Parenteral Intake Goals:

Preterm: 90-100 Total kcals/kg
3.5-4 g/kg Protein

Term: 80-90 Total kcals/kg
2-3 g/kg Protein

Starter PN = D_{10}, amino acids & calcium gluconate

- Run @ the infant's weight x 1.5
  - For example: 800g = 1.2 ml/hr
  - Do not exceed this rate
- Provides: 3g protein/kg, GIR of 2.5 & 0.54 mEq/kg Ca+
  - Do not give starter TPN if enteral feeds are fortified- leads to excessive protein intake
  - Does not meet any micronutrient needs

Use birth weight through DOL 7

Calculating TPN

Example: 750 g infant

Step 1: Determine the total fluids allowed
i.e. 80 ml/kg/d x 0.75 kg = 60 ml/day

Step 2: Determine lipid intake and rate
- We use 20% lipids (1g = 5 ml)
- i.e. 1 g/kg/d x 0.75 kg x 5 ml = 3.75 ml/day
- Subtract lipids from total fluids
  - 60 ml/day–3.75 ml= 56ml (for Dextrose and AA)
  - 56 ml / 24 hours = 2.3 ml/hr

Step 3: Determine dextrose concentration
- Calculate % Dextrose from GIR
  (GIR x wt in kg x 6) / rate per hour
  - (5 mg/kg/min x 0.75 kg x 6) ÷ 2.3 ml/hr = 9.8% Dextrose

Step 4: Determine AA
- Pick AA goal, i.e. 3 g/kg/day

Step 5: Calculating Calories from TPN
- Dextrose= 3.4 kcal/gram
  - (rate x 24 hr) x (% Dextrose/100) x 3.4 kcal/g
  - i.e. (2.3x24) x (9.8/100) x 3.4 cal/g =18.4 kcals
- Amino Acids= 4 kcal/gm
  - 3 g/kg x 0.75 kg x 4 kcal/g = 9 kcal from AA
- Lipids= 2 kcal/ml
  - Volume per day x 2 kcal/ml
  - 3.75 ml/day x 2 kcal/ml = 7.5 kcal
- Add calories together and divide by wt in kg
  - 18.4 (D) + 9 (AA) + 7.5 (L) = 34.9 kcal
  - 34.9 kcal / 0.75 kg = 46.5 kcal/kg

Initiating TPN:

Preterm	Initiation:	GIR 6 mg/kg/min Dextrose 3.5 g/kg/d AA 2-3 g/kg/d Lipids
	Advancing:	GIR 1-2 mg/kg/min Dextrose 0.5–1 g/kg/d AA if needed 1 g/kg/d Lipids
	Goals:	≤ 12 mg/kg/min Dextrose 3.5–4 g/kg/d AA 3–3.5 g/kg/d Lipids
Term	Initiation:	GIR 6-8 mg/kg/min Dextrose 2–3 g/kg/d AA 2 g/kg/d Lipids
	Advancing:	GIR 1-2 mg/kg/min Dextrose 0.5–1 g/kg/d AA if needed 1 g/kg/d Lipids if needed
	Goals:	≤ 12 mg/kg/min Dextrose 2.5–3 g/kg/d AA 2.5–3 g/kg/d Lipids

Calcium & Phosphorus Goals

- Initiate @ 2mEq/kg Ca+ and 1 mmol/kg PO_4
- Advance to goal of 3mEq/kg Ca+ and 1.5-2 mmol/kg PO_4, maintaining a 1.5-2:1 Ca+ to PO_4 ratio
- With hypercalcemia and hypophosphatemia, change the ratio to 1:1 until levels correct, then resume a 2:1 ratio
- Never give more PO_4 than Ca+. If you are unable to add any phosphorus, give ≤ 2mEq Ca+/kg/day.

Tapering TPN

Enteral Nutrition		TPN		
mL/kg	kcals/oz.	kcals/kg	g pro/kg	g fat/kg
40	20	75-85	3.5	≤ 3
60	20	60-70	3.5	≤ 2
80	20	50-55	3.5	≤ 1
80	**24**	35-45	2	≤ 1
100	**24**	20-30	1.5	D/c Lipids
120	**24**	*Switch to IV Fluids*		

****Feeds should be fortified before TPN is D/C'd****

- Overall goals when receiving both EN & TPN:
  - **100-110 kcal/kg/day & 3.5-4.5 g protein/kg/day**
- GIR can be increased in TPN to achieve energy goal as long as glucose levels are ≤ 120 mg/dL
- If TPN rate <1.2 ml/hr → Discontinue TPN

References 1. *Tsang RC, 2005, Nutrition of the Preterm Infant, Schientific Basis and Practical Guidelines, 2nd edition.*
2. *Newborn and nursing reviews. 4(3):133-5*
3. *Brine E, Ernst JA, 2004, Total Parenteral Nutrition for Premature Infants.*
4. *AAP Guidelines (2005-2008)*

Children's MINNESOTA Neonatal Nutrition Reference (2/19)

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Fluid Requirements

Fluid needs depend on:

1. Urine water loss
2. Evaporative water loss
3. Unusual loss in special situations (gastric drainage, chest tube drainage, etc.)
4. Environmental humidity and skin maturation vary per infant during first 10-14 DOL
5. Overhead phototherapy requires 15-20% extra fluid

Typical Parenteral fluids

<1500 g	ml/kg/day
Day 1	60-75
Day 2	70-80
Day 3	80-90
Day 4	100-120
Day 5	140-150*

* Full kcal fluids for normal growth (150)
**extreme prematurity fluids are much higher and based on daily individual assessment

Electrolytes

- **Sodium:** 3-5 mEq/kg/d of NaCl
  ELBW 5-8 mEq/kg/d
- **Potassium:** Start when K+ <3.8 mEq/L and urine output is good
- **Magnesium:** Do not give Mg initially if mother was given dose of $MgSO_4$

Adjust levels in TPN based on lab values

Initiating Enteral Nutrition

- Trophic Feeding: *"GI priming"*
  - Initiate 1-2 days after birth if medically appropriate
  - Begin trophic feeds @ 10-20 ml/kg/day & 20 kcal/oz.
    - *Infants >28 weeks may tolerate larger volumes*
  - Continue trophic feeds for 3-5 days before advancing

- **Advancing Enteral Nutrition:**
  - Once trophic feeds are complete, advance by ~20 ml/kg/d to goal of 150-160 ml/kg/day
  - **Fortify feeds to 24 kcal/oz once infants are tolerating enteral feeds @ 80-100 ml/kg/day**

✓ Don't advance if aspirates >50% of feeding volume
✓ Don't forget to taper TPN

Enteral Nutrition Goals

	Calories/kg/day	Protein g/kg/day
Preterm	120-130*	3.5-4.5
Term	100-110	2-3

** 24 kcal/oz. feeds @ 150-160 ml/kg/day will provide 120-130 kcals/kg/day*

Feeding Options

GA & Birth Wt	Appropriate Formula
<35 wk, <2000 gm	24 kcal/oz. Breast milk + HMF 24 kcal/oz. Preterm Formula
>36 wk, >2500 gm	Term Formula OR MBM
35-37 wks 2000-2500 gm	22 kcal/oz. Breast milk + HMF 22 kcal/oz. Transitional Formula *May need to adjust based on labs/growth
IUGR, >35 wks, <3%	Transitional formula or fortified breast milk (22 or 24cal based on labs/growth)
Term, Hypoglycemic	24 cal term formula or MBM until sugars correct

Children's Products

	Similac	Enfamil
HMF*	SHMF	----------
Preterm	Similac Special Care (SCF or SSC)	Enfamil Premature (EPF)
Transitional	NeoSure	Enfacare
Term	Similac Advance	Enfamil Premium

** Prolacta fortifier(human milk based) is available for ELBW infants with severe feeding intolerance. RD must approve.*

Donor Milk

- All infants <34 weeks and <1500 grams offered donor milk until they reach 32-34 weeks &/or 1500 grams. At this time, transition to 24 SCF if MBM is unavailable.
- Consent for donor milk must be obtained before use.
- Donor milk has ~40% less protein than MBM and no lipase to aid in fat metabolism- monitor growth!

Assessing Nutrition Status

Growth Goals

- DOL 1-7: 10-20% weight loss from diuresis
  - Goal is to regain birth weight by DOL 10-14
- After regaining birth weight, goals are:
  - <2000g = 18-20 g/kg/day
  - >2000g = 25-35 g/day
- Length: 0.8-1.1 cm/wk
- OFC : 0.6-1.0 cm/wk

Common reasons for poor growth:

- **Inadequate protein intake**
- Inadequate or excessive energy intake
- Increased energy expenditure (↑ WOB, temp control)
- Use of steroids and diuretics

Nutrition Labs

Initial labs drawn at 1 month of age

- **Alkaline Phosphatase & Phosphorus:**
  - Goals: ALP <500 u/L, Phos >4.5 mg/dL
  - Osteopenia= ALP >800 *and* phosphorus <4.5
  - Check labs together since ALP can increase from rapid growth or cholestasis
- **BUN:**
  - Goal: > 9 mg/dL
  - Used to assess protein stores
- **Ferritin:**
  - Goal: 100-400 ng/mL
- **25-(OH) Vitamin D**
  - Goal: >30ng/mL

Conditional Nutrition Labs

- Urine Sodium:
  - Monitor with poor growth or excessive stool output
  - Goal= >30; *See protocol for dosing guidelines*
- D. Bili weekly if on TPN >2 weeks or >2mg/dL
  - Goal= <2mg/dL
- Triglycerides:
  - Check after 3 days of TPN if not advancing enteral feeds
  - Goal= <250 mg/dL
  - Increase GIR if limiting lipids to meet energy goal

- **Additives**
  - Liquid Protein Fortifier: hydrolyzed protein supplement- *dose calculated by RD*
  - Complete Amino Acid Mix: used to increase protein intake if liquid protein is not tolerated- *RD will recommend if needed*
  - Tribasic powder- Calcium/Phosphorus supplement used to treat osteopenia- *requested by RD*
  - Oatmeal Cereal: used for aspiration, *not* reflux
    - 5 teaspoons per 2oz of formula= honey-thick
    - **Will NOT thicken breast milk**

Vitamin D and Iron Supplementation

Iron: Birth weight <1800g on breast milk…….3.5-4 mg/kg
Birth weight 1800-2500g on breast milk……..…..2 mg/kg
<1800g receiving formula……..….1.5- 2 mg/kg

Do not add iron until infant is tolerating full, fortified enteral feeds and is at least 2 weeks old

Vitamin D: 400 IUs per day for all infants in NICU
Initiate when infant is on full enteral feeds

Discharge Guidelines

✓ Children's does not allow powder formula on the unit, unless made by family. Before discharge, infants on:

1. Formula – Change to Neosure/Enfacare 22-24 kcal/oz. when placed on an ALD schedule.
2. Breast Milk – Continue to use HMF until discharge or until the infant weighs 3.6kg. After D/C, MBM will be fortified with formula powder.

Home Feeding Plans

Preterm (<2000 gm BW, <35 weeks)
- **Formula:** Neosure or Enfacare 22-24 kcal/oz.
- **Breast Feeding:** 2-4 bottles per day of 24 cal/oz MBM + transitional formula

Term (>2500 gm BW, >35 weeks)
- OK for discharge on unfortified breast milk or term formula if taking adequate volumes

"Late Pre-Term" (2000-2500 gm BW, 34-37 weeks)
- ✓ *Check growth curve, intakes and lab values*
- **Formula:** 22 kcal/oz. Nesoure until the infant reaches 40 weeks**.** May use up to 3 months CGA if needed for growth.
- **Breast Feeding:** Encourage 2-4 bottles of 22-24 cal/oz MBM + transitional formula until 1-3 months CGA for increased nutrient intake.

** Feeding plans may be adjusted depending on intakes, weight gain, lab values and desire to breastfeed**

Discharge Vitamin Supplements

All Formula Fed Premature Infants:
- 0.5 ml/day of Tri-vi-sol without iron
  - Vitamins A, C & D

Breast Fed Preterm Infants or Combo Formula/MBM:
- 1 ml/day of Poly-vi-sol with iron
  - Vitamins A, C, E, D & B(s) + 10mg Fe

Breast Fed Infants; Birth weight >2500g:
- 1 ml/day of D-vi-sol
  - 400 IUs Vitamin D

(Poly-vi-sol is bitter due to B-vitamins- if pt is having troubles with taking MVI, try Tri-vi-sol instead)