

TOTAL PARENTERAL NUTRITION (TPN)

DEFINITION

Parenteral nutrition (PN) is the intravenous infusion of some or all nutrients for tissue maintenance, metabolic requirements and growth promotion in neonates unable to tolerate full enteral feeds

Seek advice from TPN pharmacist

INDICATIONS FOR PN

- Temporary supply of nutrients <2 weeks:
 - decreased enteral intake
 - functional gut immaturity
 - necrotising enterocolitis (10-14 days)
 - extremely low in birth weight, <1,000 grams
 - temporary feeding intolerance
 - medical instability
 - meconium ileus
- Prolonged non-use of the gastrointestinal (GI) tract >2 weeks:
 - necrotising enterocolitis (14 days maximal)
 - surgical GI disorders – gastroschisis, large omphalocele
 - short bowel syndrome

PRESCRIBING PARENTERAL NUTRITION

Peripheral vs central PN (long line/UVC)

Peripheral PN

- Limited by glucose concentration (usually no more than 10-12%)
- Indicated if full enteral feeds likely to be introduced relatively soon
- some post-surgical infants
- larger premature infants tolerating enteral feeds relatively quickly
- short episodes of feeding intolerance or suspected NEC

Central TPN

- Requires placement of a central catheter (see **Long line** guideline) with tip in either the superior vena cava or the inferior vena cava

TPN prescription

- Most units have specific PN bags that are used to allow nutrients to be increased over 4 days. These may be added to (but nothing may be removed) by discussing with TPN pharmacist
- Modify PN infusion according to requirements and tolerance of each infant and taper as enteral feeding becomes established

Daily requirements

| <2.5 kg | Day 1 | Day 2 | Day 3 | Day 4 | Comment |
|-------------------------|-----------------------------|-----------------|-------|----------|--|
| Amino acid (g/kg/day) | 1 | 2 | 3 | 3 (3.5*) | |
| Carbohydrate (g/kg/day) | 6-15 (based on maintenance) | ↑ by 2 each day | | | If possible, calculate Day 1 glucose from maintenance infusion |
| Fat (g/kg/day) | 1 | 2 | 3 | 3.5 (4*) | *If acceptable not routine |

*for neonates <1.5 kg

| 2.5 – 5 kg | Day 1 | Day 2 | Day 3 | Day 4 | Comment |
|-------------------------|-----------------|--------|-------|-------|--|
| Amino acid (g/kg/day) | 1 | 2 | 2.5 | 2.5 | |
| Carbohydrate (g/kg/day) | 6-14 (based on) | ↑ by 2 | 14 | 14 | If possible calculate day 1 glucose from |

| | maintenance) | each day | | | maintenance infusion |
|----------------|--------------|----------|---|-----|----------------------|
| Fat (g/kg/day) | 1 | 2 | 3 | 3.5 | |

| | <2.5 kg | 2.5 - 5 kg |
|-------------------------------|-----------------------------------|----------------------------------|
| Na (mmol/kg/day) | 3 (range 2-4) | 3 (range 2-4) |
| K (mmol/kg/day) | 2.5 | 2.5 |
| Ca (mmol/kg/day) | 1 | 1 |
| PO ₄ (mmol/kg/day) | 1.5 | 1 |
| Mg (mmol/kg/day) | 0.2 | 0.2 |
| Peditrace (mL/kg/day) | 0.5 (day 1), 1 (day 2 onwards) | 0.5 (day 1) 1 (day 2 onwards) |
| Solvito N (mL/kg/day) | 1 | 1 |
| Vitilipid (infant) | 4 mL/kg/day | 10 mL daily (total) |

Glucose – maximum concentration:

- Peripheral PN 10-12%
- Central PN up to 20-25% (may rise occasionally)

Fat

- Fat >4 g/kg/day only in very preterm with normal TG, not septic, not on phototherapy
- fat should provide ideally 35-40% of non-protein nitrogen (NPN) calories

Nitrogen

- For effective nitrogen utilisation 150-200 kcal NPN for every gram of nitrogen
- as rough guideline, maintain P:NPN ratio approx. 3.5 g/100 kcal

Volume and calories

- Remember to account for volume, and electrolyte and glucose content of other infusions (e.g. UAC/UVC fluid, inotropes, drugs)
- Healthy preterm requires 50 kcal/kg/day for basal energy expenditure (not growth) and 1-1.5 g protein to preserve endogenous protein stores
- 60 kcal/kg/day will meet energy requirements during sepsis
- 90 kcal/kg/day and 2.7-3.5 g protein will support growth and positive nitrogen balance

NUTRITIONAL SOURCES

Fluids

- Maintenance up to 150 mL/kg/day (see **Intravenous V fluid** guideline for fluid requirement) – maximal fluid volume vary with individual management

Glucose (provides 3.4 kcal/g)

- Initiated at the endogenous hepatic glucose production and utilisation rate of 4–6 mg/kg/min; [8–10 mg/kg/min in extremely low birth weight (ELBW) infants]. The osmolality of glucose limits its concentration

Protein (provides 4 kcal/g)

- At least 1 g/kg/d in preterm and 2 g/kg/d in ELBW decrease catabolism
- 3-3.5 grams protein/kg/d and adequate non-protein energy meets requirements for anabolism

Fat (provides 2.0 kcal/mL)

- To minimise essential fatty acid deficiency, hyperlipidaemia, bilirubin displacement, and respiratory compromise, lipid infusion rates ≤0.15 g/kg/h are recommended to span over 24 hr

- in neonates, the maximal removal capacity of plasma lipids was shown to be 0.3 g/kg/hr
- delivery of 3 g/kg/d of a 20% lipid emulsion equates to an infusion rate of 0.125 g/kg/hr

Energy

- Carbohydrate (glucose) and fat (lipid emulsions) provide the necessary energy to meet the demands and, when provided in adequate amounts, spare protein (amino acids) to support cell maturation, remodelling, growth, activity of enzymes and transport proteins for all body organs
- PN requirement for growth 90-115 kcal/kg/day

Electrolytes

- Sodium, potassium, and chloride dependent on obligatory losses, abnormal losses and amounts necessary for growth, and can be adjusted daily
- Infants who receive electrolytes solely as chloride salts may develop hyperchloraemic metabolic acidosis (may need to add acetate to PN)

Vitamins

- Vitamin and mineral requirements are best estimates based on limited data

Increased energy needs

- Infection
- Chronic lung disease
- Healing, growth
- Babies who have experienced IUGR

Decreased energy needs

- Sedation
- Mechanical ventilation

SPECIAL NEEDS

Hyperglycaemia

- If hyperglycaemia severe or persistent, start insulin infusion – Actrapid 0.01–0.05 units/kg/hr

Osteopenia

- If infant at risk of, or has established, osteopenia, give higher than usual intakes of calcium and phosphorus
- consult dietitian and/or pharmacist regarding prescribing information
- permissible concentrations depend on amino acid and glucose concentrations in the TPN solution

Metabolic acidosis

- For management of metabolic acidosis, add acetate as Na or K salt
- choice of salt(s) will depend on serum electrolytes

MONITORING

| | |
|---------------|---|
| Daily | <ul style="list-style-type: none"> • fluid input • fluid output • energy intake • protein • NPN calories |
| Daily | <ul style="list-style-type: none"> • urine glucose • BM • blood glucose (if urine glucose positive) |
| Thrice weekly | <ul style="list-style-type: none"> • urine electrolytes • weight |
| Weekly | <ul style="list-style-type: none"> • length • head circumference |
| Twice weekly* | <ul style="list-style-type: none"> • FBC • Na |

| | |
|--------|---|
| | <ul style="list-style-type: none"> • K • glucose • urea • creatinine • albumin • bone • bilirubin ** • blood gas (arterial or venous) |
| Weekly | <ul style="list-style-type: none"> • serum TG** • magnesium • zinc** • head circumference • length |

*Initially daily and decrease frequency once stable

**In prolonged TPN more than 2 weeks

COMPLICATIONS

Catheter related: (see **Long-lines** guideline)

- Peripheral catheters – extravasations and skin sloughs

Electrolyte abnormalities

- Electrolyte and acid-base disturbances

Metabolic

- Hyper/hypoglycaemia, osmotic diuresis
- Metabolic bone disease – mineral abnormalities (Ca/PO₄/Mg)
- Hyperlipidaemia and hypercholesterolaemia
- Conjugated hyperbilirubinaemia

PN-associated cholestatic hepatitis

- Infants having prolonged TPN (>10-14 days) can develop cholestasis, probably owing to TPN toxicity combined with reduced oral feeding, and often transient – usually manifest as rising serum bilirubin (with increased direct component) and mildly elevated transaminases – leads to deficiencies of fatty acids and trace minerals
- even small enteral feeds will limit or prevent this problem
- consider reduction of fat or infusion hours
- add trace minerals
- consider other causes direct hyperbilirubinaemia (TPN-induced cholestasis is diagnosis of exclusion)

WEANING PN

- When advancing enteral feedings, reduce rate of PN administration to achieve desired total fluid volume
- Assess nutrient intake from both PN and enteral feed in relation to overall nutrition goals