مدينة الملك فهد الطبية
King Fahad Medical City

Ordering and Monitoring Parental Nutrition for Neonate

Guidelines

Premature and low birth weight infants need a source of nutrition immediately after birth due to low nutrient reserves, increased energy expenditure, immaturity of the GI tract, as well as their increased propensity for acute and chronic illness.

- Infants should receive PN if it is anticipated that they will be unable to receive enteral feeding for more than 2 to 3 days.
- Infants have very limited fat and glycogen stores and when these have been depleted infants begin to catabolize protein stores for energy.

Nutrition Assessment of Premature Infants

Nutrition assessment of premature infants is critical component in the medical management of high-risk neonates.

Routine assessment is vital to ensure adequate nutrition status of critically ill neonate. Premature infants are classified according to their birth weight and gestation age at birth.

- The goal for premature infant is to mimic intrauterine weight gain.

Classification Parameters

Premature infants are classified by the infant's gestational age, growth curve parameters and maturational examination. The maturational examination, known as the ballard score is postnatal, indirect method of assessing neonate's gestational age.

Low birth weight(LBW)	<2500g
Very low birth weight (VLBW)	<1500g
Extremely Low birth weight(ELBW)	<1000G
Micronate	<750g

Special Consideration

Specific medical condition will alter the neonate's nutrition needs and ability to feed enterally and by mouth.

1. Gastrointestinal anomalies such as, Gastroschisis, Omphalocele, and Necrotizing Enterocolitis(NEC) will mandate feeding the infant with PN support for longer time, may suffer from SBS if surgery was required and may require long-term PN. The transition to enteral feeds is often need to be with slower advancement to full feeds.
2. The premature infant's respiratory status may alter his/her energy requirements and ability to feed orally. For instance, chronically ventilator-dependent infants may require decrease energy requirements since they aren't working to breath conversely, infants may have increased energy expenditure during times of weaning from respiratory support.
3. Infants with chronic lung disease (CDL) and bronchopulmonary dysplasia(BPD) often require fluid restrictions.

Energy and calories

Goal: 100-120 kcal/kg/day

The resting metabolic rate (MR) in ventilated infants in the first few days of life is around 40 kcal/kg/day. Energy intake to cover protein accretion over resting MR should be at minimum of 10 kcal/gm proteins. For relatively stable ventilated infant, this gives a minimum energy requirement of approximately 50 kcal/kg/ day at an amino acid intake of 2 gm/kg/day.

- Dextrose = 3.4 kcal/gm
- Protein = 4 kcal/gm
- 20% IL = 10 kcal/gm (2 cal/ml)

Flued requirements

NEONATE	INITIAL	INCREASE BY	MAXIMUM
Full-Term (>= 37 wks)	60-80 ml/kg/day	10 ml/kg/day	150 ml/kg/day
Pre-Term (28-36 wks >= 1000 gm)	70-80 ml/kg/day	10 ml/kg/day	150 ml/kg/day
ELBW (23-27wks <1000gm)	80-100 ml/kg/day	10 ml/kg/day	200ml/kg/day to maintain Output/Input Ratio. Usually will level out

- Infants are born with high water content and will lose about 10% of body weight. If weight loss is extreme, more fluids may be required.
- Urine output (UOP) usually 2-5ml/kg/hr. however, preterm infants may have urine output as high as 10-12ml/kg/hr. output/input ratio is usually about 0.7 if the output is high, the ratio will be higher and infant may need more fluids.

- The electrolytes panel can be helpful in determining fluid requirements. Na and Cl are good indicators of fluid status in the first few days of life. When Na and Cl levels are high, more fluids are required.

Factors affecting fluid requirements

Factors increasing fluid requirements ↑	Factor decreasing fluid requirements ↓
Phototherapy	Humidified incubator
Increase permeability of the skin	Humidified ventilation
Larger body surface area relative to body weight	respiratory distress Syndrome (RDS)
Increase respiratory distress	Renal oliguria
Elevated body temperature	Patent Ductus Arteriosus (PDA)

Glycosuria with osmotic diuresis	Broncho Pulmonary Disorder (BPD)
Gastric or intestinal losses	

Dextrose requirements

NEONATE	INITIAL	ADVANCEMENT	GOAL
Term	6-9 mg/kg/ min	1-2 or 2.5-5% dextrose per day	12mg/kg/min* Max (14-18)
Preterm	5-7 mg/kg/ min	1-2.5% dextrose per day	8-12 mg/kg/min Max 14-18

* maximum recommended upper limit for glucose intake.

- Glucose is the main energy substrate of the infant.
- You can give up to 12.5% dextrose in peripheral lines.

How to calculate the dextrose in mg/kg/min from concentration?

$$\frac{\%\ \text{of glucose} \times \text{rate (ml/Hr.)} \times 0.167}{\text{Weight (kg)}}$$

Amino acid requirements

Neonate	Initial	Advancement	Goal
Term*	1.5-3 g/kg/d	1 g/kg/d	2-3 g/kg/d
Preterm	1.5-3 g/kg/d	1 g/kg/d	3-4 g/kg/d
Septic, Hypoxic**	1 g/kg/d	0.25-0.5 g/kg/d	3-4 g/kg/d

* (BUN) Blood Urea Nitrogen, Ammonia, Arterial pH (Blood or plasma monitoring).

** Lactate concentration (blood or plasma monitoring).

- 25-30 non-protein calories are needed for each gram of proteins to avoid catabolism.
- 1.5-2 g/kg/d is sufficient to avoid catabolism in most infants.

Protein

- Protein is administered as crystalline amino acid solution, specialized amino acid solution are available for infants, these include TrophAmine 6% and 10%(B.BRAUN), Premasol 6% and 10% Baxter (healthcare). These specialized solutions contain high concentration of essential amino acids, including histadine and tyrosine, low concentrations of phenylalanine, methionine, and glycine, as well as glutamic acid, aspartic acid, taurine, and N-acetyl-L-tyrosine.

The amino acid solution for infants are designed to replicate plasma amino acids in breastfed infants. They also have lower Ph., which allows higher levels of calcium and phosphate to be added.

- Protein are the key components of every organ: bones, muscles, skin, and brain.

- Infants who receive only glucose, lose 1% of their protein store each day.
- Proteins yield amino acid up on hydrolysis.
- Pediatric essential amino acids over adult's amino acid are cysteine (enhance Calcium, Phosphate solubility) Taurine (prevents cholastasis, vital for brain and retinal development).

IVFE consists of either soybean oil or a combination of safflower and soybean oil. These products provide 10Kcal/g regardless of the product concentration, and are available in 10% (1.1kcl/ml), 20%(2kcal/ml), and 30% concentrations.

The 20% concentration is preferred over the 10% product because it allows adequate lipid intake in less volume.

The 10% solution has higher phospholipid/triglyceride weight ratio than 20% solution and this higher ratio may affect the activity of lipoprotein lipase, the primary enzyme for lipid clearance, resulting in higher triglyceride and other plasma lipids in infants.

Lipid requirements

Neonate	Initial	Advancement	Goal
Term	1-2 g/kg/d	0.5-1 g/kg/d	3 g/kg/d* (max0.15 g/kg/hr)
Preterm	0.5 -1 g/kg/d	0.25-1 g/kg/d	3-3.5 g/kg/d (max0.17 g/kg/hr)
Hyperbilirubinemic	0.5 g/kg/d**	0-0.5 g/kg/d	1-2 g/kg/d
Sepsis			
Severe respiratory distress			

* may consider slightly higher dose in growth failure.

** minimum fat needed to prevent essential fatty acid deficiency.

- IV fat emulsion infusion over 24 hrs. maximizes clearance.
- IV lipid dose can be increased to normal range when bilirubin is below 50% of exchange level and when sepsis and respiratory distress is under adequate control.

Monitoring lipid (IVFE)

1. Check triglyceride daily until full intralipid rate given.
2. Acceptable triglycerides < 200 mg/dl (2mMol/L).
3. Contraindication to IV fat when triglycerides more than 4.5 mmol/l.
4. To check the triglyceride level, you need to stop the intralipid infusion for 4 hrs. then take the sample.

Why do we give IVFE?

- IVFE not only supplies a concentrated source of calories but also provides essential fatty acids(EFAs)
- IVFE are needed for brain development.
- IVFE helps to prolong the integrity of peripheral lines because of their lower osmolality.

- Lipids are used for:
  - Myelin formation
  - Neuronal growth
  - Retinal development
  - Cell membrane formation

It is crucial to provide infants a minimum amount of lipids(0.5-1g/kg/d) to prevent essential fatty acid deficiency(EFAD). However, premature infants require at least 0.6-0.8g/kg/d

EFAD was historically defined as triene:tetraene ratio equal to greater than 0.4, mayo clinical laboratories recently developed a new set of standards for assessing triene:tetraene ratio, but it has to be run by its laboratory

Electrolytes requirements

- Close monitoring of electrolyte status is essential. In newborns, the addition of electrolyte to pn may be deferred until the second day of life in some cases.

- Potassium is generally added once normal kidney status and good urine output are established, and sodium often added once diuresis begins.
- Daily adjustments to electrolyte intake are often necessary.
- Electrolyte requirements of preterm and full-term infants are generally similar, with exception of calcium and phosphorus.
- Electrolytes are typically prescribed per kilogram in infants

Maximum calcium and phosphate on central PN

The recommended ratio of calcium to phosphorus is 1.3 mg Cal:

- 1mg phos in infants > 28 wks. and infants > 1000 gm.
- The ratio is 1.7 mg Cal: 1mg phos in ELBW infants.

- Precipitation of crystals is much more likely when the concentration of both calcium and

phosphorus is high or the pH of the PN solution is high.

- The pH is mostly dependent on 2 factors:
    - Primene concentration: the amino acid solution has a low pH. The more concentration of the AA solution, the lower the pH (allowing more calcium and phosphorus to be added).
    - Acetate concentration: acetate can raise the pH of the solution. The amount of acetate should be limited in the PN to allow for maximum calcium and phosphorus.
- Sodium glycerophosphate used as source of organic phosphate. That's will yield to a maximum use of calcium and phosphate in the PN.

Electrolyte Dosing Guidelines

Electrolyte	Preterm neonate	Infants
Sodium	2-5mEq/kg/day	2-5mEq/k/d
Potassium	2-4mEq/kg/day	2-4mEq/k/d
calcium	2-4mEq/kg/day	0.5-4mEq/k/d
phosphorus	1-2mmol/kg/day	0.5-2mmol/k/d
Magnesium	0.3-0.5mEq/kg/d	0.3-0.5mEq/k/d
acetate	As needed to maintain acide-base balance	
chloride	As needed to maintain acid-base balance	

Assumes normal organ function and losses

Vitamins, Minerals, and trace Elements

Dosing Recommendations for parenteral multivitamins(MVI-Pediatric)

Manufacturer recommendation		NAG-AMA Recommendation	
Weight(kg)	Dose(ml)	Weight(kg)	Dose(ml)
<1	1.5	<2.5	2ml/kg
3	3.25	>2.5	5ml
>3	5		

Trace elements

Standard infant and pediatric trace commercial products are available, however, in cases of specific medical conditions, such as renal or hepatic diseases may use "custom" trace elements.

- **Zinc** is important for maintenance of cell growth and development. Zinc requirements may increase

in infants with high stool output, gastrointestinal fluid losses, or renal failure

- **copper** is an essential constituent of many enzymes, clinical manifestation of copper deficiency includes hypochromic anemia that is unresponsive to iron therapy
- Conditions requiring higher copper intake include biliary losses due to jejunostomy and losses via external biliary drainage,
- Copper deficiency have recently been reported when copper was withheld in PN. In patients with cholestasis, it is recommended to reduce supplementation by 50% of the amount typically provided for age,
- **Manganese** is an important of several enzymes, manganese deficiency has not been documented, however manganese toxicity has been reported, manganese supplementation in PN should be withheld in patients with cholestasis or other liver function impairment. Fok et al. provided evidence suggested that high manganese intake contribute to the development of cholestasis, therefore should be used with caution in PN provided to

infants because they are more susceptible to cholestasis.it is recommended to monitor serum levels.

- **Selenium** is a component of the enzyme glutathione peroxidase, which is involved in protecting cell membrane from peroxidase damage through detoxification of peroxides and free radicals. Supplementation with selenium is recommended when patient is on long –term PN (longer than one month), it is recommended to decrease selenium intake when renal dysfunction is present.
- **Chromium** potentiates the action of insulin and plays a role in glucose, protein and lipid metabolism, therefore, chromium is essential for growth.it is also recommended to decrease chromium intake with renal dysfunction.
- **Molybdenum** supplementation is recommended in cases when exclusive PN exceeds 4 weeks. Deficiency of molybdenum has not been reported in pediatrics, however, one adult case has been reported.

- **Iodine** is often omitted from PN since iodine-containing disinfectant and detergents on the skin and absorbed.
- **Iron** supplementation should be considered only among long –term PN –depended patients who are not receiving frequent blood transfusion.
- **Carnitine**
  - Carnitine is responsible for the transport of fatty acids into the mitochondria for oxidation
  - Carnitine deficiency results in impaired fatty acid oxidation and can present as hypertriglyceridemia.
  - Carnitine synthesis and storage are not optimal at birth, when compared to older children
  - Premature infants less than 34 weeks' gestation receiving PN without carnitine can develop carnitine deficiency 6 to 10 days after birth.
  - Carnitine initial safe dose to consider for infants on PN for more than 4 weeks is 8-10mg/kg/d

Heparin

- Heparin is added to PN solutions to reduce the formation of a fibrin sheath around the catheter and may reduce phlebitis and increase the duration of catheter patency.
- Heparin also stimulates the release of lipoprotein lipase, which may improve lipid clearance.
  It is recommended to add heparin o.25-1 units/ml pn solution. There is an increased risk of anti-coagulation with higher doses of heparin

TRACE ELEMENT	PRETERM NEONATES < 3KG (MCG/KG/D)	TERM NEONATES 3/10KG(MCG/KG /D)
ZINC	400	50-250
COPPER	20	20
MANGANESE	1	1
CHROMIUM	0.05-0.2	0.2
SELENIUM	1.5-2	2

Assumes normal organ function and losses

Guidelines for metabolic monitoring during parenteral nutrition

What to be monitored	Initially	Later
weight head circumference	Daily Baseline	Daily Twice weekly
Intake and output	Every shift	Daily
Serum electrolytes urea nitrogen creatinine.	Baseline and every 1-3 days	Every week
Total and direct bilirubin	Baseline, then as needed clinically	Every 1-2 weeks
Alanine, Aminotransferase, Aspartate amino-transferase and alkaline phosphatase	Baseline	Every 1-2 weeks

- Admixture osmolarity refers to the osmoles of solute per liter of solution. Osmolarity is measured

in milliosmoles per liter (mOsm/L). PN admixture osmolarity is important because the IV access site used for a given infusion is dictated by admixture osmolarity. The higher the osmolarity, the larger the vein needed to accommodate the formulation. A formulation with high osmolarity infused into a small peripheral nein will cause irritation and pain, with damage to the vessel (phlebitis), which will necessitate frequent changes of the IV site.

- Estimating osmolarity: Formulation osmolarity can be estimated by adding the osmolar contribution from each component of the PN formulation and dividing by the total volume (in liters) of the formulation. The approximate osmolar contribution of commonly used components of a PN admixture is as follows:
    a) Amino acids: 1g = 10 mOsm
    b) Dextrose: 1g = 5 mOsm
    c) 20% IVFE: 1g = 0.71 mOsm (product dependent)
    d) Calcium Gluconate: 1 mEq = 1.4 mOsm
    e) Magnesium sulfate: 1 mEq = 1 mOsm

f) Potassium (chloride, acetate, of phosphate salt): 1 mEq= 2 mOsm
g) Sodium (chloride, acetate, of phosphate salt): 1 mEq = 2 mOsm

لأن الوعي وقاية ..

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