

Local Guideline



Parenteral Nutrition in NICU

Sites where Local Guideline applies	Neonatal Intensive Care Unit JHCH
This Local Guideline applies to:	
1. Adults	No
2. Children up to 16 years	No
3. Neonates – less than 29 days	Yes
Target audience	Clinicians ordering and administering parenteral nutrition to infants in NICU
Description	Provides guidance to ordering and the management of infants receiving parenteral nutrition in NICU
National Standard	Standard 4 Medication Safety

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Keywords	amino acids, calories, central line, lipids, nutrition, PN (Parenteral Nutrition)
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Replaces existing document?	Yes
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Related Legislation, Australian Standard, NSW Ministry of Health Policy Directive or Guideline, National Safety and Quality Health Service Standard (NSQHSS) and/or other, HNE Health Document, Professional Guideline, Code of Practice or Ethics:	
<ul style="list-style-type: none"> • Aseptic Technique for medium or Higher Risk Procedures Conducted in Clinical Settings • NSW health Policy Directive PD 2017_013 Infection Control and prevention Policy • NSW Health Policy Directive PD2017_032 Clinical Procedure Safety • Medication Safety in HNE Health PD2013_043:PCP31 	
Prerequisites (if required)	Current prescription / fluid order
Local Guideline note	This document reflects what is currently regarded as safe and appropriate practice. The guideline section does not replace the need for the application of clinical judgment in respect to each individual patient but the procedure/s require mandatory compliance . If staff believe that the procedure/s should not apply in a particular clinical situation they must seek advice from their unit manager/delegate and document the variance in the patients' health record.
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PURPOSE AND RISKS

This local clinical guideline has been developed to provide instruction to the health clinician and to ensure that the risks of harm to the infant associated with ordering & administration of Parenteral Nutrition are prevented, identified and managed.

The risks are:

- *hypoglycaemia*
- *electrolyte imbalance*
- *chemical burns if IV extravasation occurs*

The risks are minimised by:

- *Clinicians having knowledge of parenteral nutrition ordering and management of intravenous access lines*
- *Clinicians seeking assistance if caring for infants is outside their scope of practice*
- *Following the instructions set out in the local guideline*
- *Recognition of the common clinical signs of the complications of Parenteral Nutrition delivery*
- *Notification and management of the complications/ risks to the patient*

Risk Category: *Clinical Care & Patient Safety*

GLOSSARY

Acronym or Term	Definition
CXR	Chest X-ray
IV	Intravenous
NICU	Neonatal Intensive care
PICC	Peripherally inserted Central catheter
PN	Parenteral Nutrition

Parenteral Nutrition - One Page Summary and Checklist

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Rationale

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To provide parenteral nutrition (PN) that meets current recommended daily intakes of nutrients in a safe manner to optimise growth and development for infants unable to receive adequate nutrition from enteral feeds.

Outcomes

1. PN (amino acid-glucose solution + Lipid emulsion) and or IV fluids will be administered to the infant for the period of time required to establish adequate enteral intake.
2. All precautions will be taken to ensure the safe administration of PN and fluids to prevent contamination of fluids and lines as well as ensuring patency and preservation of lines in situ.
3. Appropriate checking of solutions and identification of infants to ensure correct PN and fluid administration are completed with accurate documentation on fluid order sheet.

Individual patient circumstances may mean that practice has to diverge from this guideline.

Background

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- parenteral nutrition is an essential component in the management of many newborn infants, particularly premature low birth weight infants admitted to Newborn Intensive Care Units (NICUs).
- In NSW the Neonatal TPN Group has developed standardised PN solutions. The group has achieved consensus upon a total of 8 amino acid-glucose solutions and 1 lipid emulsion.

Scope

This guideline focuses on the practical aspects of PN prescription and practice in the NICU.

Patients

Neonates admitted to NICU

Clinical practice

Consider the following issues:

- Venous access and administration
- Which babies require PN and when to start?
- What and how much to administer?
- Types of aminoacid-glucose solutions
- Lipid emulsion administration
- Hanging time
- What monitoring is needed?
- When to cease lipids and aminoacid-glucose solutions?

Venous access options

Umbilical catheters

In neonates, umbilical vein can be used for administration of PN. The risk of complications may increase if the umbilical venous catheter is left in situ for more than 14 days. In our unit, we aim to have catheters removed by 7 days, longer use will be at the discretion of the attending neonatologist.

Central catheters

Peripherally inserted central catheter (PICC) should be preferentially used to provide central venous access in neonates receiving PN as PICC use results in improved nutrient intake and fewer peripheral venous cannulation attempts.

Peripheral cannula

Peripheral venous cannula can be used to administer PN in the short term. Phlebitis of peripheral veins can occur if the osmolality of the intravenous solution exceeds 1000 mOsm⁸

The PN consensus group has developed a peripheral preterm amino acid-glucose solution (see below) that can run through the peripheral cannula. Although extravasation injury occurs in up to 10% of infants managed only with peripheral infusion of PN, it is unclear if the risk of tissue injury caused by extravasated peripheral PN is greater than the risk of peripheral crystalloid infusion.

Any peripheral extravasation of amino acid-glucose solution or lipid should be treated according to the ***“Management of a Significant Extravasation of IV Fluids in the Neonate” Guideline. (No 5.4.5)***

If a PICC line is inserted or resited in a neonate who is already receiving PN, a new bag of amino acid-glucose solution and lipids is required. However the existing bags of PN solutions can be connected to the newly inserted peripheral cannula performing a “no touch” technique. **A new filter is required if the IV site is changed.**

Avoid bleed back into line as this is a medium for infection and may block the fine catheters.

Refer to [‘Aseptic Technique in NICU’ JHCH_NICU_03.01](#), for guidelines on **scrubbing and setting up sterile field** in preparation to administer PN and Lipids for **all central line insertions**.

When to start?

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No study has defined the clear cut gestational age or birthweight criteria for prescribing PN in neonates, however, at JHCH NICU we use the following guidelines:

- **Preterm infants ≤ 30 weeks or ≤ 1250 gm at birth** should be started on PN immediately after birth.
- **For preterm Infants >30 weeks and >1250 gm at birth**, PN should be considered if the clinical team anticipates that enteral feeding of at least 120 ml/kg/day can’t be established by day 5 of life.

- **Infants with perinatal asphyxia** if adequate enteral intake is going to be delayed for > 5 days.
- **Infants with gastrointestinal anomalies** who are not likely to be on enteral feed of at least 120ml/kg/day by the age of 5 days should be commenced on PN soon after birth (usually post op in babies who need surgical intervention immediately after birth.)
- Start lipids soon after birth along with amino acid-glucose solution. See section on lipid emulsion below.

What PN and how much to administer?

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- First decide on the daily total fluid intake of the neonate.
- For babies <30 weeks or < 1250gm at birth, we usually start at 80 ml/kg/day. For babies \geq 30 weeks and >1250gm, start at 60 ml/kg/day.
- Any intra-arterial line infusions, continuous drug infusions such as morphine and dopamine should be included in the total fluids.
- **Lipid infusion should also be included in the total fluids.**

Note: amino acid-glucose solutions (except the starter solution) are designed in such a way that the solution at 135 ml/kg/day and lipid emulsion at 3 g/kg/day meets the parenteral nutrient and energy needs of most of the infants.

DO NOT EXCEED 100 ML/KG/DAY of STARTER SOLUTION and 135 ML/KG/DAY of other amino acid-glucose solutions at any time. Rates higher than these will deliver excessive protein.

A sideline of glucose may be necessary if total parenteral fluid requirement of infant exceed the amount of fluids provided by the combination of amino acid-glucose solution (max 135 mls/kg/day) and lipid emulsion (max 18 ml/kg/day).

Types of amino acid-glucose parenteral nutrition (PN) solutions

For amino acid-glucose administration, 5 solutions will be available for preterm infants and two preparations for infants > 34 weeks gestation at birth.

1. Starter PN

This solution is suitable both preterm and term infants in the first 24-48 hours of life. Do not administer this solution at rates greater than 80 ml/kg/day in the first 24 hours and at >100ml/kg/day at any time.

2. Standard Preterm PN

This solution should be used in preterm infants after 24-48 hours of life. At <100ml/kg/day, this solution may not meet the daily nutrient requirements of neonates.

3. High Sodium Preterm PN

This solution is designed for use in preterm infants with low serum sodium. At 135ml/kg/day, it gives 8 mmol/kg/day of sodium as opposed to 4.6 mmol/kg/day given by

the standard solution. At <100ml/kg/day, this solution may not meet the daily nutrient intake of neonates.

4. 7.5% Glucose Preterm PN

This can be used as a first step to manage hyperglycemia in infants. This PN has glucose of 75 g/L and provides 10 g/kg/day of glucose at 135 ml/kg/day as opposed to 13.5 g/kg/day with standard preterm PN solution. Glucose content (and therefore osmolality) is the only difference between the two solutions. At <100ml/kg/day, this solution may not meet the daily nutrient intake of neonates.

5. Peripheral Preterm PN

This solution is developed for preterm infants who don't have central venous access. It has less calcium content (3.5 mmol/L), compared to the standard and starter preterm solutions (17mmol/L), to avoid theoretical risk of calcium extravasation injury. Prolonged usage of this PN solution may compromise calcium intake. Osmolality of this solution (913 mOsm/L) is similar to the standard preterm PN solution (956 mOsm/L).

6. 34 weeks to Term PN

This PN is suitable for infants > 34 weeks gestation and >24 hours of age.

The compositions of these amino acid-glucose formulations are detailed in the appendix. The TPN consensus group also has designed concentrated versions of the starter and standard preterm PN. At JHCH NICU these formulations will not be stocked.

Physico-chemical stability

Physico-chemical stability of the formulations have been tested by Baxter Pharmaceuticals and confirmed to be stable for up to 61 days at 2°-80°C and 5 days at below 25°C.

Lipid Emulsions

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Lipids should be commenced soon after birth along with the amino acid-glucose solution and should be counted in the total daily fluids. We use SMOF lipid formulation at the JHCH neonatal unit. For some infants who need PN for very long periods, Omegaven emulsion may be prescribed by the gastroenterologist.

SMOFLipid formulations

Contents	45 mL syringe	145 mL bag
	For ≤1 Kg	For > 1Kg
SMOF lipid	32.5 mL	100 mL
Soluvit N	2.5 mL	8.4 mL
Vitalipid N Infant	10 mL	36.6 mL

PLEASE NOTE: - this solution is not 20% lipid due to added vitamins

Both bags and syringes contain the same concentration of vitamins.

How to prescribe the lipids?

Amount of lipid emulsion prescribed depends upon the desired daily intake of lipids. At JHCH lipids are usually commenced at 2gm/kg/day and then increased to 3 gm/kg/day if appropriate.

- 1 g/kg/day = 6 ml/kg/day
- 2 g/kg/day = 12 ml/kg/day
- 3 g/kg/day = 18 ml/kg/day

If Lipids running at

- ≤ 0.8 mls/hr: 1 syringe required per 48 hour hang time
- ≤ 1.7 mls/hr: 2 syringes required per 48 hour hang time
- > 1.7 mls/hr: contact Pharmacy to make a bag of lipid with vitamins. The first chart must be faxed to Pharmacy and then a daily confirmation of the rate can be done via phone with a medical officer or nurse practitioner. If a bag is not available, syringes can be used.

Titration Lipid Emulsions:

Check plasma triglycerides once in the first week after the infant is established on 3 gm/kg/day of lipid emulsion and weekly as long as the infant is on lipid emulsions or as clinically indicated.

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.

An example of fluid calculations:

Case scenario

28 week baby, 1kg birth weight, day 2 of age receiving 80 ml/kg/day and lipids at 2 g/kg/day

Total fluids: 80 ml/kg/day = 3.3ml/hr.

PN (amino acid-glucose) solution: (68ml/kg/day) = 2.8 ml/hr

Lipid emulsion (12ml/kg/day) = 0.5ml/hr

When to cease IV Lipids

Mature human milk contains 3.5 g of fat per 100 mL. Recommended enteral fat intakes for LBW neonates are 4.8-6.6 g/kg/d (or 4.4-6 g/100 kcal/d). If PN is still running and the infant has reached a daily enteral intake of 120mls/kg/day or more, lipids should be ceased and the amino acid-glucose solution should be adjusted to maintain total fluid requirements of the infant.

Vitamins

Vitamins (Soluvit and Vitalipid N Infant) are supplied in the lipid emulsion. The table below shows the amount of vitamins supplied to infants at 3gm/kg/day:

Element	
Vit A, IU/k/day	920
Vit D, IU/k/day	160
Vit E, IU/K/day	2.8
Vit K, µg/k/day	80
Ascorbate, mg/k/day	10
Thiamine, µg/k/day	310
Riboflavine, µg/k/day	360
Pyridoxine, µg/k/day	400
Nicotinamide, mg/k/day	4

Pantothenate, mg/k/day	1.5
Biotin, µg/k/day	6
Folate, µg/k/day	40
Vit B12, µg/k/day	0.5

Trace elements

All the amino acid-glucose formulations supply the following trace element dosages at 135 ml/kg/day:

- Zinc – 450-500 ug/k/day
- Selenium – 2-3 ug/k/day
- Iodine – 1 ug/kg/day

Prolonged PN Usage

Infants (e.g. post-surgical infants) who are exclusively on PN for long periods (>4 weeks) may be at risk of other trace element (TE) deficiency such as copper and manganese as these trace elements are not present in the current PN solutions. There are 2 additional PN solutions supplied by Baxter (Standard Preterm PN + TE and Standard Term PN+TE) that contain copper and manganese for this particular group of infants.

Special comments

Patients with cholestatic jaundice should be closely monitored for Manganese and Copper toxicity as they are primarily excreted in bile. Patients with renal impairment may not be able to excrete selenium, molybdenum, zinc and chromium.

Hanging Time

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Both amino acid-glucose solution bags and lipid emulsions will be run for 48 hours if electrolytes are stable before changing the bags. A label applied to each bag will state a date and time of change. Before bags are due to be changed, the baby should have bloods taken for routine monitoring.

Note: PN will no longer be day specific but will be changed when a baby requires it. The stickers are available in a pouch on the PN fridge door.

Bag Change Due	
Date:	Time.....
Filter/Line Change Due	
Date:.....	Time.....
Signature.....	
Date.....	Time.....

Filters are used for both amino acid-glucose solutions and lipids emulsions (0.2 micron filter for amino acid-dextrose solution and 1.2 micron filter for lipid emulsion).

Monitoring on PN

Biochemical abnormalities such as high blood urea nitrogen, hyperglycaemia, metabolic acidosis, hypertriglyceridemia and conjugated hyperbilirubinemia may occur in infants who are receiving PN. In addition to routine clinical observations, periodic measurements of the following biochemical parameters are suggested during PN therapy.

Suggested biochemistry orders for infants on PN

Test	First 3-7 Days	Thereafter
UEC (Na, K, urea), HCO ₃ (blood gas)	Daily or the night before the PN is changed	Weekly
Ca, PO ₄	If clinically indicated	Weekly
Triglyceride	Once	Weekly or as clinically indicated
Blood glucose level	6-8 hourly for 48-72 hours, then daily till full feeds of 120ml/kg/day achieved	Daily until full feeds after 48-72 hours
Plasma ammonia, chloride, albumin and total bilirubin	If clinically indicated	
Copper, Zinc, Selenium, Manganese, GGT, LFTs, Albumin, Bilirubin Vit A, D, E Coagulation profile TSH (iodine deficiency)	If on TPN > 2-3 months	

Blood Urea

Given the data supporting the importance of early amino-acid administration in premature infants, limiting amino acid intake based on serum urea 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 (e.g. hyperammonemia >122 µmol/L, Plasma ammonia: Serum ammonia >122 µmol/L will be considered indicative of hyperammonemia in preterm infants.

Hyperglycemia It is not uncommon to see mild hyperglycemia (>8.3 mmol/L). If blood glucose >10 mmol/L (moderate hyperglycemia), calculate glucose intake in mg/kg/min and discuss with the neonatologist on call for further management.

Watch for hyperchloremia (>115 mmol/L). New standard solutions have acetate/chloride balance designed to minimise the incidence of hyperchloremia.¹⁷

Watch for cholestasis - serum level of direct bilirubin > 20% of total serum bilirubin or serum level of direct bilirubin >34 mmol/L

Complications[Top](#)

Sepsis – minimise by maintaining strict sterility of lines during insertion of central lines and standard aseptic non- touch technique for line and fluid changes with 'swabable' bung in place to render a closed system. **Nothing must be added to PN solutions.** The use of an in-line filter decreases contaminants in the line and the subsequent risk of infection.

Thrombophlebitis - peripheral lines require vigilant observation of infusion sites

Extravasation - escape of IV fluids into soft tissue which may lead to tissue necrosis if not detected early. For peripheral lines monitor IV site frequently, for central lines know where the line ends and monitor accordingly (e.g. if known to end in the shoulder monitor for shoulder swelling.)

Thrombus formation- Avoid bleed back into catheter.

Metabolic Complications: Hyperglycaemia, hypoglycaemia, hyperlipidaemia, cholestasis, fatty liver, hyponatraemia, hypernatraemia, hypokalaemia, hyperkalaemia, hypomagnesaemia, acidosis, alkalosis, uraemia

Nursing considerations

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- Second daily weight
- Weekly head circumference (Sunday night)
- Check correct fluid order and rate with nurse receiving handover at commencement of shift
- Check line placement on CXR. The ideal position for a percutaneous central line of lower extremity or umbilical venous catheter is the junction of the inferior vena cava and the right atrium. A PICC line inserted in the brachial cephalic, the axilla or scalp vessels will be viewed on CXR and should be at the junction of superior vena cava and right atrium but may be sited elsewhere if there was difficulty in placement.
- Check IV site at least hourly and document changes-see previous complications
- Always cover PN bag with light protective cover pouch as amino acids in PN are destroyed by exposure to light. It is not necessary to use light safe tubing for PN.
- Ensure light protective tubing and filters are used for lipids.

Line Changes/Filter Changes

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- Lipid syringes/bags, lines and filters - change every 48 hours.
- PN bags - change every 48 hrs.
- Filters and lines for PN change every 96hrs –change filter only if re-siting infusion to a peripheral IV and original bag is used, or from a peripheral IV to another peripheral IV.
- A new bag, lines and filters are required if re-siting from peripheral IV to a PICC- Surgical Aseptic non-touch technique if new line being inserted and Standard aseptic non-touch technique if existing PICC line with 'swabable' bung in situ.
- When changing PN bags if the total amount of fluid remaining in the burette and giving set will not be infused over the next 4 hours then the giving set and lines should also be changed using the standard non-touch technique i.e. when infant is receiving small hourly volumes such as 2 to 3mls per hour it will be many hours before they receive new PN.
- For new PN order- change lines and filters.
- Clear fluid infusions with electrolyte/glucose/medication additives- change every 24hrs
- Clear fluid filters- change every 96hrs

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APPENDIX 1. 2017 Consensus amino acid-glucose Formulations [Top](#)

STARTER PN

1. For infants in the first 24-48 hours after birth.
2. Do not use at > 80ml/kg/day in the first 24 hours.
3. Do not use at rates >100 ml/kg/day.

	STARTER								
	per 1000 mL	mL/kg/day							
		40	50	60	70	80	90	100	110
Amino acids, 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	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Potassium, mmol	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calcium, mmol	17	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.9
Magnesium, mmol	1.5	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Phosphate, mmol	10	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
Chloride, mmol	10.1	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1
Acetate, mmol	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
zinc, ug	3270	131	164	196	229	262	294	327	360
Selenium, ug	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2
Iodine, ug	8.16	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9
Heparin, units	500	20	25	30	35	40	45	50	55
Osmolarity(mosm/L)	898	Alert - below minimal recommended amino acid if no enteral intake Alert - above maximal starter amino acid intake							
Kcal - AA & GI	550								
Solution pH value	5.65								
Bag volume	500	Stability: up to 61 days @ 2-8 degrees C and 5 days at below 25 degrees C.							

STANDARD PRETERM PN

1. Standard solution for preterm infants after 24-48 h.
2. Do not use at rates >135ml/kg/day.

	STANDARD PRETERM													
	per 1000 mL	mL/kg/day												
		40	50	60	70	80	90	100	110	120	130	135	140	150
Amino acids, 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
Sodium, mmol	34	1.4	1.7	2.0	2.4	2.7	3.1	3.4	3.7	4.1	4.4	4.6	4.8	5.1
Potassium, 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
Calcium, mmol	17	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.9	2.0	2.2	2.3	2.4	2.6
Magnesium, 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
Phosphate, mmol	13	0.5	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.8	1.8	2.0
Chloride, 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	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
zinc, ug	3270	131	164	196	229	262	294	327	360	392	425	441	458	491
Selenium, ug	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.7	2.8	3.0
Iodine, ug	8.16	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2
Heparin, units	500	20	25	30	35	40	45	50	55	60	65	68	70	75
Osmolarity(mOsm/L)	956													
Kcal - AA & GI	520	Alert - below minimal recommended maintenance AA intake if no enteral intake												
Solution pH value	5.98	Alert - above safety limit for calcium and above maximal recommended AA intake												
Bag volume, mL	750	Stability: up to 61 days @ 2-8 degrees C and 5 days at below 25 degrees C												

HIGH SODIUM PN

1. For hyponatraemic preterm infants.
2. Provides Na at 8 mmol/kg/day at 135 ml/kg/day
3. Do not use at rates >135 ml/kg/day.

		HIGH SODIUM PRETERM													
		per 1000 mL	mL/kg/day												
			40	50	60	70	80	90	100	110	120	130	135	140	150
Amino acids, 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	
Sodium, mmol	60	2.4	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.1	8.4	9.0	
Potassium, 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	
Calcium, mmol	17	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.9	2.0	2.2	2.3	2.4	2.6	
Magnesium, 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	
Phosphate, mmol	13	0.5	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.8	1.8	2.0	
Chloride, mmol	30.7	1.2	1.5	1.8	2.1	2.5	2.8	3.1	3.4	3.7	4.0	4.1	4.3	4.6	
Acetate, mmol	34	1.4	1.7	2.0	2.4	2.7	3.1	3.4	3.7	4.1	4.4	4.6	4.8	5.1	
zinc, ug	3270	131	164	196	229	262	294	327	360	392	425	441	458	491	
Selenium, ug	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.7	2.8	3.0	
Iodine, ug	8.16	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2	
Heparin, units	500	20	25	30	35	40	45	50	55	60	65	68	70	75	
Osmolarity(mOsm/L)	1008														
Kcal - AA & GI	520	Alert - below minimal recommended maintenance AA intake if no enteral intake													
Solution pH value	5.95	Alert - above safety limit for calcium and above maximal recommended AA intake.													
Bag volume, mL	750	Stability: up to 61 days @ 2-8 degrees C and 5 days at below 25 degrees C													

7.5% GLUCOSE PRETERM PN

1. For hyperglycaemic preterm infants.
2. Do not use at rates >135 ml/kg/day.

	7.5% GLUCOSE PRETERM													
	per 1000 mL	mL/kg/day												
		40	50	60	70	80	90	100	110	120	130	135	140	150
Amino acids, 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	3.0	3.8	4.5	5.3	6.0	6.8	7.5	8.3	9.0	9.8	10.1	10.5	11.3
Sodium, mmol	34	1.4	1.7	2.0	2.4	2.7	3.1	3.4	3.7	4.1	4.4	4.6	4.8	5.1
Potassium, 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
Calcium, mmol	17	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.9	2.0	2.2	2.3	2.4	2.6
Magnesium, 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
Phosphate, mmol	13	0.5	0.7	0.8	0.9	1.0	1.2	1.3	1.4	1.6	1.7	1.8	1.8	2.0
Chloride, 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	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
Zinc, ug	3270	131	164	196	229	262	294	327	360	392	425	441	458	491
Selenium, ug	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.7	2.8	3.0
Iodine, ug	8.16	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2
Heparin, units	500	20	25	30	35	40	45	50	55	60	65	68	70	75
Osmolarity(mOsm/L)	805	Alert - below minimal recommended maintenance AA intake if no enteral intake Alert - above safety limit for calcium and above maximal recommended AA intake Stability: up to 61 days @ 2-8 degrees C and 5 days at below 25 degrees C												
Kcal - AA & GI	425													
Solution pH value	5.9													
Bag volume, mL	750													

PERIPHERAL PRETERM PN

1. For preterm infants without long lines.
2. Do not use at rates >135 ml/kg/day.

	Peripheral Preterm													
	per 1000 mL	mL/kg/day												
		40	50	60	70	80	90	100	110	120	130	135	140	150
Amino acids, 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
Sodium, mmol	34	1.4	1.7	2.0	2.4	2.7	3.1	3.4	3.7	4.1	4.4	4.6	4.8	5.1
Potassium, 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
Calcium, mmol	3.5	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Magnesium, 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
Phosphate, mmol	3	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5
Chloride, mmol	18.7	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.2	2.4	2.5	2.6	2.8
Acetate, mmol	40	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.4	5.6	6.0
zinc, ug	3270	131	164	196	229	262	294	327	360	392	425	441	458	491
Selenium, ug	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.7	2.8	3.0
Iodine, ug	8.16	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2
Heparin, units	500	20	25	30	35	40	45	50	55	60	65	68	70	75
Osmolarity(mOsm/L)	913	Alert - above maximal recommended amino acid intake Alert - below minimal recommended maintenance AA intake if no enteral intake Stability: up to 61 days @ 2-8 degrees C and 5 days at below 25 degrees C												
Kcal - AA & GI	520													
Solution pH value	5.55													
Bag volume, mL	750													

34 WEEKS TO TERM PN

Do not use at rates >135ml/kg/day

	34wk-TERM PN													
	per 1000 mL	mL/kg/day												
		40	50	60	70	80	90	100	110	120	130	135	140	150
Amino acids, 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	120	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4	15.6	16.2	16.8	18.0
Sodium, mmol	25	1.0	1.3	1.5	1.8	2.0	2.3	2.5	2.8	3.0	3.3	3.4	3.5	3.8
Potassium, mmol	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.7	2.8	3.0
Calcium, mmol	7	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.1
Magnesium, 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
Phosphate, mmol	4	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6
Chloride, mmol	28.2	1.1	1.4	1.7	2.0	2.3	2.5	2.8	3.1	3.4	3.7	3.8	3.9	4.2
Acetate, mmol	16.2	0.6	0.8	1.0	1.1	1.3	1.5	1.6	1.8	1.9	2.1	2.2	2.3	2.4
Zinc, ug	1900	76	95	114	133	152	171	190	209	228	247	257	266	285
Selenium, ug	20	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.7	2.8	3.0
Iodine, ug	8.16	0.3	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.1	1.1	1.1	1.2
Heparin, units	500	20	25	30	35	40	45	50	55	60	65	68	70	75
Osmolarity(mOsm/L)	957													
Kcal - AA & GI	548	Alert - below minimal recommended amino acid if no enteral intake												
Solution pH value	?6.03	Alert - above recommended maximal calcium and amino acid intake												
Bag volume, mL	1200	Stability: up to 61 days @ 2-8 degrees C and 5 days at below 25 degrees C												

APPENDIX 2. 2017 Consensus Lipid Formulations[Top](#)**SMOFLipid formulations**

Contents	45 mL syringe For ≤ 1 Kg	145 mL bag For > 1 Kg
SMOF lipid	32.5 mL	100 mL
Soluvit N	2.5 mL	8.4 mL
Vitalipid N Infant	10 mL	36.6 mL

APPENDIX 3. 2017 Consensus amino acid-glucose Formulations Summary Table

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PN	Starter	Standard Preterm	High Sodium	7.5% Glucose Preterm	Peripheral preterm	34 weeks to Term
Indication	Birth to 24-48 hrs	After 24-48 hrs	Hyponatremic Preterm	Hyperglycaemic Preterm	No central line	After 24-48 hrs
Concentration per litre						
Amino acids, g	37.5	30	30	30	30	23
Glucose, g	100	100	100	75	100	120
Sodium, mmol	20	34	60	34	34	25
Potassium, mmol	0	22	22	22	22	20
Calcium, mmol	17	17	17	17	3.5	7
Magnesium, mmol	1.5	1.5	1.5	1.5	1.5	1.5
Phosphate, mmol	10	13	13	13	3	4
Chloride, mmol	10.1	12.7	30.7	12.7	18.7	28.2
Acetate, mmol	0	26	34	26	40	16.2
Zinc, micgm	3270	3270	3270	3270	3270	1900
Selenium, micgm	20	20	20	20	20	20
Iodine, micgm	8.16	8.16	8.16	8.16	8.16	8.16
Heparin, units	500	500	500	500	500	500
Osmolarity, mosm	898	959	1008	895	913	957
At 135 ml/kg/day						
Amino acids, g		4.1	4.1	4.1	4.1	3.1
Glucose, g		13.5	13.5	10.1	13.5	16.2
Sodium, mmol		4.6	8.1	4.6	4.6	3.4
Potassium, mmol		3.0	3.0	3.0	3.0	2.7
Calcium, mmol		2.3	2.3	2.3	0.5	0.9
Magnesium, mmol		0.2	0.2	0.2	0.2	0.2
Phosphate, mmol		1.8	1.8	1.8	0.4	0.5
Chloride, mmol		1.7	4.1	1.7	2.5	3.8
Acetate, mmol		3.5	4.6	3.5	5.4	2.2
Zinc, micgm		441	441	441	441	257
Selenium, micgm		2.7	2.7	2.7	2.7	2.7
Iodine, micgm		1.1	1.1	1.1	1.1	1.1

APPENDIX 4. 2017 consensus formulations and comparison to recommended parenteral nutrient intakes in preterm neonates [Top](#)

Recommended parenteral nutrient intakes for Preterm Neonates. Values are per kg per day, unless otherwise indicated.						
Nutrient	ESPGHAN 2005			AAP 2014 consensus		Australasian 2018 consensus®
	Preterm			Weight <1000 gm	Weight 1000-1500 g	
	Day 0	Transition	Growing			
Energy, Kcal				105-115	90-100	100
Protein, g	≥1.5	≤4.0	≤4.0	3.5-4 g	3.2-3.8 g	4.05 g
Carbohydrate, g	5.8-11.5	≤12.0	≤12.0	13-17 g	9.7-15 g	13.5 g
Fat, g	1	1.0-3.0*	≤3.0*	3.0 - 4.0	3.0 - 4.0	3
Linoleic acid, mg	≥250			340-800	340-800	-
Sodium, mmol	0-3.0 (0-7d)	2.0-3.0	3.0-5.0	3.0-5.0	3.0-5.0	4.59
Potassium, mmol	0-2.0 (0-7d)	1.0-2.0	2.0-5.0	2.0 - 3.0	2.0 - 3.0	2.97
Chloride, mmol	0-5.0 (0-7d)	2.0-3.0		3.0 - 7.0	3.0 - 7.0	1.7
Calcium, mmol			1.3-3.0	1.5-2.0	1.5-2.0	2.3
Ph, mmol			1.0-2.3	1.5-1.9	1.5-1.9	1.8
Mg, mmol	0.2	0.2	0.2	0.17-0.29	0.17-0.29	0.2
Iron, ug	0	0 (<3 wks)	50-200	100-200	100-200	-
Zinc, ug	450-500	450-500	450-500	400	400	441
Copper, ug	20	20	20	20	20	-
Selenium, ug	2.0-3.0	2.0-3.0	2.0-3.0	1.5-4.5	1.5-4.5	2.7 ug
Chromium, ug	0	0	0	0.05-0.3	0.05-0.3	-
Molybdenum, ug	1	1	1	0.25	0.25	-
Manganese, ug	<1	<1	<1	1	1	-
Iodine, ug/day	1	1	1	1	1	1.1 ug
Vitamin A, IU	495-990	495-990	495-990	700-1500	700-1500	920
Vitamin D, IU	32	32	32	40-160	40-160	160
Vitamin E, IU	2.8-3.5	2.8-3.5	2.8-3.5	2.8-3.5	2.8-3.5	2.8
Vitamin K, ug	10	10	10	10	10	80 [#]
Thiamin, ug	350-500	350-500	350-500	200-350	200-350	310
Riboflavin, ug	150-200	150-200	150-200	150-200	150-200	360 [#]
Niacin, mg	4.0-6.8	4.0-6.8	4.0-6.8	4.0-6.8	4.0-6.8	4
Pyridoxine, ug	150-200	150-200	150-200	150-200	150-200	400 [#]
Folate, ug	56	56	56	56	56	40 [*]
Vitamin B12, ug	0.3	0.3	0.3	0.3	0.3	0.5 [#]
Pantothenate, mg	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.0-2.0	1.5
Biotin, ug	5.0-8.0	5.0-8.0	5.0-8.0	5.0-8.0	5.0-8.0	6
Vitamin C, mg	15-25	15-25	15-25	15-25	15-25	10 [*]
Acetate, mmol						3.51

@At135ml/kg/d of standard Preterm PN plus 3 g/kg/d of Lipid: *Below RDI, #Above RDI

APPENDIX 5. 2017 consensus formulations and comparison to recommended parenteral nutrient intakes in term neonates

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Reasonable Parenteral Nutrient Intakes in Term Neonates					
Nutrient, per/kg/day	ESPGHAN 2005			Australasian 2018 consensus 34wk-Term PN @ 135ml/kg/day	Australasian 2018 consensus Lipid @ 3g/kg/day
	Day 0	≤30 days	1-12 months		
Energy, Kcal		90-100	90-100	74	30
Protein, g	1.5-3.0	1.5-3.0	1.0-2.5	3.1	
Carbohydrate, g	5.8-11.5	≤18.0	5.0-12	16.2	
Fat, g	1	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)			2.7	
Calcium, mmol	0.8	0.8		2	
Phosphorus, mmol	0.5	0.5		1.6	
Magnesium, mmol	0.2	0.2	0.2-0.3	0.2	
Iron, umol	0	0(<3 weeks)	1.8-3.6		
Zinc, ug	250	250	100 (>3 months)	257	
Copper, ug	20	20	20		
Selenium, ug	2.0-3.0	2.0-3.0	2.0-3.0	2.7	
Chromium, ug	0	0	0		
Molybdenum, ug	0.25	0.25	0.25		
Manganese, ug	<1	<1	<1		
Iodine, (ug/day)	1	1	1	1.1	
Vitamin A, IU	495-990	495-990	495-990		920
Vitamin D, IU	32	32	32		160
Vitamin E, IU	2.8-3.5	2.8-3.5	2.8-3.5		2.8
Vitamin K, ug	10	10	10		80 [#]
Thiamin, ug	350-500	350-500	350-500		310
Riboflavin, ug	150-200	150-200	150-200		360 [#]
Niacin, mg	4.0-6.8	4.0-6.8	4.0-6.8		4
Pyridoxine, ug	150-200	150-200	150-200		400 [#]
Folate, ug	56	56	56		40 [*]
Vitamin B12, ug	0.3	0.3	0.3		0.5 [#]
Pantothenate, mg	1.0-2.0	1.0-2.0	1.0-2.0		1.5
Biotin, ug	5.0-8.0	5.0-8.0	5.0-8.0		6
Vitamin C, mg	15-25	15-25	15-25		10 [*]

*Below RDI, [#]Above RDI

APPENDIX 6**Composition of Vitalipid and Soluvit****Soluvit N**

Per vial:

thiamine nitrate 3.1 mg,
 riboflavine sodium phosphite (corresponding to vitamin B₂ 3.6 mg) 4.9 mg,
 nicotinamide 40 mg,
 pyridoxine hydrochloride (corresponding to vitamin B₆ 4.0 mg) 4.9 mg,
 sodium pantothenate (corresponding to pantothenic acid 15.0 mg) 16.5 mg,
 sodium ascorbate (corresponding to vitamin C 100 mg) 113 mg,
 biotin 60 microgram,
 folic acid 400 microgram,
 cyanocobalamin 5.0 microgram.

Vitalipid N**Table 1**

One mL contains	Adult	Infant
Vitamin A (as retinyl palmitate)	99 microgram	69 microgram
Ergocalciferol	0.5 microgram	1.0 microgram
dl- α -Tocopherol	0.91 mg	0.64 mg
Phytomenadione	15 microgram	20 microgram
Soya oil	100 mg	100 mg
Egg lecithin	12 mg	12 mg
Glycerol	22.0 mg	22.0 mg
Sodium hydroxide	to pH 8	to pH 8
Water for Injections	to 1 mL	to 1 mL

The vitamins are soluble in the oil phase of the emulsion, which has the composition corresponding to that of Intralipid 10%. The daily maintenance dosage of the vitamins A, D₂, E and K₁ are supplied during intravenous nutrition when:

- (i) 10 mL of Vitalipid N Adult are added to 500 mL Intralipid 10% or 20% ;
- (ii) 1 mL of Vitalipid N Infant per kg bodyweight per day up to a maximum of 10 mL is added to Intralipid 10% or 20%.

Guideline

This Guideline does not replace the need for the application of clinical judgment in respect to each individual patient.

Staff Preparation

It is mandatory for staff to follow relevant: "Five moments of hand hygiene", infection control, moving safely/safe manual handling, documentation practices and to use HAIDET for patient/carer communication: **H**and hygiene **A**cknowledge, **I**ntroduce, **D**uration, **E**xplanation, **T**hank you or closing comment.

Implementation, Monitoring & Compliance

1. Approved clinical guideline will be uploaded to the PPG and communication of updated 'Parenteral Nutrition in NICU' clinical guideline to NICU staff will be via email and message on the HUB.
2. Incident investigations associated with this Guideline and Procedure will include a review of process.
3. The Guideline and Procedure will be amended in line with the recommendations.
4. The person or leadership team who has approved the Guideline and Procedure is responsible for ensuring timely and effective review of the Guideline and Procedure.
5. Evaluation will include a review of the most current evidence as well as a consideration of the experience of Neonatal staff at JHCH in the implementation of the Guideline and Procedure.

Feedback

Any feedback on this document should be sent to the Contact Officer listed on the front page.