Newborn Parenteral Nutrition

Summary:	**Parenteral nutrition soon after birth should be used for preterm infants <32 weeks and/or <1500 g; infants at high risk of necrotising enterocolitis; and those infants with illness in whom establishment of enteral feeding is thought to be delayed by 3-5 days.**
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Author:	**Dr Srinivas Bolisetty**
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INTRODUCTION

- Parenteral nutrition (PN) is an essential component in the management of newborn infants in Newborn Intensive Care Units (NICUs).
- 2022 consensus PN guidelines are based on the majority consensus from the Australasian PN consensus group meetings held between September 2021 and December 2021.
- PN is associated with risks and benefits and clinical judgement is required to balance these competing outcomes.
- These PN guidelines do not account for every variation in the clinical circumstance, particularly very sick and unstable. The professional judgement of the health professional in these individual cases must take precedence.

INDICATIONS

Common indications are:

- Preterm infants <32 weeks and/or <1500 g
- Infants at high risk of necrotising enterocolitis
- Infants in whom establishment of enteral feeding is anticipated to be delayed by 3-5 days.

2022 CONSENSUS FORMULATIONS – KEY POINTS

There are 8 Amino acid (AA)/dextrose formulations (Appendix 1). Among them:

- **Starter:** At 60 mL/kg/day provides 2 g/kg/day AA and 2 mmol/kg/day of sodium (Na).
- **Starter concentrated:** At 40 mL/kg/day provides 2 g/kg/day AA and 2 mmol/kg/day Na.
- **Standard preterm:** At 135 mL/kg/day provides 4 g/kg/day AA and 5.4 mmol/kg/day Na.
- **Preterm concentrated**: At 100 mL/kg/day provides 4 g/kg/day AA and 5.4 mmol/kg/day Na.
- **High sodium preterm:** At 135 mL/kg/day provides 8 mmol/kg/day Na.
- **7.5% Dextrose preterm** formulation provides 7.5% dextrose.
- **34 week- term: Dextrose concentration changed from 12% to 10%.** At 135 mL/kg/day provides about 3 g/kg/day of AA and 3.4 mmol/kg/day of Na.
- **Peripheral preterm:** Calcium (Ca) and phosphorus (P) contents are 50% of standard preterm.

Calcium (Ca) and Phosphorus (P) contents in the formulations are increased and Ca:P ratios are optimised:

- **Starter:** At 60 mL/kg/day provides Ca and P of 0.8 and 1 mmol/kg/day at 0.8:1 ratio.
- **Standard preterm:** At 135 mL/kg/day provides Ca and P of 2.7 mmol/kg/day each at 1:1 ratio.
- **34 wk- Term:** At 135 mL/kg/day provides Ca and P of 1.2 mmol/kg/day each at 1:1 ratio.

Trace elements are added in the form of Paediatric Trace element formula (Paed TE) plus additional zinc (Zn) and selenium (Se).

New formulations also contain copper (Cu)

A formulary on sodium acetate infusion was developed to administer sodium acetate in metabolic acidosis.

PRINCIPLES/GUIDELINES

<u>Energy</u>

- One gram of glucose and protein provide 4 kcal each and 1 g of lipid provides 9 kcals.
- ESPGHAN 2018 guidelines recommend minimum/starting energy intake of 45-55 kcal/kg/day and 90-120 kcal/kg/day in the growth phase.(1)
- NICE 2020 guidelines recommend starting energy intake of 40-60 kcal/kg/day and 75-120 kcal/kg/day in the growth phase.(2)
- The 2022 consensus formulations provide the following:
    - Starter PN at 60 mL/kg/day with 1 g/kg/day of lipid: 42 kcal/kg/day.
    - Starter PN at 60 mL/kg/day with 2 g/kg/day of lipid: 51 kcal/kg/day.
    - Standard preterm PN at 135 mL/kg/day with 3 g/kg/day of lipid: 97 kcal/kg/day.
    - 34 wk- term PN at 135 mL/kg/day with 3 g/kg/day of lipid: 93 kcal/kg/day.

Fluids

- A systematic review indicates that restricted fluid intake is significantly associated with reduced risks of patent ductus arteriosus and necrotizing enterocolitis.(3) (LOE 1, GOR B) Restricted fluid intake was also associated with a non-significant trend towards increased risk of dehydration and reduced risk of bronchopulmonary dysplasia, intracranial haemorrhage, and death.(3)
- The 2022 standard consensus formulations provide recommended nutrient intakes in a total fluid intake of 150 ml/kg/day. This includes 135 ml/kg/day of AA/Dextrose formulation and 15 ml/kg/day water in the 20% lipid emulsion.
- For those units who opt for a total fluid intake below 150 ml/kg/day, or unwell babies with multiple non-protein intravenous infusions such as inotropes and opioid analgesics contributing to a significant proportion of fluid volume, the concentrated PN formulations provide an adequate nutrient and mineral intake on a lower volume.

Amino acids

- Three systematic reviews evaluated the efficacy and safety of parenteral AA in preterm neonates.
- Trivedi et al, reviewed early administration of AA within the first 24 hours of birth and found no benefits on mortality, early and late growth and neurodevelopment.(4)
- Leenders et al reviewed the effects of early parenteral AA within 24 hours of birth versus later initiation and high dose (>3.0 g/kg/day) versus a lower dose. There were no significant difference in growth or morbidity. Initiation of AA within the first 24 hours of life appeared safe and well tolerated in this review.(5)
- Osborn et al reviewed higher versus lower intake of parenteral AA in preterm infants. Overall, higher AA intake had no effect on pre-discharge mortality (typical RR 0.90, 95% CI 0.69 to 1.17). There was insufficient evidence on neurodevelopment with no reported benefit found. Similarly, they did not notice any beneficial impact on mortality or neurodevelopmental outcome in the subgroup analyses including high amino acid (>2 g/kg/day) at commencement, high amino acid at maximal infusion rate (>3 to <4 g/kg/day) and high amino acid intake within 24 hours of birth. Higher AA intake was associated with a reduction in postnatal growth failure (< 10th centile) at discharge (typical RR 0.74, 95% CI 0.56 to 0.97). Higher AA intake was associated with a reduction in days to regain birth weight (MD -1.14, 95% CI -1.73 to -0.56). There were varying effects on growth parameters and no consistent effects on anthropometric z-scores at any time point. Higher AA intake was not associated with an effect on days to full enteral feeds, late onset sepsis, necrotising enterocolitis, chronic lung disease, any or severe intraventricular haemorrhage or periventricular leukomalacia. There was a reduction in retinopathy of prematurity (typical RR 0.44, 95% CI 0.21 to 0.93), but no difference in severe retinopathy of prematurity.(6)
- The 2022 Consensus remains the same as 2017 consensus: (1) commence parenteral AA within the first 24 hours of birth, (2) commence parenteral AA at 2 g/kg/day and (3) incrementally increase amino acid infusions to a maximum 4 g/kg/day by day 3-5 of life in preterm neonates.
- The 2022 consensus noted the latest ESPGHAN 2018 recommendation of maximum 3.5 g/kg/day of AA and NICE 2020 recommendations of maximum 4 g/kg/day. The consensus group also noted the findings of the Australian study that reported the actual intake of AA using the consensus formulations average around 3.5 g/kg/day.(7)

Carbohydrates

- Carbohydrate is recommended to provide 40-60% of total energy.(8)
- Maximal glucose oxidation in preterm and term infants is reported to be 8.3 mg/kg/min (12 g/kg/day) and 13 mg/kg/min (18 g/kg/day) respectively.(8)
- ESPGHAN 2018 recommendation from day 2 onwards: Preterm neonates – 8-10 mg/kg/min (11.5-14.4 g/kg/day) and term neonates – 5-10 mg/kg/min (7.2-14.4 g/kg/day).
- NICE 2020 recommendation from day 4 onwards: 6.25-11 mg/kg/min (9-16 g/kg/day) for both preterm and term infants.
- 2022 preterm and term PN formulations contain 10% dextrose providing 9.4 mg/kg/min (13.5 g/kg/day) at 135 ml/kg/day.

Lipids

- Two systematic reviews found no statistically significant benefit of introducing lipids before two to five days of age, including no measured beneficial effects on growth. They also found no increased side effects.(9, 10) Further, composition of growth was not assessed in these studies.

- Essential fatty acid deficiency occurs rapidly and can be prevented with introduction of as little as 0.5 to 1 g/kg/day of lipid infusion.(9)
- The 2022 Consensus is to remain with the current recommendation of the commencement of parenteral lipid on day 1 of PN administration, particularly for extremely preterm neonates.
- There is no evidence that gradual increments in the infusion rate of lipids improve fat tolerance.(11) Starting dose 1 g/kg/day was safely tolerated in most clinical trials.
- The 2022 consensus is to continue with current recommendation on the commencement dose at 1-2 g/kg/day. Majority consensus was to increase lipid by 1 g/kg each day to 3 g/kg/day.
- A number of trials have been published with variable biochemical and clinical benefits reported among lipid emulsions in newborn infants.(11-14)
- The 2022 consensus lipid formulations provide SMOFlipid and Clinoleic as suitable lipid preparations and anticipate individual units will take cost and waste minimisation into consideration when choosing the specific type of lipid preparation most suited to their needs.
- The formulations have been designed in such a way that volumes of preparations per each gram of lipid is the same for all the formulations:
    - 1 g/kg/day equates to 6 ml/kg/day
    - 2 g/kg/day equates to 12 ml/kg/day
    - 3 g/kg/day equates to 18 ml/kg/day
- The contents of the consensus lipid formulations are listed in Appendix 2.
- The lipid emulsions contain 80% water (6 mL lipid emulsion contains 5 mL water; 12 mL lipid emulsion contains 10 mL water; 18 mL lipid emulsion 15 mL water).
- Suggested plasma triglyceride monitoring: Check plasma triglycerides before each step of increase to 3 g/kg/day and then 24 hours later and then whenever the infant is sick as long as the infant is on lipid emulsions.
- 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.(11)
- In view of benefits with restricted fluid intake,(3) the consensus group recommends to include lipids in the total fluid intake, particularly when the lipid intake reaches 3 g/kg/day, which equates to 15 ml/kg/d of water.

Sodium, potassium, chloride and acetate

- The timing of the introduction of Na supplementation in neonates is controversial. Traditional guidelines suggest addition of Na after the onset of postnatal diuresis from 2nd or 3rd day of life. However salt wasting due to renal immaturity is common in extremely preterm infants and inadequate Na intakes have been attributed to postnatal growth failure. It is unclear whether early fluid therapy should contain some Na to facilitate extracellular volume reduction or to compensate for renal Na losses. Higher early sodium intake may be associated with early hypernatraemia and increased oxygen requirements to 28 days. Subsequent higher sodium intake may reduce the incidence of hyponatraemia.(15-18)
- The 2022 consensus reaffirmed the consensus reached in 2013 and 2017, agreeing to minimal Na intake on day 1 using a starter PN formulation. Sodium in starter formulation is a component of organic phosphorus (P) (sodium glycerophosphate which contains 2 mmol Na per 1 mmol of phosphate). Given the current recommended intake of P on day 1 of life is about 1 mmol/kg/day, proposed 2022 starter formulation provides 2 mmol/kg/day of Na on day 1 of life.
- The 2022 standard preterm and term formulations provide Na intakes of 5.4 mmol/kg/day and 3.4 mmol/kg/day at 135 mL/kg/day respectively.
- Hyperkalaemia is a common complication in the first 48 hours of life in extremely preterm infants, but is not affected by early and high administration of protein.
- The 2022 consensus formulations provide K intake as below:
    - Starter formulation at 60 mL/kg/day: 0 mmol/kg/day
    - Standard preterm formulation at 135 mL/kg/day: 3 mmol/kg/day
    - 34 wk-Term formulation at 135 mL/kg/day: 2.7 mmol/kg/day.
- Hyperchloraemia (>115 mmol/L) is common in VLBW infants on PN and is associated with hyperchloremic acidosis. ESPGHAN 2018 recommend “Cl-free” Na and K solutions in preterm infants on PN in order to reduce the risk of metabolic acidosis. (19) Incidence of hyperchloraemia and acidosis can be reduced by partly replacing chloride with acetate in PN.(20) However, excess acetate can lead to hypercarbia.(20)
- Acetate in PN formulation: Sodium acetate is an alkalinising agent. It is metabolised in the liver to bicarbonate. Sodium acetate can be used as the source of sodium replacing sodium chloride in

parenteral nutrition solution in preterm neonates. In a double blind randomised controlled trial, Ali et al compared the parenteral nutrition (PN) solutions containing sodium acetate or sodium chloride on biochemical parameters and clinical outcomes in 52 infants <33 weeks including 29 extremely low birth weight infants <1000 g. The intervention arm received sodium acetate as the entire source of sodium whereas the control arm received sodium chloride as the source of sodium. In the first 6 days of life, intervention arm received mean intake of sodium (acetate) 4 mmol/kg/day. The study showed that the blood pH and base excess rose to normal values after 3 days of PN in the acetate group. There was no significant difference in pCO2 between groups. There was a significantly lower occurrence of BPD in the acetate group. The occurrence of severe IVH was also lower but did not reach statistical significance.(21) The 2022 formulations contain sodium glycerophosphate as the source of organic phosphate and the intake of sodium from this source cannot be altered for a given amount of phosphate. Therefore, the option of adding acetate greater than 15 mmol/L in preterm formulation is not feasible.

- The 2022 consensus formulations provide acetate intake as below:
    - Starter formulation at 60 mL/kg/day: 0 mmol/kg/day
    - Standard preterm formulation at 135 mL/kg/day: 2 mmol/kg/day
    - 34 wk-Term formulation at 135 mL/kg/day: 1.1 mmol/kg/day.

Calcium, phosphorus and magnesium

- One mmol of calcium (Ca) equates to 40 mg calcium and 1 mmol of phosphorus (P) equates to 31 mg phosphorus (P).
- 1:1 Ca:P **molar** ratio is equal to 1.3: 1 **weight** (mg) ratio.
- ELBW infants are at increased risk of developing refeeding syndrome with hypokalemia, hypophosphataemia and hypercalcemia with early aggressive amino acid intake without optimal Ca and P intake. (19) ELBW infants are also at high risk of metabolic bone disease.
- ESPGHAN 2018 recommendation for preterm infants: (1) In the first few days: 0.8-2.0 mmol/kg/day of Ca and 1-2 mmol/kg/day of P with Ca:P ratio of 0.8:1.0; (2) In growing preterm: 1.6-3.5 mmol/kg/day of Ca and 1.6-3.5 mmol/kg/day of P with a Ca:P ratio of 1:1.(22)
- NICE 2020 recommendations for preterm and term infants: (1) Ca:P ratio of 0.75:1 in the first 48 hours of life and 1:1 after 48 hours of life; (2) Ca in the first 48 hours: 0.8-1 mmol/kg/day and after 48 hours of life 1.5-2 mmol/kg/day; (3) P in the first 48 hours: 1 mmol/kg/day and after 48 hours of life 2 mmol/kg/day.(2)
- 2022 consensus formulations provide the following Ca and P intakes:
    - Starter at 60 mL/kg/day: Ca 0.8 mmol/kg/day, P 1.0 mmol/kg/day and Ca:P ratio 0.8:1.0.
    - Standard preterm at 135 mL/kg/day: Ca 2.7 mmol/kg/day, P 2.7 mmol/kg/day and ratio 1:1.
    - 34 wk-Term at 135 mL/kg/day: Ca 1.2 mmol/kg/day, P 1.2 mmol/kg/day and ratio 1:1.
- Mg: A minimum Mg intake of 0.2 mmol/kg/day and maximum 0.3 mmol/kg/day is considered appropriate for LBW infants.(22) The consensus formulations provide 0.2 mmol/kg/day of Mg.

Vitamins

- There is no optimal neonatal vitamin formulation available. Water and fat soluble vitamins (Soluvit N® and Vitalipid N Infant® 10%) are added to the lipid emulsion to increase the vitamin stability.(23)
- Appendix 3(preterm neonates) and 4 (term neonate) shows the quantity of vitamins supplied through the consensus lipid emulsion at 3 g/kg/day. The doses of vitamin K, pyridoxine, riboflavin and vitamin B12 are slightly above recommended parenteral doses, and ascorbate, folate and pantothenate below.(23) Loss of vitamins and formation of peroxides from exposure to light is substantially reduced by adding the preparation to the lipid infusate, covering the tubing and by use of amber/dark syringes and tubing. (11)
- Vitamin D: The consensus formulation delivers vitamin D 160 IU/kg/day. ESPGHAN 2018 recommendation for parenteral vitamin D in preterm and term infants is 80-400 IU/kg/day and 40-150 IU/kg/day respectively. (23)
- Vitamin E: Evidence does not support the routine use of intravenous vitamin E supplementation at high doses or aiming at serum tocopherol levels greater than 3.5 mg/dL, supporting the current recommendation for parenteral intake of vitamin E.(23, 24)
- Vitamin K: Preterm infants who received intramuscular Vitamin K 0.5-1 mg at birth, followed by parenteral intake (60 µg/day for infants <1000 g and 130 µg/day for infants 1000 to 3000g) had

much higher vitamin K plasma concentrations at 2 and 6 weeks of age than previously reported in healthy, term, formula-fed infants (4–6 ng/mL).(25)

TRACE ELEMENTS (TE)

- **Appendix 3 (preterm neonate) and 4 (term neonate)** shows the parenteral RDIs of trace elements (EPSGHAN 2018)(26) and the comparison to the consensus group formulations using the Baxter paediatric trace element formula plus additional zinc and selenium. Nutritional deficiency in low birth weight infants or preterm infants on PN has been mostly reported for zinc and copper.
- **Zinc (Zn):** Parenteral zinc is recommended at a dose of 400–500 µg/kg/day for premature infants and 250 µg/kg/day for term infants.(26)
- **Copper (Cu):** While there are case reports of copper deficiency associated with osteoporosis, neutropenia, anaemia, oedema, poor growth, apnea, skin pallor and distended veins,(27) no cases of copper deficiency were reported in babies fed appropriate milk. (28) ESPGHAN 2018 recommendation is 40 µg/kg/day in preterm infants and 20 µg/kg/day in term infants. ESPGHAN recommendations are based on expert consensus. (26) Cu is a pro-oxidant and the Australian expert review suggested 15-20 µg/kg/day is adequate in PN to prevent copper deficiency.(28) Serum Cu and ceruloplasmin concentrations seem to have no relationship to intake, and reference ranges are poor and of little value. (28) Cu should be carefully monitored in patients with cholestatic liver disease.(26) The current consensus standard preterm formulation with 1 mL Paed TE provides 27 µg/kg/day of Cu.
- **Selenium (Se):** Selenium supply of up to 7 µg/kg/day in preterm infants and 2-3 µg/kg/day in term infants is currently recommended for parenterally fed LBW infants.(26, 29). The amount of selenium in the current consensus formulations is limited by Primene 10% used as the source of amino acid in the formulation. The current stability limit for selenium in the proposed consensus formulation is 30 micrograms/L, which provides 4 µg/kg/day in preterm infants at 135 mL/kg/day.
- **Iodine (I):** The recommended parenteral intake is currently 1-10 µg/kg/day in preterms and at least 1 µg/kg/day in term infants.(26)
- **Manganese (Mn):** In infants receiving long-term PN, a dose of no more than 1 µg/kg/day is recommended.(26)
- **Molybdenum (Mo):** Deficiency has not been reported in newborns. Intravenous molybdenum supply of not more than 1 µg/kg/day is recommended for the LBW infant on long term PN.(26)
- The contents of the new Baxter paediatric trace element formula is below:

	1 mL
Zn, µg	2000
Cu, µg	200
Se, µg	30
I, µg	10

- The 2022 Consensus is to use the new trace element formula as the preferred TE formula and add extra Zn and Se to optimise the intakes in preterm and term neonates (Refer to Appendices 1, 3 and 4).

Heparin

- Prophylactic heparin for peripherally placed percutaneous central venous catheters has a reduced risk of catheter occlusion but no statistically significant difference in the duration of catheter patency, risk of thrombosis, catheter related sepsis or extension of intraventricular haemorrhage.(30) Routine use of heparin is not recommended by ESPGHAN 2018 consensus.(31)
- Heparin was added at 0.5 to 1 IU/ml to PN formulations with no adverse effect reported.
- The consensus AA/Dextrose formulations have heparin 0.5 IU/ml of heparin.

Physicochemical stability

- Physicochemical stability of the latest AA/dextrose formulations have been tested by Baxter Pharmaceuticals and confirmed to be stable for up to 61 days at 2-8^{0}C and 5 days at below 25^{0}C.

Hanging time

AA/Dextrose solution: In a randomised trial enrolling 166 infants, there was no significant difference in bacterial or fungal colonisation of infusate or neonatal sepsis in infants receiving 24 or 48 hour infusions of parenteral nutrition solution.(32) A before-after intervention study reported extending PN solution hang time from 24 to 48 hours did not alter central line associated blood stream infection rate and was associated with a reduced PN-related cost and perceived nursing workload.(33)

Lipid infusion: In the previously mentioned randomised trial, fungal contamination may be increased in infants receiving lipid infusion for 24 hours compared to 48 hours. In another trial randomising PN set changes (rather than infants), microbial contamination of infusion sets was significantly more frequent with 72-hour than with 24-hour set changes in neonates receiving lipid solutions.(34)

The majority 2022 consensus recommended a hanging time of 48 hours for PN solution and 24-48 hours for lipid.

Route of administration

Osmolality: A prospective study reported that administration of PN through peripheral vein resulted in 8% and 30% incidence of extravasation/phlebitis with PN osmolarity of ≤1000 mOsm/L and >1000 mOsm/L respectively.(35) A retrospective cohort study that included 151 neonates found that administration of PN with osmolarity >1000 mOsm/L significantly increased infiltration (17% vs 7%; OR, 2.47; 95% CI, 1.24–4.94; P = .01) and the combined composite end point of phlebitis or infiltration (45% vs 34%; OR, 1.65; 95% CI, 1.07–2.54; P = .02). In multivariate analysis, osmolarity >1000 mOsm/L was an independent risk factor for developing complications (OR, 1.67; 95% CI, 1.08–2.52; P = .02).(36) These studies suggest that peripheral administration of PN in neonates should be limited to 1000 mOsm/L.

Consensus 2022 remained the same as 2017: PN formulations with osmolality below 1000 mOsm/L can be administered peripherally for short term use provided that close monitoring of the IV site for any extravasation/phlebitis is followed. In view of the dearth of evidence, the consensus group agreed to continue the peripheral PN formulation in case of concerns regarding the amount of calcium infused through peripheral veins.

Late preterm (34+0 to 36+6 weeks) and term neonates

There is paucity of data on the efficacy and safety of PN in this age group. Two small studies enrolled late preterm and term neonates, but neither reported on any major clinical outcomes. Hata 2002 et al randomised 30 neonatal surgical patients into 3 groups according to the dose of AA given: group H (3.45 +/- 0.07 g/kg/day), group M (2.59 +/- 0.07 g/kg/day), and group L (1.72 +/- 0.06 g/kg/day). All patients received the same amount of dextrose (average 21.5 g/kg/day) and no lipid was administered. The primary outcome was cholestasis. There were no significant differences in liver function tests among 3 groups on 10th day of PN.(37) Makay 2007 et al enrolled newborns with a gestational age ≥ 35 weeks whose clinical condition precluded oral feeding for 3 days. The higher group, received 1.0 g/kg/day AA started within the first 8 hours and 1.0 g/kg/day lipid on day 2. The lower group received glucose 10% in the 1st day followed by glucose and electrolyte solution and added amino acids (0.5 g/kg/d) and lipid (0.5 g/kg/d) on day 3 and 4, respectively. In all infants, amino acids and lipid were each increased by 0.5 g/kg/day to a maximum of 3.0 g/kg/day in both groups. Primary outcome was serum bilirubin levels. Serum bilirubin level did not significantly differ between groups. A higher energy intake was achieved after the first day in early PN group.(38)

2022 Consensus remained the same as 2017 consensus: PN is widely used in Australian facilities in late preterm and term neonates who are not enterally fed. The consensus group followed the human milk approach to develop the PN formulations for this group and nutrient intake estimates are based on the average composition and intake of human milk.(39)

Cessation of PN

Amino acid/Dextrose infusion: There is no clear evidence to guide the practice. The risk of late onset sepsis with intravenous access and the cost of PN are to be considered. The 2015 consensus survey revealed that majority of the NICUs in ANZ cease AA/Dextrose formulation once the infant tolerates 120-140 ml/kg/day of enteral feeds.(40)

Lipids: Mature human milk contains 3.5 g of fat per 100 mL. 2015 consensus survey reported majority of NICUs cease IV lipids once the infant tolerates 100 -120 mL/kg/day of enteral feeds.(40)

Biochemical monitoring

High blood urea nitrogen, hyperglycaemia, metabolic acidosis, hypertriglyceridemia and conjugated hyperbilirubinemia are frequently encountered on PN. Periodic measurements of the following biochemical parameters are suggested during PN therapy.

Blood Urea Nitrogen (BUN): Six studies reported BUN levels.(6) The criteria for abnormal BUN in studies varied from >10 mmol/L to 21.4 mmol/L. There was a significant increase in abnormal BUN from higher AA intake in all these studies although a threshold level was not clear. Given the data supporting the importance of early AA administration in premature infants, limiting AA intake based on serum BUN alone is not warranted. BUN levels up to 14.3 mmol/L may be considered acceptable in VLBW infants on PN provided there are no other parameters to suggest protein intolerance (eg hyperammonaemia >122 µmol/L).(6)

Hyperglycaemia: It is not uncommon to see mild hyperglycaemia (>8.3 mmol/L). If blood glucose >10 mmol/L (moderate hyperglycaemia),(41, 42) further management to control hyperglycaemia needs to be considered including reducing glucose infusion rate (e.g. changing over to 7.5% Dextrose PN) or insulin infusion.

Cholestasis: Defined as serum level of direct bilirubin > 20% of total serum bilirubin or serum level of direct bilirubin > 34 mmol/L (mg/dL x 17.10).(43)

Hypoalbuminemia: Defined as serum albumin, preterm < 18 g/L in preterm and < 25 g/L in term neonates.(44)

Hypertriglyceridemia (HT) (Plasma triglyceride >2.8 mmol/L): ESPGHAN 2018 Guidelines recommend monitoring of triglycerides in preterm and term infants and suggest a triglyceride level of 2.8mmol/L as the upper limit.(11) 2015 Consensus survey revealed 62% of respondents monitor plasma triglyceride levels either routinely or in specific circumstances.(40) A retrospective study in an Australian NICU showed HT incidence of 32.5% in 23-25 weeks and 16.1% in 26-28 weeks. Severe HT (>4.5 mmol/L) was noted in 10% in 23-25 weeks and 4.5% in 26-28 weeks. There was no significant association of HT with either mortality or severe retinopathy of prematurity in multivariate analysis.(45)

Suggested routine PN biochemistry orders

Test	First 3-7 days	Thereafter
Electrolytes, BUN, HCO_3, Creatinine	Daily or as needed	Once or twice a week
Ca, P, Mg, albumin	D2,5 and 7	Once a week
Triglyceride	24 hours after each increase	Once a week or when sick
Blood glucose	4-6 hourly	Once or twice a day
Liver function test including alkaline phosphatase	As needed	Once weekly or fortnightly

PN in non-tertiary neonatal facilities

- Many non-tertiary nurseries manage moderate to late preterm and growth restricted term neonates often requiring partial parenteral nutrition while establishing enteral feeds.
- No clear cut guidelines can be drawn from the literature for this setting.
- The benefits of parenteral nutrition in this group need to be balanced against the potential risks of therapy, skill mix and the resource availability.
- Short term PN using peripheral preterm PN via peripheral cannula can be given for these infants if enteral feeding cannot be established by day 3-5 of life.

Appendix 1: Amino acid-dextrose Formulations

STARTER PN

1. For all preterm and term infants in the first 24-48 hours after birth.
2. Do not use at > 80ml/kg/day in the first 24 hours.
3. Recommended volume is ≤100 ml/kg/day.
4. Trace elements/1000 mL: 1 mL Paed TE + 1250 µg Zn

	STARTER PN (Baxter code: NIC-STARTER2)								
	per 1000mL	**mL/kg/day**							
		40	50	60	70	80	90	100	110
AA, g	37.5	1.5	1.9	2.3	2.6	3.0	3.4	3.8	4.1
Glucose, g	100	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
Na, mmol	34	1.4	1.7	2.0	2.4	2.7	3.1	3.4	3.7
K, mmol	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ca, mmol	14	0.6	0.7	0.8	1.0	1.1	1.3	1.4	1.5
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
P, mmol	17	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.9
Cl, mmol	7.1	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8
Acetate, mmol	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zn, µg	3250	130	162.5	195	227.5	260	292.5	325	357.5
Se, µg	30	1.2	1.5	1.8	2.1	2.4	2.7	3	3.3
I, µg	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1
Cu, µg	200	8	10	12	14	16	18	20	22
Heparin, units	500	20	25	30	35	40	45	50	55
Energy, kcal/kg	550	22	27.5	33	38.5	44	49.5	55	60.5
Osmolarity, mOsm/L	944	Alert - above maximal starter amino acid intake on day 1 of life							
pH	5.96	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.							
Volume, mL	500								

STARTER CONCENTRATED

1. For preterm infants on restricted PN and water intake in the first 24-48 hours.
2. Recommended volume is ≤60 ml/kg/day.
3. Trace elements/1000 mL: 1.0 mL Paed TE + 2250 µg Zn+5 mcg Iodide+100 mcg copper.

	STARTER CONCENTRATED PN (Baxter code: NIC-STARTCNC2)					
	per 1000 mL	**mL/kg/day**				
		40	50	60	70	80
AA, g	50	2.0	2.5	3.0	3.5	4.0
Glucose, g	125	5	6.25	7.5	8.8	10
Na, mmol	50	2	2.5	3	3.5	4
K, mmol	0	0.0	0.0	0.0	0.0	0.0
Ca, mmol	21	0.8	1.1	1.3	1.5	1.7
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1
P, mmol	25	1	1.25	1.5	1.75	2
Cl, mmol	9.5	0.4	0.5	0.6	0.7	0.8
Acetate, mmol	0	0.0	0.0	0.0	0.0	0.0
Zn, µg[$]	4250	170	212.5	255	297.5	340
Se, µg[$]	30	1.2	1.5	1.8	2.1	2.4
I, µg[$]	15	0.6	0.75	0.9	1.05	1.2
Cu, µg[$]	300	12	15	18	21	24
Heparin, units	500	20	25	30	35	40
Energy, kcal/kg	700	28	35	42	49	56
Osmolarity, mOsm/L	1226	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.				
pH	5.99					
Volume, mL	500					

STANDARD PRETERM

1. Standard solution for preterm infants after 24-48 h.
2. Recommended volume is ≤135ml/kg/day.
3. Trace elements/1000 mL: 1 mL Paed TE + 1267 µg Zn.

	STANDARD PRETERM PN (Baxter code:NIC-PRESTD2)													
	per 1000 mL	**mL/kg/day**												
		40	50	60	70	80	90	100	110	120	130	135	140	150
AA, g	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.1	4.2	4.5
Glucose, g	100	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	13.5	14.0	15.0
Na, mmol	40	1.6	2	2.4	2.8	3.2	3.6	4	4.4	4.8	5.2	5.4	5.6	6
K, mmol	22	0.9	1.1	1.3	1.5	1.8	2.0	2.2	2.4	2.6	2.9	3.0	3.1	3.3
Ca, mmol	20	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.8	3
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P, mmol	20	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.8	3
Cl, mmol	12.7	0.5	0.6	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.7	1.8	1.9
Acetate, mmol	15.1	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.0	2.1	2.3
Zn, µg	3267	131	163	196	229	261	294	327	359	392	425	441	457	490
Se, µg	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4	4.2	4.5
I, µg	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.4	1.5
Cu, µg	200	8	10	12	14	16	18	20	22	24	26	27	28	30
Heparin, units	500	20	25	30	35	40	45	50	55	60	65	67.5	70	75
Energy, kcal/kg	520	21	26	31	36	42	47	52	57	62	68	70	73	78
Osmolarity, mOsm/L	957	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.												
pH	6.21													
Volume, mL	750													

CONCENTRATED PRETERM

1. For preterm infants with restricted PN or water intake after 24-48 hours.
2. **Recommended volume is ≤100 ml/kg/day.**
3. Trace elements/1000 mL: 1.0 mL Paed TE + 2700 µg Zn + 5 µg Iodide + 100 µg copper.

	CONCENTRATED PRETERM (Baxter code: NIC-PRECONC2)								
	per 1000 mL	**mL/kg/day**							
		40	50	60	70	80	90	100	110
AA, g	40	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4
Glucose, g	125	5	6.25	7.5	8.8	10	11.3	12.5	13.8
Na, mmol	54	2.16	2.7	3.2	3.8	4.3	4.9	5.4	5.9
K, mmol	35	1.4	1.8	2.1	2.5	2.8	3.2	3.5	3.9
Ca, mmol	27	1.1	1.4	1.6	1.9	2.2	2.4	2.7	3.0
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
P, mmol	27	1.1	1.4	1.6	1.9	2.2	2.4	2.7	3.0
Cl, mmol	16.6	0.7	0.8	1.0	1.2	1.3	1.5	1.7	1.8
Acetate, mmol	26	1.0	1.3	1.6	1.8	2.1	2.3	2.6	2.9
Zn, µg	4700	188	235	282	329	376	423	470	517
Se, µg	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3
I, µg	15	0.6	0.75	0.9	1.05	1.2	1.35	1.5	1.65
Cu, µg	300	12	15	18	21	24	27	30	33
Heparin, units	500								
Energy, Kcal/kg	660	26	33	40	46	53	59	66	73
Osmolarity, mOsm/L	1242	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.							
pH	6.17								
Volume, mL	750								

HIGH SODIUM PRETERM

1. For preterm infants with hyponatraemia.
2. Contents are the same as standard preterm except Na at 8 mmol/kg/day at 135 ml/kg/day.
3. Recommended volume is ≤135 ml/kg/day.
4. Trace elements/1000 mL: 1.0 mL Paed TE + 1267 µg Zn.

	High sodium PRETERM PN (Baxter code: NIC-PRENA2)													
	per 1000 mL	**mL/kg/day**												
		40	50	60	70	80	90	100	110	120	130	135	140	150
AA, g	30	1.2	1.5	1.8	2.1	2.4	2.7	3	3.3	3.6	3.9	4.1	4.2	4.5
Glucose, g	100	4	5	6	7	8	9	10	11	12	13	13.5	14	15
Na, mmol	60	2.4	3	3.6	4.2	4.8	5.4	6	6.6	7.2	7.8	8.1	8.4	9
K, mmol	22	0.9	1.1	1.3	1.5	1.8	2.0	2.2	2.4	2.6	2.9	3.0	3.1	3.3
Ca, mmol	20	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.8	3
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P, mmol	20	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.8	3
Cl, mmol	21.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2	2.4	2.6	2.8	2.9	3.0	3.2
Acetate, mmol	26	1.0	1.3	1.6	1.8	2.1	2.3	2.6	2.9	3.1	3.4	3.5	3.6	3.9
Zn, µg	3267	131	163	196	229	261	294	327	359	392	425	441	457	490
Se, µg	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4	4.2	4.5
I, µg	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.4	1.5
Cu, µg	200	8	10	12	14	16	18	20	22	24	26	27	28	30
Heparin, units	500													
Energy, kcal/kg	520	21	26	31	36	42	47	52	57	62	68	70	73	78
Osmolarity, mOsm/L	997	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.												
pH	6.21													
Volume, mL	750													

7.5% GLUCOSE PRETERM

1. For hyperglycaemic preterm infants.
2. Contents are the same as standard preterm except 7.5% dextrose.
3. Recommended volume is ≤135 ml/kg/day.
4. Trace elements/1000 mL: 1.0 mL Paed TE + 1267 µg Zn

	7.5% glucose PRETERM (Baxter code: NIC-PRE7.5G2)													
	per 1000 mL	**mL/kg/day**												
		40	50	60	70	80	90	100	110	120	130	135	140	150
AA, g	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.1	4.2	4.5
Glucose, g	75	3	3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.1	10.5	11.3
Na, mmol	40	1.6	2	2.4	2.8	3.2	3.6	4	4.4	4.8	5.2	5.4	5.6	6
K, mmol	22	0.9	1.1	1.3	1.5	1.8	2.0	2.2	2.4	2.6	2.9	3.0	3.1	3.3
Ca, mmol	20	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.8	3
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P, mmol	20	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.8	3
Cl, mmol	12.7	0.5	0.6	0.8	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.7	1.8	1.9
Acetate, mmol	15.1	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.0	2.1	2.3
Zn, µg	3267	131	163	196	229	261	294	327	359	392	425	441	457	490
Se, µg	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4	4.2	4.5
I, µg	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.4	1.5
Cu, µg	200	8	10	12	14	16	18	20	22	24	26	27	28	30
Heparin, units	500													
Energy, kcal/kg	420	17	21	25	29	34	38	42	46	50	55	57	59	63
Osmolarity, mOsm/L	818	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.												
pH	6.22													
Volume, mL	750													

PERIPHERAL PRETERM

1. For preterm infants without central venous access.
2. Recommended volume is ≤135 ml/kg/day.
3. Trace elements/1000 mL: 1 mL Paed TE + 1267 µg Zn.

	Peripheral PRETERM PN (Baxter code: NIC-NPVL2)													
	per 1000 mL	**mL/kg/day**												
		40	50	60	70	80	90	100	110	120	130	135	140	150
AA, g	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.1	4.2	4.5
Glucose, g	100	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	13.5	14.0	15.0
Na, mmol	40	1.6	2	2.4	2.8	3.2	3.6	4	4.4	4.8	5.2	5.4	5.6	6
K, mmol	22	0.9	1.1	1.3	1.5	1.8	2.0	2.2	2.4	2.6	2.9	3.0	3.1	3.3
Ca, mmol	10	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.4
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P, mmol	10	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.4
Cl, mmol	21.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2	2.4	2.6	2.8	3.0	3.0	3.3
Acetate, mmol	26	1.0	1.3	1.6	1.8	2.1	2.3	2.6	2.9	3.1	3.4	3.5	3.6	3.9
Zn, µg	3267	131	163	196	229	261	294	327	359	392	425	441	457	490
Se, µg	30	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4	4.2	4.5
I, µg	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.4	1.5
Cu, µg	200	8	10	12	14	16	18	20	22	24	26	27	28	30
Heparin, units	500													
Energy, kcal/kg	520	21	26	31	36	42	47	52	57	62	68	70	73	78
Osmolarity, mOsm/L	919	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.												
pH	5.92													
Volume, mL	750													

34 WEEK TO TERM PN

1. For infants born ≥34 weeks.
2. Do not use at rates >135ml/kg/day.
3. Trace elements: 0.75 mL Paed TE + 396 µg Zn.

	34 week to term PN (Baxter code: NIC-TERM2)													
	per 1000 mL	**mL/kg/day**												
		40	50	60	70	80	90	100	110	120	130	135	140	150
AA, g	23	0.9	1.2	1.4	1.6	1.8	2.1	2.3	2.5	2.8	3.0	3.1	3.2	3.5
Glucose, g	100	4	5	6	7	8	9	10	11	12	13	13.5	14	15
Na, mmol	25	1	1.3	1.5	1.8	2	2.3	2.5	2.8	3.0	3.3	3.4	3.5	3.8
K, mmol	20	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.7	2.8	3.0
Ca, mmol	9	0.4	0.5	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4
Mg, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.15	0.2	0.2	0.2	0.2	0.2	0.2
P, mmol	9	0.4	0.5	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.4
Cl, mmol	22.9	0.9	1.1	1.4	1.6	1.8	2.1	2.3	2.5	2.7	3.0	3.1	3.2	3.4
Acetate, mmol	8.5	0.34	0.425	0.51	0.595	0.68	0.765	0.9	0.9	1.0	1.1	1.1	1.2	1.3
Zn, µg	1896	76	95	114	132	151	170	189	208	227	246	255	265	284
Se, µg	22.5	0.9	1.1	1.4	1.6	1.8	2.0	2.3	2.5	2.7	2.9	3.0	3.2	3.4
I, µg	7.5	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1
Cu, µg	150	6	7.5	9	11	12	14	15	17	18	20	20	21	23
Heparin, units	500	20	25	30	35	40	45	50	55	60	65	67.5	70	75
Energy, kcal/Kg	492	20	25	30	34	39	44	49	54	59	64	66	69	74
Osmolarity, mOsm/L	846	Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.												
pH	5.94													
Volume, mL	1200													

Appendix 2: Lipid Formulations

SMOFLipid formulation (Fresenius-Kabi)

Contents	45 mL syringe For ≤1 Kg	151 mL bag For >1 Kg
SMOFlipid 20%	32.5 mL	109 mL
Soluvit N	2.5 mL	8.4 mL
Vitalipid N Infant	10 mL	33.5 mL
FK code	FKS045V	FKCPLV1
Stability	13 days at 2-8^{0}C	12 days at 2-8^{0}C

ClinOleic formulation

Contents	45 mL syringe For ≤1 kg	90 mL bag For >1 to ≤2 Kg	150 mL bag For >2 kg
ClinOleic	32.5 mL	65 mL	108 mL
Soluvit N	2.5 mL	5 mL	8.4 mL
Vitalipid N Infant	10 mL	20 mL	33.6 mL

Appendix 3: Preterm neonates - 2022 consensus formulations and ESPGHAN 2018 recommendations

Unit/kg/day	ESPGHAN 2018 Day 0	ESPGHAN 2018 Growing	Australasian 2022 consensus: 135 mL/kg/day of standard preterm and 3 g/kg/day of lipid formulation
Energy, Kcal	45-55	90-120	97
Protein, g	≥1.5	≤3.5	4.05 g
Carbohydrate, g	5.8-11.5	5.8-17.3	13.5 g
Fat, g	0-1	3-4	3
Na, mmol	0-2	3-5	5.4
K, mmol	0-3	2-5	3
Cl, mmol	0-3	3-5	1.7
Acetate, mmol			2.0
Ca, mmol	0.8-2.0	1.6-3.5	2.7
P, mmol	1.0-2.0	1.6-3.5	2.7
Ca:P ratio	0.8:1.0	1:1	1:1
Mg, mmol	0.2	0.2	0.2
Iron, µg	0	50-200	-
Zn, µg[$]	400-500	400-500	441
Cu, µg[$]	40	40	27
Se, µg[$]	7	7	6 µg
I, µg[$]	1-10	1-10	1.4 µg
Cr, µg	0	0	-
Mo, µg	1 Long term PN	1 Long term PN	-
Mn, µg	<1 Long term PN	<1 Long term PN	-
Vit A, IU	700-1500	700-1500	920
Vit D, IU	80-400	80-400	160
Vit E, IU	2.8-3.5	2.8-3.5	2.8
Vit K, µg	10	10	80[#]
Thiamine, µg	350-500	350-500	310
Riboflavin, µg	150-200	150-200	360[#]
Niacin, mg	4.0-6.8	4.0-6.8	4
Pyridoxine, µg	150-200	150-200	400[#]
Folate, µg	56	56	40[*]
Vit B12, µg	0.3	0.3	0.5[#]
Pantothenate, mg	2.5	2.5	1.5[*]
Biotin, µg	5-8	5-8	6
Vit C, mg	15-25	15-25	10[*]
Acetate, mmol			3.51

[*]Below Recommended dietary intake (RDI), #Above RDI. $TE intakes are achieved by adding 1 mL Baxter paediatric TE formula with additional 1270 µg Zn and 15 µg Se in 1 Litre.

Appendix 4: Term neonates - 2022 consensus formulations and ESPGHAN 2018 recommendations

Nutrient, Unit/kg/day	ESPGHAN 2018			Australasian 2022 consensus: 135 mL/kg/day of 34 week-Term PN and 3 g/kg/day of lipid formulation
	Day 0	≤30 days	1-12 months	
Energy, Kcal		90-100	90-100	93
Protein, g	≥1.5	≤3.0	1.0-2.5	3.1
Carbohydrate, g	3.6-7.2	3.6-17.3	8.6-14	16.2
Fat, g		3.0-4.0	3.0-4.0	3
Sodium, mmol	0-3.0 (0-7days)	2.0-5.0	2.0-3.0	3.4
Potassium, mmol	0-2.0 (0-7days)	1.0-3.0	1.0-3.0	2.7
Chloride, mmol	0-5.0 (0-7days)			3.1
Calcium, mmol	0.8	0.8		1.2
Phosphate, mmol	0.5	0.5		1.2
Magnesium, mmol	0.2	0.2	0.2-0.3	0.2
Iron, µmol	0	0(<3 weeks)	1.8-3.6	0
Zn, µg	250	250	100 (>3 months)	257
Cu, µg	20	20	20	20.3
Se, µg	2-3	2-3	2-3	3.0
I, µg	≥1	≥1	≥1	1.0
Cr, µg	0	0	0	
Mo, µg	0.25 Long term PN	0.25 Long term PN	0.25 Long term PN	0
Mn, µg	<1 Long term PN	<1 Long term PN	<1 Long term PN	0
Vit A, IU	462-989	462-989	462-989	920
Vit D, IU	40-150	40-150	40-150	160
Vit E, IU	2.8-3.5	2.8-3.5	2.8-3.5	2.8
Vit K, µg	10	10	10	80#
Thiamine, µg	350-500	350-500	350-500	310
Riboflavin, µg	150-200	150-200	150-200	360#
Niacin, mg	4.0-6.8	4.0-6.8	4.0-6.8	4
Pyridoxine, µg	150-200	150-200	150-200	400#
Folate, µg	56	56	56	40*
Vit B12, µg	0.3	0.3	0.3	0.5#
Pantothenate, mg	2.5	2.5	2.5	1.5*
Biotin, µg	5-8	5-8	5-8	6
Vit C, mg	15-25	15-25	15-25	10*

*Below Recommended dietary intake (RDI), #Above RDI. $TE intakes are achieved by adding 0.75 mL Baxter paediatric TE formula with additional 400 µg Zn in 1 Litre.

Baxter Compounding

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CONSENSUS NEONATAL TAILORED PARENTERAL NUTRITION (PN) ORDER FORM

Complete form and fax to Baxter Compounding: **1800 025 887** or email to **pharmacyservices@baxter.com** before 10.30am (Mon - Fri)

Weight for calculation of PN: _____kg No. of bags required: ___ Hang time (please circle): 24hrs / 48hrs

Date: _____ **Contact Person:** _____ **Phone Number:** _____

Ordering Hospital: _____ **Purchase Order Number:** _____

Prescriber Signature: _____

Item	**Amount/kg/day** (Medical Officer to Complete)	**Examples of Daily Intakes from 2022 Standard Solutions @ 135 mL/kg/day**	
Fluid	mL/kg/day	Standard Preterm	34 week to term
Amino Acid (Primene)	g/kg/day	4.1g/kg/day	3.1g/kg/day
Glucose	5% / 7.5% / 10% / 12.5% Other (specify): _____	10%	10%
Sodium	mmol/kg/day	5.4 mmol/kg/day	3.1 mmol/kg/day
Potassium	mmol/kg/day	3.0 mmol/kg/day	2.7 mmol/kg/day
Calcium	mmol/kg/day	2.7 mmol/kg/day	1.2 mmol/kg/day
Magnesium	mmol/kg/day	0.2 mmol/kg/day	0.2 mmol/kg/day
Phosphate (circle): Organic / Inorganic	mmol/kg/day	2.7 mmol/kg/day	1.2 mmol/kg/day
Acetate	mmol/kg/day	2.0 mmol/kg/day	1.1 mmol/kg/day
Zinc (as single TE)	microgram/kg/day	441 microgram/kg/day	255.9 microgram/kg/day
Selenium (as single TE)	microgram/kg/day	4.05 microgram/kg/day	3.04 microgram/kg/day
Iodide (as single TE)	microgram/kg/day	1.4 microgram/kg/day	1.01 microgram/kg/day
Copper (as single TE)	microgram/kg/day	27 microgram/kg/day	20.3 microgram/kg/day
Heparin	Units/mL	0.5 Units/mL	0.5 Units/mL
Additional Notes:			

This form Is based on NIC consensus group standard formulations.
Changes to these formulations by agreement only with Baxter Compounding

NIC Daily Order v5: Issued 27Apr 22

Baxter Internal Use:	*Use DT codes: DTE-NIC-A/DTE-NICP-A, DT-NIC-A/DT-NICP-A as applicable per order*

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