NUTRITION GUIDELINES

NEWBORN PARENTERAL NUTRITION PROTOCOL

Summary: Parenteral nutrition soon after birth should be used for preterm infants <30 weeks and/<1500g; infants at high risk of necrotizing enterocolitis, and those infants with illness or sepsis in whom establishment of enteral feeding is thought to be delayed by 3-5days.

Aim: To improve feeding tolerance and growth (weight, length, and head circumference in low birth weight infants) and reduce days of parenteral nutrition.

Goal: To provide consistent, evidence based approach to feeding the low birth weight infant.

Introduction: The placenta is the only source of nutrition for growing fetus during the intrauterine life. Neonates delivered at less than 30 weeks gestation are born at a time of rapid brain and body growth. Abrupt cessation of the placental supply of nutrients at birth makes these premature neonates vulnerable to nutritional deficiencies unless enteral or parenteral nutrition is established rapidly. In very premature neonates enteral feeding is often established slowly and therefore, during this period, nutrients are provided parenterally in the form of parenteral nutrition (PN).

GUIDELINE STATEMENT: PARENTERAL NUTRITION SOON AFTER BIRTH SHOULD BE USED FOR:

Table A:

Gestation age	**<30 Weeks**
Antenatal	**Severe Intra uterine growth retardation (<3rd centile of gestation)/ Abnormal Dopplers**
Weight	**<1500 grams**
Risk factors	**Necrotizing enterocolitis, ceased/delayed feeding, feed intolerance, short bowel syndrome, intractable diarrhea**
Post operative	**Post GI surgeries like repair of TOF, malrotation, omphalocele, gastroschisis**
Feed	**Unlikely to achieve full feeds within 5 days**

Table B: Recommended Volume for babies

Day	Day1	Day2	Day3	Day4	Day5	Day6	Day7
Fluid/ml/kg/d	80	100	120	140	160	180	Upto200
Lipid g/kg/d	1	2	3.5g (can cease once we reach 140ml/kg/d)				
Amino acids g/kg/d	2	3	Upto 4.5g (reduce as we achieve full feeds)				

Table C: Components of TPN Solution

Protein	**Crystalline Amino acids**
Fat	**Lipids**
Carbohydrates	**Glucose (10/12.5%)**
Electrolytes	**Sodium, potassium, chloride, calcium and magnesium**
Vitamins	**A,C,D,E,K, Thiamine, Riboflavin, Niacin, pantothenic acid, pyridoxine, biotin, choline and folic acid**
Trace elements	**Zinc, copper, manganese, chromium, selenium**

Energy

American Academy of Pediatrics (AAP) Committee on Nutrition 2014 recommends a parenteral caloric intake of 90-115 kcal/kg/day in preterm infants. ESPGHAN 2018 recommends parenteral intakes of 90-120 kcal/kg/day for extreme low birth weight infants. Minimal energy requirements are met with 50–60 kcal/kg/day, but intakes of 100–120 kcal/kg/day facilitates maximal protein accretion. Glucose and amino acids are estimated to provide 4 kcal/g and lipid emulsion 9 kcal/g. Carbohydrates are recommended to provide 40-60% of total energy so is the largest source of non-protein energy. ESPGHAN 2009 recommended glucose commencement infusion rates of 4- 8mg/kg/min in preterm neonates, cautioning against exceeding the maximum rate of glucose oxidation and potentiating hyperglycemia. Maximal glucose oxidation in preterm and term infants is reported to be 8.3 mg/kg per min (12 g/kg per day) and 13 mg/kg per min (18 g/kg per day) respectively.

Table C1: Energy composition of TPN in preterm infants.

Initial Dose	**35-50 kcal/kg/day**
Transition dose	**60-85 kcal/kg/day**
Growing premature infant	**90-115 kcal/kg/day**
Growing term infant	**90-120 kcal/kg/day**

Fluids

Systematic review of five studies indicates that restricted fluid intake is significantly associated with postnatal weight loss and reduced risks of patent ductus arteriosus and necrotizing enterocolitis (LOE 1, GOR B). Restricted water intake was shown to also be associated with trending towards increased risk of dehydration and reduced risk of bronchopulmonary dysplasia, intracranial hemorrhage, and death, but these trends were not statistically significant. Volume should be increased gradually over first week based on electrolytes, hydration and clinical status with an aim of delivering 150ml/kg/day by the end of a week.

Table C2: Fluid calculation in TPN for preterm infants.

Minimal Range	**80ml/kg/day**
Maximal Range	**200ml/kg/day**

Amino Acid

Early administration of amino acids within the first 24 hours of birth helps with growth and neuro-developmental outcome in preterm newborns, Delay in administering amino acids could result in a protein catabolic state and could impact on growth and development in preterm neonates. Supra-physiological dose of amino acids can cause high blood levels of ammonia and urea, and an exacerbation of metabolic acidosis. Protein delivered as synthetic amino acid solution, gives 4kcal/g. This solution contains 9 essential amino acids and cystine, tyrosine, taurine and arginine as the semi essential amino acids**. A maximum of 15% calories should be given as proteins.** The amino acid solution used in our NICU is **INTRAVENOUS AMINO ACID SOLUTION 10% FOR INFANTS (AMINOVEN INFANT 10%)** the composition is as follows

COMPOSITION -Each 100ml contains:

Ingredient	**Quantity**
L-leucine Ph.Eur	**1.30g**
L-isoleucine Ph.Eur	**0.80g**
L-lysine Acetate USP	**1.20g**
L-lysine	**0.851g**
L-methionine Ph.Eur	**0.312g**
L-phenylalanine Ph.Eur	**0.375g**
L-threonine Ph.Eur	**0.440g**
L-trptophan Ph.Eur	**0.201g**
L-Valine Ph.Eur	**0.900g**
L-arginine Ph.Eur	**0.750g**
L-histidine Ph.Eur	**0.476g**
Glycine Ph.Eur	**0.415g**

L-serine Ph.Eur	0.767g
L-Alanine Ph.Eur	0.930g
L-proline Ph.Eur	0.971g
N-acetyl L-tyrosine DAB1997	0.5176g
L-tyrosine	0.420g
N-acetyl- L-cystine DAB 1997	0.070g
L-cysteine	0.052g
L-malic acid DAB1997	0.262g
Total amino acids	100g/l
Total nitrogen content	14.9g/l
Ph value	5.5-6
Titration acidity	27-40mmol NaOH/l
Theor. Osmolality	885mosm/l

Table C3: Protein dose in TPN for preterm infants.

Phase	g/kg/day
Initial Dose	2-3
Transition dose	3.5-4
Growing premature infant	3.2-3.8
Growing term infant	4.0-4.5
Maximum safe dose	4.5

LIPIDS

Lipids are a major source of non-protein energy and have a nitrogen sparing effect. It serves as a source of essential fatty acids as well as long chain polyunsaturated fatty acids (LC-PUFA) which is essential for development of brain and retina. When lipids are exposed to light, they form potentially toxic lipid hydro-peroxides. Hence lipid syringes and tubing should be covered by wrapping in foil or carbon paper if foil is not available. Due to its isotonicity, it can be given through the peripheral line. The tolerance of lipids in extreme preterm babies is poor and hence triglycerides levels should be monitored. The lipids are reduced following acute episodes of sepsis, respiratory distress, TCP, and severe hyperbilirubinemia.

We recommend commencing lipids at 1 g/kg/day and increase by 1 g each day to 3 g/kg/day. If triglyceride levels >2.8mmol/L, consider reducing the lipid emulsions by 1 g/kg/day increments but continue at least 0.5g/kg/day to prevent essential fatty acid deficiency. Our NICU unit uses SMOF lipid

SMOF lipid

Composition: Soyabean oil (30%), coconut oil (30%), Olive oil (25%), fish oil (15%),20% Lipid (200g lipid/L), 2kcal/ml, 380 mOsm/L, A- Tocopherol: 500umol/L, Ratio n-6 to n-3 PUFAs:2:5:1

% of Fatty acids

Linoleic acid	**18.6%**
Linolenic acid	**2.3%**
ARA	**0.5%**
DHA	**2.2%**
MCT	**27.8%**

This Intralipid is superior to the other intralipid formulas available as it is fish based intralipid and the bio availability of the fatty acids are higher when compared to others , and presence of higher percentage of MCT facilitates growth in preterm infants.

Table C4: Fat dose in TPN for preterm infants.

Phase	g/kg/day
Initial Dose	**0.5-1**
Transition dose	**1-3**
Growing premature infant	**0.5-3**
Growing term infant	**0.5-3**
Maximum safe dose	**3.5**

SODIUM, POTASSIUM AND CHLORIDE

- Water and sodium balances change over time after birth. Initially after birth, the extracellular fluid space contracts in association with a net negative sodium and water balance with accompanying weight loss. Excess water loss is associated with early hypernatraemia. On the other hand, early hyponatraemia within the first 48 hours of life likely represents maternal sodium status and/or with too much water administration.
- Guidelines suggest addition of sodium only after the onset of postnatal diuresis from the second or third day after birth.
- Hyperkalaemia is a common complication in the first 48 hours of life in extremely low birth weight and/or extremely preterm infants, but is not affected by early and high administration of protein.

- Hyperchloraemia (>115 mmol/L) is common in VLBW infants on PN and is associated with acidosis. Trial evidence found the incidence of hyperchloraemia and acidosis is reduced by partly replacing chloride with acetate in parenteral nutrition

CALCIUM

- One mmol of calcium (Ca) equates to 40 mg calcium and 1 mmol of phosphorus equates to 31 mg phosphorus (P).75 A 1:1 Ca:P molar ratio is equal to 1.3: 1 weight (mg) ratio. Transplacental Ca and P delivery to the fetus occurs actively against a concentration gradient and is greatest after the 24th gestational week. Generally, it is estimated that 80% of mineral accretion occurs in the 3rd trimester of pregnancy.

Sodium	• **3 MEq/kg/day in 1st week** • **3-6 MEq/kg/day beyond 1st week**
Potassium	• **0-2 MEq /kg/day in 1st week** • **1-3 MEq/kg/day beyond 1 week**
Calcium	• **2 MEq/kg/day or 4MEq/kg/day or 100-150mg/kg/day**
Magnesium	**15-25mg/kg/day**
Phosphate	**20-40mg/kg/day**

TABLE D: STEPS TO CALCULATE TPN

Step 1	Calculate total Fluid Intake
Step 2	Amino acids: 1-4g/kg/day
Step 3	Lipids: 1-3g /kg/day
Step 4	Supplementation
Step 5	Sodium, Potassium, Calcium, Magnesium, Phosphate, Multivitamin
Step 6	Calculate dextrose infusion
Step 7	Calculate Caloric Nitrogen ratio (CNR)

	Carbohydrate calories + Fat calories * 6.25 (constant) Amino acid in gm This ratio should be between 100-200 cal/g
Step 8	Add Heparin 1 unit/ml

TABLE D1: PERIPHERAL VERSUS CENTRAL VENOUS ACCESS

Peripheral line	10-12.5% dextrose, electrolytes and minerals, drugs, antibiotics	>3 days
Central Venous line	Hypertonic solutions	10-18 days
Umbilical vein	TPN	14 days

MONITORING PROTOCOL FOR PARENTERAL NUTRITION

Meticulous monitoring is necessary not only to detect complications, but to document clinical benefit. Most septic and metabolic complications can be prevented or detected before they cause serious consequences, if the monitoring protocol is followed rigidly. Monitoring should be more frequent in initial stages. Once a steady metabolic stage has been achieved, monitoring can be reduced to once a week. Table below gives the monitoring protocol of neonates on PN in our hospital. Blood sampling volumes should be carefully recorded and replenished, especially in ELBW neonates. Adjustments of daily electrolytes, nutrients, and fluid orders are based on biochemical monitoring.

TABLE D2

Parameter	Frequency
Serum Electrolytes	**3-4 times/ week initially, then weekly**
Blood urea	**3 times/ week initially, then weekly**
Calcium, magnesium, phosphorous	**3 times/ week initially, then weekly**

Glucose	**2 times/day**
Urine glucose	**Daily**
Protein	**Weekly**
Liver function test	**Weekly**
Hematocrit	**weekly**
Serum triglycerides	**4 hours after a dose increase initially, then weekly**
Physical assessment	
Weight	**Daily**
Intake/ output	**Daily**
Inspection of catheter Insertion site (for swelling, redness, extravasations)	**Daily**
Anthropometry measurements	**Weekly**
Growth curves	**Weekly**

REFERENCES:

AIIMS protocol

ESPGN Total parenteral nutrition guidelines for neonates 2019

https://www.naspghan.org/files/documents/pdfs/Parenteral%20Nutrition%20Slide%20Set.pdf

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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2795370/

https://www.cpqcc.org/sites/default/files/Section%202_Parenteral%20Nutrition_Nutrition%20Toolkit_September%202018%20.pdf

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