Royal Hospital for Women (RHW)
NEONATAL BUSINESS RULE
COVER SHEET

Health
South Eastern Sydney
Local Health District

Ref: T24/68619

NAME OF DOCUMENT	Newborn Parenteral Nutrition
TYPE OF DOCUMENT	Clinical Business Rule
DOCUMENT NUMBER	RHW CLIN091
DATE OF PUBLICATION	14 October 2024
RISK RATING	Medium
REVIEW DATE	October 2027
FORMER REFERENCE(S)	Parenteral Nutrition in NICU
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SUMMARY	To provide guidelines on newborn Parenteral Nutrition (PN) for preterm infants <32 weeks and/or <1500g; infants with high risk of necrotising enterocolitis (NEC); and those infants in whom establishment of enteral feeding is thought to be delayed by 3-5 days.
Key Words	Parenteral nutrition, newborn, neonate, fluid, electrolytes, infant

Contents

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Within this document we will use the term woman, this is not to exclude those who give birth and do not identify as female. It is crucial to use the preferred language and terminology as described and guided by each individual person when providing care.

1 BACKGROUND

Parenteral nutrition (PN) is an essential component in the management of newborn infants in Newborn Intensive Care Units (NICUs).

Royal Hospital for Women (RHW) NICU PN guidelines are based on the Australasian PN consensus group recommendations.

PN is associated with risks and clinical judgement is required to balance the benefits and risks.

These PN guidelines do not account for every variation in the clinical circumstance. The clinical judgement of the health professional must take precedence in every case.

2 RESPONSIBILITIES

2.1 Staff

2.1.1 Medical – to identify neonates that may require PN and to prescribe the correct formulation on eRIC. To monitor electrolytes and other blood tests while a neonate is receiving PN.

2.1.2 Nursing – to administer PN to neonates, to perform necessary blood tests, to change PN as appropriate based on medical orders.

3 PROCEDURE

3.1 Indications

•Preterm neonates <32 weeks and/or <1500 g

•Neonates at high risk of Necrotising Enterocolitis (NEC)

•Neonates in whom establishment of enteral feeding is anticipated to be delayed by 3-5 days.

3.2 Key Points

3.2.1 There are 9 Amino acid (AA)/dextrose formulations (see Appendix 1).

PN Formulations	Rate	Amino Acid	Sodium
Starter PN	60mL/kg/day	2g/kg/day	2mmol/kg/day
Standard Concentrated	40mL/kg/day	2g/kg/day	2mmol/kg/day
Standard Preterm	135mL/kg/day	4g/kg/day	5.4mmol/kg/day
Preterm Concentrated	100mL/kg/day	4g/kg/day	5.4mmol/kg/day
High Sodium Preterm	135mL/kg/day	4.1g/kg/day	8mmol/kg/day
7.5% glucose preterm	135mL/kg/day	4.1g/kg/day	5.4mmol/Kg/day
5% glucose preterm	135mL/kg/day	4.1g/kg/day	5.4mmol/kg/day
Peripheral Preterm	135mL/kg/day	4.1g/kg/day	5.4mmol/kg/day
34week-Term	135mL/kg/day	3g/kg/day	3,4mmol/kg/day

• 7.5% glucose preterm formulation provides 7.5% glucose.

• 5% glucose preterm formulation provides 5% glucose.

3.2.2 Calcium and Potassium contents in the formulations:

- Starter: At 60 mL/kg/day provides Calcium and Phosphorus of 0.8 and 1 mmol/kg/day at 0.8:1 ratio.
- Standard preterm: At 135 mL/kg/day provides Calcium and Phosphorus of 2.7 mmol/kg/day each at 1:1 ratio.
- 34 wk- Term: At 135 mL/kg/day provides Calcium and Phosphorus of 1.2 mmol/kg/day each at 1:1 ratio.
- Peripheral preterm: Calcium (Ca) and phosphorus (P) contents are 50% of standard preterm.
- Trace elements are added in the form of Paediatric Trace element formula (Paed TE) plus additional zinc (Zn) and selenium (Se). Formulations also contain copper (Cu)

3.3 Equipment

- Appropriate PN solution

3.4 Clinical Practice

3.4.1 Energy

- The current 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.
- For calculation of energy intake, 1 g of amino acid and 1 g of glucose are considered to provide 4 kcal, and 1 g of lipid is considered to provide 9 kcal.

3.4.2 Fluids

- The current 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 infants on restricted fluid regimen, or unwell babies requiring infusions of inotropes and opioid analgesics, concentrated PN formulations can be used.

3.4.3 Amino acids

- The current Consensus:
  - Start parenteral AA within the first 24 hours of birth at 2 g/kg/day of AA,
  - Incrementally increase infusions over 3-5 days to 4 g/kg/day of AA.
- This is in line with The European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) 2018 recommendation of maximum 3.5 g/kg/day of AA and National Institute for Health and Care Excellence (NICE) 2020 recommendations of maximum 4 g/kg/day.
- The consensus group acknowledged that the actual intake of AA using the consensus formulations average around 3.5 g/kg/day.[7]

3.4.4 Carbohydrates

- The current consensus PN formulations contain 10% dextrose providing 9.4 mg/kg/min (13.5 g/kg/day) at 135 ml/kg/day.

3.4.5 Lipids

- The current Consensus is to commence Intravenous Lipid Emulsion (IVLE) on day 1 of PN administration.
- The current consensus is to commence at 1-2 g/kg/day and increase by 1 g/kg each day to 3 g/kg/day.
- The current consensus lipid formulation is SMOF lipid (Soy Oil, MCT Oil, Olive Oil, Fish Oil Mixture).
- The consensus IVLE formulations are designed to deliver:
  - 1 g/kg/day at 6 ml/kg/day
  - 2 g/kg/day at 12 ml/kg/day

- 3 g/kg/day at 18 ml/kg/day

• The contents of the consensus IVLE formulations are listed in Appendix 2.

3.4.6 Sodium, Potassium, Chloride and Acetate

- The consensus formulations provide potassium 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 week-Term formulation at 135 mL/kg/day: 2.7 mmol/kg/day.
- The current 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.

3.4.7 Calcium , phosphorus and magnesium

• The current consensus formulations provide the following Calcium and Phosphorus intakes:

PN Formulation	Rate	Calcium	Phosphorus	Calcium: Phosphorus Ratio
Starter	60mL/kg/day	0.8mmol/kg/day	1mmol/kg/day	0.8:1.0
Standard Preterm	135mL/kg/day	2.7mmol/kg/day	2.7mmol/kg/day	1:1
34 week-Term	135mL/kg/day			

• Starter at 60 mL/kg/day: Calcium 0.8 mmol/kg/day, Phosphorus 1.0 mmol/kg/day and Calcium:Phosphorus ratio 0.8:1.0.

• Standard preterm at 135 mL/kg/day: Calcium 2.7 mmol/kg/day, Phosphorus 2.7 mmol/kg/day and ratio 1:1.

• 34 wk-Term at 135 mL/kg/day: Calcium 1.2 mmol/kg/day, Phosphorus 1.2 mmol/kg/day and ratio 1:1.

• Magmesium: The consensus formulations provide 0.2 mmol/kg/day of Magnesium.

3.4.9 Trace Elements (TE)

• The current consensus is to use the new Baxter trace element formula as the preferred Trace Elements formula and add extra Zinc and Selenium to optimise intakes. (Refer to Appendices 1, 3 and 4).

3.4.10 Heparin

• The consensus AA/Dextrose formulations have heparin 0.5 IU/mL of heparin.

3.4.11 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.

3.4.12 Hanging time

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

3.4.13 Route of administration

- Consensus: 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.

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

- The current 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]

3.4.15 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]

3.4.16 PN in non-tertiary neonatal facilities

• Many non-tertiary nurseries manage moderate to late preterm and growth restricted term neonates often requiring partial PN. No clearcut guidelines can be drawn from the literature for this setting.

• The benefits of PN in this group need to be balanced against the potential risks of therapy, skill mix and the resource availability.

• Short term PN via peripheral cannula can be given for these infants if enteral feeding cannot be established by day 3-5 of life.

3.5 Documentation

- eRIC

3.6 Education Notes

3.6.1 Energy

- 1 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]

3.6.2. Fluids

- Restricted fluid intake is significantly associated with reduced risks of patent ductus arteriosus and NEC.[3] (LOE 1, GOR B) Restricted fluid intake was also associated with a non-significant trend towards reduced risk of bronchopulmonary dysplasia, intracranial haemorrhage, and death.[3]

3.6.3 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 mortality. There was insufficient evidence on neurodevelopment. There was no noticeable beneficial on mortality or neurodevelopment 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 and days to regain birth weight. Higher AA intake was not associated with an effect on days to full enteral feeds, late onset sepsis, NEC, 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]

3.6.4 Carbohydrates

- Carbohydrates are to provide 40-60% of total energy.[8]
- Maximal glucose oxidation in preterm and term infants is 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)
    - Term neonates – 5-10 mg/kg/min (7.2-14.4 g/kg/day).

- NICE 2020 recommendation from day 4 onwards:
    - 6-11 mg/kg/min (9-16 g/kg/day) for both preterm and term infants

3.6.5 Lipids

- Two systematic reviews found no significant benefit on growth. But there are also no side effects.[9,10]
- A number of trials have been published with variable biochemical and clinical benefits reported among lipid emulsions in newborn infants.[11-14]
- Essential fatty acid (EFA) deficiency can occur rapidly, but can be prevented with 0.5 to 1 g/kg/day of IVLE.[9]
- There is no evidence that gradual increments in IVLE improve fat tolerance.[11] Starting dose 1 g/kg/day was safely tolerated in most clinical trials.

3.6.6 Sodium (Na), Potassium (K), Chloride (Cl) and Acetate

- Traditional guidelines suggest addition of sodium from 2nd or 3rd day of life. However, sodium wasting due to renal immaturity is common in extremely preterm infants and inadequate sodium intakes are associated with postnatal growth failure. Higher early Na intake may be associated with early hypernatraemia and increased oxygen requirements. Subsequent higher sodium intake may reduce the incidence of hyponatraemia.[15-18]
- The current starter PN formulation has organic phosphorus [sodium glycerophosphate which contains 2 mmol sodium per 1 mmol of Phosphorus]. Given the current recommended intake of Phosphorus on day 1 of life is about 1 mmol/kg/day, the starter formulation provides 2 mmol/kg/day of sodium on day 1 of life.
- Standard preterm and term formulations provide sodium 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.
- Hyperchloraemia (>115 mmol/L) is common in Very Low Birth Weight (VLBW) infants on PN and is associated with hyperchloremic acidosis. ESPGHAN 2018 recommend “Chloride-free” sodium and potassium solutions in preterm infants on Parenteral Nutrition 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 PN solution in preterm neonates. In a double blind randomised controlled trial, Ali et al compared the 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 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 Na (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 Bronchopulmonary Dysplasia in the acetate group. The occurrence of severe Iintraventricular Haemorrhage was also lower but did not reach statistical significance.[21] The current 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.

3.6.7 Calcium , Phosphorus and magnesium

- 1 mmol of Calcium equates to 40 mg calcium
- 1 mmol of Phosphorus equates to 31 mg Phosphorus.
- 1:1 Calcium:Phosphate molar ratio is equal to 1.3: 1 weight (mg) ratio.
- Extremely Low Birth Weight (ELBW) infants are at increased risk of developing refeeding syndrome with hypokalemia, hypophosphataemia and hypercalcemia with early aggressive amino acid intake without optimal Calcium and Phosphorus 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 Calcium and 1-2 mmol/kg/day of Phosphorus with Calcium:Phosphorus ratio of 0.8:1.0

(2) In growing preterm: 1.6-3.5 mmol/kg/day of Calcium and 1.6-3.5 mmol/kg/day of Phosphorus with a Calcium:Phosphorus ratio of 1:1.[22]

- NICE 2020 recommendations for preterm and term infants: (1) Calcium:Phosphorus ratio of 0.75:1 in the first 48 hours of life and 1:1 after 48 hours of life; (2) Calcium in the first 48 hours: 0.8-1 mmol/kg/day and after 48 hours of life 1.5-2 mmol/kg/day; (3) Phosphorus in the first 48 hours: 1 mmol/kg/day and after 48 hours of life 2 mmol/kg/day.[2]
- Magnesium: A minimum Magnesium intake of 0.2 mmol/kg/day and maximum 0.3 mmol/kg/day is considered appropriate for LBW infants.[22]

3.6.8 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 Appendix 4 (Term neonate) show 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 microg/day for infants <1000 g and 130 microg/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]

3.6.9 Trace elements (TE)

- Appendix 3 (preterm neonate) and Appendix 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.
- Recommended Parenteral Zinc:
    - 400-500microg/kg/day for Premature Infants
    - 250microg/kg/day for Term Infants[26]
- Copper: While there are case reports of copper deficiency associated with osteoporosis, neutropenia, anaemia, oedema, poor growth, apnoea, 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] Copper is a pro-oxidant and the Australian expert review suggested 15-20 microg/kg/day is adequate in PN to prevent copper deficiency.[28] Serum Copper and ceruloplasmin concentrations seem to have no relationship to intake, and reference ranges are poor and of little value.[28] Copper should be carefully monitored in patients with cholestatic liver disease.[26] The current consensus standard preterm formulation with 1 mL Paed Trace Element provides 27 microg/kg/day of Copper.

- Selenium: Selenium supply of up to 7 microgg/kg/day in preterm infants and 2-3 microgg/kg/day in term infants is currently recommended for parenterally fed Low Birth Weight (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 microg/kg/day in preterm infants at 135 mL/kg/day.
- Iodine (I): The recommended parenteral intake is currently 1-10 microgg/kg/day in preterm infants 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

Trace Element	**1 mL**
Zinc,	2000microg
Copper,	200microg
Selenium,	30 microg
Iodine,	10 microg

3.6.10 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.

3.6.11 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]

3.6.12 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.

3.6.13 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 surgical neonates 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. 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 amino acids (0.5 g/kg/d) and lipid (0.5 g/kg/d) on day 3 and 4, respectively. In both groups, AA and lipid were increased by 0.5 g/kg/day to a maximum of 3.0 g/kg/day. 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]

3.6.14 Biochemical monitoring

- High blood urea nitrogen (BUN), hyperglycaemia, metabolic acidosis, hypertriglyceridemia and conjugated hyperbilirubinemia are frequently encountered on PN. Periodic measurements of the following biochemical parameters are suggested during PN therapy.
- 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 >3.0 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, Bicarbonate (HCO_3), Creatinine	Daily or as needed	Once or twice a week
Calcium, Phosphorus, Magnesium, 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

3.7 Abbreviations

PN	Parenteral Nutrition	NEC	Necrotising Enterocolitis
NICUs	Newborn Intensive Care Units	RHW	Royal Hospital for Women
AA	Amino Acid	Na	Sodium
Ca	Calcium	P	Phosphorus
Paed TE	Paediatric Trace Elements	ESPGHAN	The European Society for Paediatric Gastroenterology Hepatology and Nutrition
NICE	National Institute for Health and Care Excellence	IVLE	Intravenous Lipid Emulsion
SMOF Lipid	Soy Oil, MCT Oil, Olive Oil, Fish Oil Mixture	TE	Trace Elements
EFA	Essential Fatty Acids	VLBW	Very Low Birth Weight
pH	Potential of Hydrogen	ELBW	Extremely Low Birth Weight
LBW	Low Birth Weight	BUN	Blood, Urea, Nitrogen

HT	Hypertriglyceridemia	HCO_3	Bicarbonate

3.8 CBR Implementation Plan

The revised CBR will be distributed to all medical, nursing and midwifery staff via @health email. The CBR will be discussed at ward meetings, education and patient quality and safety meetings. Education will occur through in-services, open forum and local ward implementation strategies to address changes to practice. The staff are asked to respond to an email or sign an audit sheet in their clinical area to acknowledge they have read and understood the revised CBR. The CBR will be uploaded to the CBR tab on the intranet and staff are informed how to access

3.9 Related Policies/procedures

- RHW NCC Medical CBR- Enteral Nutrition - human milk fortification - preparation
- RHW NCC Medical CBR - Enteral Nutrition - preterm infants 1000g and under
- RHW NCC Medical CBR - Enteral Nutrition - preterm infants 1001-1500g
- RHW NCC Medical CBR - Enteral Nutrition - preterm infants 1501-1800g
- RHW NCC Medical CBR - Enteral Nutrition - infants greater than 1800g
- RHW NCC Nursing - Total Parenteral Nutrition - Infusion Line Change

3.10 References

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4 ABORIGINAL HEALTH IMPACT STATEMENT DOCUMENTATION

- Considerations for culturally safe and appropriate care provision have been made in the development of this Business Rule and will be accounted for in its implementation.
- When clinical risks are identified for an Aboriginal and/or Torres Strait Islander woman or family, they may require additional supports. This may include Aboriginal health professionals such as Aboriginal liaison officers, health workers or other culturally specific services

5 CULTURAL SUPPORT

- For a Culturally and Linguistically Diverse CALD woman, notify the nominated cross-cultural health worker during Monday to Friday business hours
- If the woman is from a non-English speaking background, call the interpreter service: NSW Ministry of Health Policy Directive PD2017 044-Interpreters Standard Procedures for Working with Health Care Interpreters.

6 NATIONAL STANDARDS

- Standard 1 Clinical Governance
- Standard 3 Preventing and Controlling Infections
- Standard 4 Medication Safety
- Standard 5 Comprehensive Care
- Standard 8 Recognising and Responding to Acute Deterioration

7 REVISION AND APPROVAL HISTORY

Date	Revision No.	Author and Approval
9.12.2015	1	S Bolisetty (Neonatologist), RHW Newborn Care Local Operating procedures committee, RHW Patent safety and quality committee
28.2.2018	2	S Bolisetty (Neonatologist), RHW Newborn Care Local Operating procedures committee, RHW Patent safety and quality committee
18.2.2019	3	S Bolisetty (Neonatologist), RHW Newborn Care Local Operating procedures committee, RHW Patent safety and quality committee
1.5.2022	4	S Bolisetty (Neonatologist), RHW Newborn Care Local Operating procedures committee, RHW Patent safety and quality committee
11.6.2024	5	S Bolisetty (Neonatologist)
23.9.24	5	Endorsed RHW BRGC

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 bag: 1 mL Paed TE + 1250 µg Zinc as extra.

	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
Sodium, mmol	34	1.4	1.7	2.0	2.4	2.7	3.1	3.4	3.7
Potassium, mmol	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calcium, mmol	14	0.6	0.7	0.8	1.0	1.1	1.3	1.4	1.5
Magnesium, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Phosphorus, mmol	17	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.9
Chloride, 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
Zinc, microg	3250	130	162.5	195	227.5	260	292.5	325	357.5
Selenium, microgg	30	1.2	1.5	1.8	2.1	2.4	2.7	3	3.3
Iodine, microg	10	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1
Copper, microg	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 Stability: up to 61 days @ 2-8^{O}C and 5 days at below 25^{O}C.							
pH	5.96								
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 bag: 1.0 mL Paed TE + 2250 microg Zinc+5 microg Iodide+100 microg 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
Sodium, mmol	50	2	2.5	3	3.5	4
Potassium, mmol	0	0.0	0.0	0.0	0.0	0.0
Calcium, mmol	21	0.8	1.1	1.3	1.5	1.7
Magnesium, mmol	1.5	0.1	0.1	0.1	0.1	0.1
Phosphorus, 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, microg$	4250	170	212.5	255	297.5	340
Se, microg$	30	1.2	1.5	1.8	2.1	2.4
I, microg$	15	0.6	0.75	0.9	1.05	1.2
Cu, microg$	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 bag: 1 mL Paed TE + 1267 µg Zinc as extra.

	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 bag: 1.0 mL Paed TE + 2700 µg Zinc + 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 neonates 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 bag: 1.0 mL Paed TE + 1267 µg Zinc as extra.

	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 neonates.
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 bag: 1.0 mL Paed TE + 1267 µg Zinc as extra.

	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													

5% GLUCOSE PRETERM

1.For hyperglycaemic preterm neonates.
2. Contents are the same as standard preterm except 5% dextrose.
3. Recommended volume is ≤135 ml/kg/day.
4.Trace elements/1000 mL bag: 1.0 mL Paed TE + 1267 µg Zinc as extra

	5% glucose PRETERM (Baxter code: NIC-PRE5G2)													
	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	50	2	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	6.7	7	7.5
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	320	13	16	19	22	26	29	32	35	38	42	43	45	48
Osmolarity, mOsm/L	680	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 neonates 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 neonates 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

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.

Newborn Parenteral Nutrition

RHW CLIN091

Baxter Compounding

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PLEASE ATTACH PATIENT

STICKER HERE

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*

Baxter

ANZ Neonatal Consensus Group PN Solutions

Content (per 1000mL)	Starter PN	Starter PN Concentrated	Standard Preterm PN	Concentrated Preterm PN	High Sodium PN	5% Glucose Preterm PN	7.5% Glucose Preterm PN	Peripheral Preterm PN	34 weeks to term PN
Ordering Code	NIC-STARTER2	NIC-STARTCNC2	NIC-PRESTD2	NIC-PRECONC2	NIC-PRENA2	NIC-PRE5G2	NIC-PRE7.5G2	NIC-NPVL2	NIC-TERM2
Amino Acid (as Primene) (g)	37.5	50	30	40	30	30	30	30	23
Glucose (g)	100	125	100	125	100	50	75	100	100
Sodium (mmol)	34	50	40	54	60	40	40	40	25
Potassium (mmol)	0	0	22	35	22	22	22	22	20
Magnesium (mmol)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Calcium (mmol)	14	21	20	27	20	20	20	10	9
Chloride (mmol)	7.1	9.5	12.7	16.6	21.7	12.7	12.7	21.7	22.9
Phosphate (mmol)	17	25	20	27	20	20	20	10	9
Acetate (mmol)	0	0	15.1	26	26	15.1	15.1	26	8.5
Paediatric Trace Elements	1 mL	1 mL	1 mL	1 mL	1 mL	1 mL	1 mL	1 mL	0.75 mL
Zinc (as single TE) (microgram)[1]	1250	2250	1267	2700	1267	1267	1267	1267	396
Copper (as single TE) (microgram)[1]		100		100					
Iodide (as single TE) (microgram)[1]		5		5					
Heparin (units)	500	500	500	500	500	500	500	500	500
Total Trace Element content (Paediatric TE + Single TE additions) *please note total Trace Elements are not listed individually on the label*									
Zinc (microgram)	3250	4250	3267	4700	3267	3267	3267	3267	1896
Copper (microgram)	200	300	200	300	200	200	200	200	150
Selenium (microgram)	30	30	30	30	30	30	30	30	22.5
Iodide (microgram)	10	15	10	15	10	10	10	10	7.5
Osmolarity (mOsmol/L) [2]	944	1226	957	1242	997	680	818	919	846
Total kJoules (kJoules/L)	2230	2840	2102	2670	2102	1306	1704	2102	1983
Total kCal (kCal/L)	530	675	500	635	500	310	405	500	472
Total volume (mL)	500	500	750	750	750	750	750	750	1200
Expiry (stored at 2-8°C)	61 days includes 96 hours at below 25°C								

[1] Doses are rounded due to small volumes
[2] Calculated from theoretical basis

Prepared by Baxter Compounding / Effective Date: May 2024