

TOTAL PARENTERAL NUTRITION FOR NEONATES

Introduction

- total parenteral nutrition (TPN) is the intravenous infusion of all nutrients necessary for metabolic requirements and growth
- earlier introduction and more aggressive advancement of TPN is shown to be safe and effective, even in the smallest and most immature infants
- premature infants tolerate TPN from day 1 of post-natal life

The goal of TPN is to

- provide sufficient nutrients to prevent negative energy and nitrogen balance and essential fatty acid deficiency
- support normal rates growth without increased significant morbidity.

Indication for TPN

- gastrointestinal tract abnormalities (tracheo-esophageal fistula, omphalocele, gastroschisis, malrotation with volvulus, etc)
- necrotizing enterocolitis (NEC)
- respiratory distress syndrome / BPD patients who are unable to tolerate feeding
- extreme prematurity
- sepsis
- malabsorption

Components of TPN

The essential components of parenteral nutrition are:

- fluids
- electrolytes
- vitamins
- trace minerals
- protein
- carbohydrate
- lipids

Goal is to provide at least 100-110 cal/kg/day. This will be achieved if we can deliver (for example) 150 mls/kg/day of 12.5% dextrose, 2.5 g/kg/day of synthetic amino acids, and 3.0 g/kg/day of intravenous lipids.

Fluid

- fluid is an essential component.
- usually started at 80-100 ml/kg/day (if newborn), or at whatever stable fluid intake the baby is already receiving.
- volumes are increased over the first 7 days in line with the fluids and electrolytes protocol with the aim to deliver 150 ml/kg/day by day 7.

Amino acids

- amino acids prevents catabolism; prompt introduction via TPN achieves an early positive nitrogen balance.
- decreases frequency and severity of neonatal hyperglycaemia by stimulating endogenous insulin secretion and stimulates growth by enhancing insulin and insulin-like growth factor release
- start protein at 1g/kg/day of crystalline amino acids; advanced by day 3-4 age to 3.0 g/kg/day of protein (term infants) and 3.7 - 4.0 g/kg/day (extremely low birth weight infants, ELBW)
- reduction in dosage may be needed in critically ill, significant hypoxaemia, suspected or proven infection and high dose steroids.

- adverse effects of excess protein include a rise in urea and ammonia and high levels of potentially toxic amino acids such as phenylalanine.

Glucose

- there is a relatively high energy requirement in the ELBW and continuous source of glucose is required for energy metabolism.
- in the ELBW minimum supply rate is 6 mg/kg/min to maintain adequate energy for cerebral function; additional 2-3 mg/kg/min (25 cal/kg) of glucose per gram of protein intake is needed to support protein deposition. Maximum rate: 12 - 13 mg/kg/min (lower if lipid also administered) but in practice often limited by hyperglycaemia (20 - 80% of ELBW) from decreased insulin secretion and insulin resistance (presumably due to glucagon, catecholamine and cortisol release).
- hyperglycaemia in the ELBW managed by decreasing glucose administration, administering intravenous amino acids and/or infusing exogenous insulin.
- glucose administration is initiated at 6 mg/kg/min, advancing to 10-12 mg/kg/min.
- if hyperglycaemia then infusion rate decreased; if hyperglycaemia on infusion rate of 3 - 4 mg/kg/min then give insulin.

Lipid

- lipids prevent essential fatty acid deficiency, provide energy substrates and improve delivery of fat soluble vitamins.
- LBW infants may have immature mechanisms for fat metabolism. A number of clinical conditions inhibit lipid clearance e.g. infection, stress and malnutrition.
- start lipids at 1g/kg/day, at the same time as amino acids prevent essential fatty acid deficiency; dose gradually increased up to 3 g/kg/day (3.5g/kg/day in ELBW infants). Use smaller doses in sepsis, compromised pulmonary function, hyperbilirubinaemia.
- it is infused continuously over as much of the 24 hour period as practical.
- avoid concentrations >2g/kg/day if infant has jaundice requiring phototherapy
- preparation of 20% emulsion is better than 10% as 20% solutions require less fluid volume with a lower phospholipid-to-triglyceride ratio and 10% interferes with triglyceride (TG) clearance leading to higher TG and cholesterol values
- the use of heparin at 0.5 to 1 units/mL of TPN solutions (max 137 units/day) can facilitate lipoprotein lipase activity to help stabilize serum triglyceride values.
- lipid clearance monitored by plasma triglyceride levels (maximum triglyceride concentration ranges from 150 mg/dl to 200 mg/dl).
- exogenous lipids may interfere with respiratory function. Suggested mechanisms include impaired gas exchange from pulmonary intravascular accumulation or impaired lymph drainage resulting in oedema. Lipids may also aggravate pulmonary hypertension in susceptible individuals.

Electrolytes

- sodium requirement: 2-3 mEq/kg/day (term infants); 4-5 mEq/kg/day (preterm)
- potassium requirement: 2-3 mEq/kg/day in both term and preterm infants.

Minerals, Calcium (Ca), Phosphorus (P) And Magnesium

- the premature infant is unable to maintain the intrauterine accretion rate of Ca and P when parenterally fed; the optimal retention of Ca and P is half the intrauterine accretion
- monitoring for osteopaenia of prematurity is important especially if prolonged PN
- a normal magnesium level is a prerequisite for a normal calcaemia. In well balanced formulations, however, magnesium does not give rise to major problems.

Trace Elements

- indicated if PN is administered for ≥ 1 week. Commercial preparations are available

Vitamins

- both fat and water soluble vitamins are essential. It should be added to the to fat infusion instead of amino-acid glucose mixture to reduce loss during administration

Administration

- TPN should be delivered where possible through central lines
- peripheral lines only if TPN ≤ 3 days duration and dextrose concentration $\leq 12.5\%$
- peripheral lines also limited by osmolality (< 600 mOsm/L) to prevent phlebitis
- percutaneous central line: confirm position of catheter tip with X-ray prior to use.
- strict aseptic technique in preparation and administration of the TPN is essential
- avoid breakage of the central line through which the TPN is infused, though compatible drugs may be administered if necessary.
- heparin is added to all TPN solutions; omitted on specialist orders if contraindicated

Caution

- *Hyperkalaemia*. Rarely required in first 3 days unless serum potassium < 4 mmol/l. Caution in renal impairment.
- *Hypocalcaemia*. May result from inadvertent use of excess phosphate. Corrects with reduction of phosphate.
- *never* add bicarbonate, as it precipitates calcium carbonate
- *never* add extra calcium to the burette, as it will precipitate the phosphates.

Complications

Delivery

The line delivering the TPN may be compromised by;

- sepsis - minimized by maintaining strict sterility during and after insertion
- malposition. X-ray mandatory before infusion commences
- thrombophlebitis - with peripheral lines; require close observation of infusion sites
- extravasation into the soft tissue, with resulting tissue necrosis

Metabolic complications

- hyperglycaemia
- hyperlipidaemia
- cholestasis

Monitoring

Before starting an infant on parenteral nutrition, investigation required:

- full blood count /haematocrit
- renal profile
- liver function test, bilirubin
- random blood sugar/dextrostix

While on TPN, monitoring required :

Laboratory

- full blood count, renal profile. Daily for 1 week then 3 times a week
- plasma calcium, magnesium, phosphate. Twice a week until stable then weekly
- triglyceride levels. After dose changes then weekly
- liver function test: If long term TPN (> 2 weeks duration)

Clinical

- blood sugar / dextrostix, 4-6 hrly first 3 days, twice a day once stable.
- daily weight
- meticulous care of the catheter site and monitoring of infection.