mEq/kg/day**
- Influenced by total body fluid status
- Routinely 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**
- Initiate when renal function is established
- Start 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**
- Prenatal administration of magnesium may lead to elevated levels in newborn.
- Start 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**
- Available as potassium phosphate or as 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 picture 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$_{mg/g\ AA}$.
Increase to 40$_{mg/g\ AA}$ 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

Enteral Nutrition Guidelines

- Use NCCC feeding pathways for all infants <2 kg or ≤32 weeks gestational age
- See Feeding pathways guidelines for details
- Goals: Calories: 110-130 kcal/kg/day Protein: pre-term 3.5-4.4g/Kg/d term not <2g/Kg/d
- Feeds administered every 3 hours
- Non-nutritive, trophic feeds are 10-20 mL/kg/day

WHAT TO FEED

HUMAN MILK (HM) PREFERRED

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

EXCLUSIVE HM DIET (PROLACTA as fortifier)

- Indicated for BW <1Kg or GA <29 weeks
- Increases protein and calories (28Kcal/oz)
- Cream HM can add additional 2Kcal/oz
- No bovine additives while using Prolacta
- Transition over few days to HM fortification with LHFM or to SSC (24Kg/oz) if weight >1kg and reached 32 weeks CGA

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 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 Advance

- Standard caloric density is 19-20 kcal/oz

FORMULA CONSIDERATIONS

PEPTIDE BASED /SEMI-ELEMENTAL

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

ELEMENTAL FORMULAS

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

SIMILAC 60/40

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

ENFAPORT

Used for lymphatic and fatty acid oxidation disorders.

SOY BASED FORMULAS

Not recommended for preterm infants

MODULAR ADDITIVES

To increase calories: MCT oil and Microlipid

To increase protein: liquid hydrolyzed protein

MICRONUTRIENT CONSIDERATIONS

MULTIVITAMINS (MVI)

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

FERROUS (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

*Multivitamins and iron supplements are indicated after 2 weeks of life.

WEIGHT GAIN GOALS

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

GROWTH CHARTS (also in EPIC)

- Use **FENTON** growth chart for ***preterm*** infants
- Use **WHO** growth chart for ***term*** infants

NUTRIENT CONTENT PER 100 ML

Feedings	CAL	Pro *gm*	Na *mEq*	K *mEq*	Ca *mg*	Phos *mg*	Vit D *IU*	Fe *mg*
HM *(20kcal/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) *(24kcal/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 formula
HP= high protein

***Unit standard to fortify HBM:** fortified with liquid Similac human milk fortifier (LSHMF) to 24 Kcal/oz; for higher caloric density SSC 30 is added.*

PRETERM DISCHARGE

To avoid nutritional deficit ALL preterm infants should at least receive nutrients for their respective CGA (see post d/c nutrition guideline

Fortification strategies:

1. ***Breastfeeding:*** Add 1-2 bottles of Neosure 22/24kcal/oz per day
2. ***HBM via bottle:***
   a. Unfortified HM and 1-3 feeds of Neosure 22/24kcal/oz per day.
   b. Fortify all HM feeds to 24 kcal/oz with Neosure powder
3. ***Formula fed only:*** Neosure 22 kcal/oz

Discharge Considerations:

- Individualized approach to optimize growth
- Pre-discharge discussion with parents, providers and dietitians
- Post discharge intervention:
  - Until indexes of growth are >-2SD
  - minimum of 12 weeks after discharge if BW < 1.25Kg or if < 2Kg at discharge

Reviewed KBD/SPW/ARM/DCM/ SMM/2018

APPENDIX 1

Neonatal Amino Acids 2.5% Solution

Indication: A stock solution mixed in D10W for use in the first 24 hours of life. This solution is useful as a source of initial protein for infant's less than 35 weeks. This fluid is for use in UAC, UVC or PIV lines. Additives include heparin at a concentration of 0.5 units per mL of fluid.

Goal: Early protein administration. Goal is 3 gm/kg/day of protein ***in the first 24 hours*** of life. The purpose of this solution is to limit early protein catabolism.

WEIGHT *(kilograms)*	**TOTAL FLUIDS** *(mL/kg/day)*	**PROTEIN** *(gm/kg/day)*	**TOTAL PROTEIN with IAA** *(gm/kg/day)*	**GIR D10AA only** *(mg/kg/min)*
0.5	80	2	2.4	5.5
	100	2.5	2.9	6.9
	120	3	3.4	8.3
0.75	80	2	2.3	5.5
	100	2.5	2.8	6.9
	120	3	3.3	8.3
1	80	2	2.2	5.5
	100	2.5	2.7	6.9
	120	3	3.2	8.3
1.25	80	2	2.2	5.5
	100	2.5	2.7	6.9
	120	3	3.2	8.3
1.5	80	2	2.1	5.5
	100	2.5	2.6	6.9
	120	3	3.1	8.3

APPENDIX 2

Neonatal Amino Acids 3.6% Isotonic Solution (IAA)

Indication: A stock isotonic solution mixed in water for use in UAC lines and PAL lines when no sodium or dextrose is desired in an arterial line. This solution is mixed with 1 unit of heparin per mL of fluid.

Special Considerations: This solution should only be used in addition to a central line or a peripheral intravenous line providing ***a separate dextrose solution.*** The preferred rate to run this solution is at 0.8 mL/hour. This solution can be used for several days if dextrose or sodium concentrations are a concern in any neonate.

WEIGHT *(kilograms)*	**AMOUNT OF PROTEIN PROVIDED** *(gm/kg/day)*	
	RATE OF 0.8 ML/HR	**RATE OF 1 ML/HR**
0.5	1.38	1.73
0.75	0.92	1.15
1	0.69	0.86
1.25	0.55	0.69
1.5	0.46	0.58