### 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

#### 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 osmolality: 1000 mOsm/L)
- Central (Broviac, PICC, UAC or UVC line): D35%
- Midline PICC: D15%

#### PROTEIN

- On admission start at total of 3g/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
- Progress >1.5g/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**

- **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: 0.25-0.5 mEq/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 Ca²⁺
- 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 LHF M or to SSC (24Kg/kg) 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

<table>
<thead>
<tr>
<th>Feedings</th>
<th>CAL</th>
<th>Pro</th>
<th>Na</th>
<th>K</th>
<th>Ca</th>
<th>Phos</th>
<th>Vit D</th>
<th>Fe</th>
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<tbody>
<tr>
<td>HM (20kcal/oz)</td>
<td>66</td>
<td>1</td>
<td>0.8</td>
<td>1.4</td>
<td>28</td>
<td>14.2</td>
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<tr>
<td>HM* (24 kcal/oz)</td>
<td>80</td>
<td>2.5</td>
<td>1.4</td>
<td>2.9</td>
<td>123</td>
<td>68.5</td>
<td>116</td>
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<tr>
<td>HM* (26 kcal/oz)</td>
<td>87</td>
<td>2.7</td>
<td>1.5</td>
<td>2.9</td>
<td>140</td>
<td>78</td>
<td>127</td>
<td>0.9</td>
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<tr>
<td>HM / Prolacta (28 kcal/oz)</td>
<td>97</td>
<td>3.0</td>
<td>2.3</td>
<td>2.4</td>
<td>125</td>
<td>65</td>
<td>53</td>
<td>0.2</td>
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<tr>
<td>HM / Neosure (24 kcal/oz)</td>
<td>80</td>
<td>1.4</td>
<td>1</td>
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<td>42</td>
<td>22.5</td>
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<tr>
<td>SSC (24 kcal/oz)</td>
<td>80</td>
<td>2.7</td>
<td>1.5</td>
<td>2.6</td>
<td>145</td>
<td>80</td>
<td>120</td>
<td>1.5</td>
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<td>Neosure (22 kcal/oz)</td>
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<td>2.1</td>
<td>1.0</td>
<td>2.7</td>
<td>78</td>
<td>46</td>
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<td>Neosure (24 kcal/oz)</td>
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<td>SSC (30 kcal/oz)</td>
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<td>1.9</td>
<td>3.3</td>
<td>180</td>
<td>100</td>
<td>150</td>
<td>1.8</td>
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</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>WEIGHT (kilograms)</th>
<th>TOTAL FLUIDS (mL/kg/day)</th>
<th>PROTEIN (gm/kg/day)</th>
<th>TOTAL PROTEIN with IAA (gm/kg/day)</th>
<th>GIR D10AA only (mg/kg/min)</th>
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<tbody>
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<td>0.5</td>
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<tr>
<td></td>
<td>120</td>
<td>3</td>
<td>3.1</td>
<td>8.3</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>WEIGHT (kilograms)</th>
<th>AMOUNT OF PROTEIN PROVIDED (gm/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RATE OF 0.8 ML/HR</td>
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<tr>
<td>0.5</td>
<td>1.38</td>
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