

## 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)

- **Begin 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

#### 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

- **Begin 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
- Do not order as KVO in infants > 1000g

### 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
- May decrease if metabolic/renal concerns

### FAT (SMOF 20% Emulsion Solution)

- **Begin at 1 gm/kg/day**
- Gives essential Fatty Acids at 2 gm/kg/day

#### Progression of fat

- Progress by 1 gm/kg/d (final goal 3 gm/kg/d)

Prevention + management of hyperglycemia:

- Consider increasing by 0.5 gm/kg/d in ELBW
- Check TG level as needed; if >200 mg/dL stop lipid for 24 hrs + restart at lower dose.

### 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<sup>2+</sup>
- 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 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<sub>mg/g</sub> AA.

Increase to 40<sub>mg/g</sub> 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

## Parenteral Nutrition: Clear Fluids

- Order as "Neonatal Custom Fluid"
- D10 with 10 NaCl + 10 KCl at 120 ml/kg/d gives GIR 8.3 mg/kg/min + 2.4 meq/kg/d of NaCl/KCl
- May add Calcium Gluconate (in mg); no Phos
- Add heparin if central line (0.5 units per mL)
- Note D10AA is a clear fluid

## 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 routinely 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 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

#### 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 (<37 weeks)
- Use [WHO](#) growth chart for **term** infants (>37 weeks)

## NUTRIENT CONTENT PER 100 ML

| Feedings                   | kcal | 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 Discharge 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

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## 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<br>(kilograms) | TOTAL FLUIDS<br>(mL/kg/day) | PROTEIN<br>(gm/kg/day) | TOTAL PROTEIN<br>with IAA<br>(gm/kg/day) | GIR<br>D10AA only<br>(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<br>(kilograms) | AMOUNT OF PROTEIN PROVIDED<br>(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            |