Standardised Concentrated Neonatal Parenteral Nutrition
Clinical Guideline
V1.0
March 2018
1. **Aim/Purpose of this Guideline**

Significantly preterm infants are born with an immature gut and are consequently unable to digest sufficient milk to meet their nutritional requirements for 10-14 days post birth. They also have limited nutrient stores, so are therefore at a high risk of accumulating significant nutrient deficits and consequential poor growth which is associated with poor neurodevelopmental outcome in later life.

Parenteral Nutrition (PN) is an important aspect of neonatal care by which the infant’s specific nutritional requirements can be met intravenously. Evidence confirms that providing optimal nutrition early can minimise growth failure and associated neuro-cognitive effects. PN is also essential for infants who may not tolerate enteral feeds such as those with congenital or acquired gut disorders.

The aim of this guideline is to provide clear, evidence based guidance and procedures for using PN on the neonatal unit. This is to ensure safe and optimum management of parenterally fed infants and minimise the risks associated with this form of nutrition support.

1.1 **Standardised PN for the SW Neonatal Network**

In developing standardised concentrated neonatal PN for the region we have tried to incorporate all of the latest evidence in a simplified and easy to follow way. The aim is to separate nutrition and hydration to ensure that the infant will receive the recommended daily intakes of nutrients to promote growth, and will not be affected too much by drug infusions and fluid volume restrictions. Changes in fluid requirements will be managed by an additional infusion of glucose 5% or 10%, if required.

The volumes of the bags available at RCHT, glucose concentration and osmolarity can be seen in the table below. Osmolarity can be reduced further by co-infusing with lipid. As usage of bag 3 is likely to be very low we do not keep stock at RCHT but stock can be obtained within 48 hours.

<table>
<thead>
<tr>
<th>Bag name</th>
<th>Volumes available</th>
<th>Glucose concentration</th>
<th>Theoretical osmolarity (mOsm/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW Neonatal PN Bag 1 (minimal electrolytes)</td>
<td>350ml</td>
<td>11.6%</td>
<td>1002</td>
</tr>
<tr>
<td>SW Neonatal PN Bag 2 (maintenance with electrolytes)</td>
<td>600ml</td>
<td>10.8%</td>
<td>1049</td>
</tr>
<tr>
<td>SW Neonatal PN Bag 3 (maintenance special with electrolytes)</td>
<td>800ml</td>
<td>10.5%</td>
<td>954</td>
</tr>
</tbody>
</table>

Lipid syringes will be manufactured “in-house” to the recipe below. In order to be able to start lipid infusions (including water and fat soluble vitamins) as soon as possible after birth stock syringes will be held on NICU.
Newborn infant:

Is the Infant < 1.25kg or < 30/40 weeks gestation?

- **Yes**
  - Start PN within 6 hours of birth
  - Moderate/high risk infant
    - Will the infant achieve >100ml/kg/day enteral nutrition by day 5 of life
      - **Yes**
        - Start enteral nutrition according to local protocol
      - **No**
        - Start PN as soon as possible after birth

- **No**
  - Start PN as soon as possible after birth
2.2 PN regime

1st 24 hrs of life (Day 1)

Aqueous ‘SW Neonatal PN Bag 1’ at 50ml/kg/day with lipid at 5ml/kg/day

Does the patient need sodium and potassium supplementation?

Yes

Change to Aqueous ‘SW Neonatal PN Bag 2’ at 65ml/kg/day with lipid at 10ml/kg/day

No

Aqueous ‘SW Neonatal PN Bag 1’ at 65ml/kg/day with lipid at 10ml/kg/day

At 24 hrs old (Day 2)

At 48 hrs old (Day 3)

Does the patient need sodium and potassium supplementation?

Yes

Aqueous ‘SW Neonatal PN Bag 2’ at 80ml/kg/day with lipid at 15ml/kg/day

No

Aqueous ‘SW Neonatal PN Bag 1’ at 80ml/kg/day with lipid at 15ml/kg/day

From 72 hrs old (Days 4 + 5)

Aqueous ‘SW Neonatal PN Bag 2’ at 100ml/kg/day with lipid at 20ml/kg/day

From day 6 onwards

Preterm < 37/40 and all infants < 2.5kg

Aqueous ‘SW Neonatal PN Bag 2’ at 100ml/kg/day with lipid at 20ml/kg/day

Term ≥ 37/40 if ≥ 2.5kg

Aqueous ‘SW Neonatal PN Bag 3’ at 100ml/kg/day with lipid at 20ml/kg/day

* For information re the availability of SW Neonatal PN Bag 3 please see p5 below.

If additional fluid is required, prescribe glucose 5% or 10% according to blood glucose levels, to make up the volume.
2.3 How to prescribe PN

Neonatal PN should be prescribed on EPMA as a separate aqueous bag (1 or 2) and a lipid syringe. The rate of each must be prescribed. All products can be located using the short code NEON.

2.4 Supply/availability of SW Neonatal PN bags 1 & 2 and lipid syringes

In order to be able to start aqueous PN and lipid infusions (including water and fat soluble vitamins) as soon as possible after birth (target within 6 hours) stock aqueous bags 1 and 2, and lipid syringes will be held on NICU for initiation both during working hours and out-of-hours. Additional stock of aqueous bags can be ordered via the dispensary and the pharmacy top-up service. Lipid syringes should be ordered via the ward pharmacist or via Technical Services on Ext 8390.

2.5 Availability of bespoke PN:

This is no longer routinely available as the majority of patients should be managed using standard PN and additional infusions (see Appendix 3 – Managing metabolic complications). If bespoke PN is indicated this must be agreed with the Consultant Neonatologist on service and discussed with the neonatal pharmacist at the earliest opportunity.

2.6 Availability of SW Neonatal PN bag 3 (Term baby with electrolytes):

As we rarely prescribe PN for term neonates at RCH we have decided not to routinely stock bag 3. However, stock can be obtained from the manufacturer within 48 hours. SW Neonatal PN bag 2 can be used in term neonates for up to 5 days. More prolonged use is not ideal as the infant would receive excessive protein. If PN is initiated in a term baby, and it is anticipated that they will need TPN for more than 5 days, please discuss with the neonatal pharmacist at the earliest opportunity to allow stock of bag 3 to be ordered.

2.7 Administration of PN

Ideally all neonatal TPN should be administered centrally. Peripheral administration is not ideal but may be used in the short term until central access can be obtained. The aqueous phase must be co-administered with the lipid to reduce osmolarity.

PN should be removed from the fridge at least 1 hour prior to use.

Aseptic Non-Touch Technique (ANTT) must be used when setting up PN. Aqueous PN bags should be infused via a 0.2 micron filter and can be connected to the patient for a maximum of 48 hours. Lipid syringes can only be connected to the patient for a maximum of 24 hours.

Additional care is required to ensure that PN is administered at the correct rate as giving PN too quickly can cause significant harm to the patient. The following checks should be carried out when putting up a new bag of aqueous PN and/or a lipid syringe and at handover of each shift:

- Identify the aqueous PN (bag) and the lipid (syringe).
- Ensure that aqueous PN (bag) and the lipid (syringe) are both running at the
correct rate. This should be checked against the EPMA prescription.
- As part of this check it should be confirmed that the correct giving set (aqueous bag or lipid syringe) is being administered via the correct pump.
- Complete the PN checklist.

The nursing staff who set up the PN, must record the administration of both the aqueous bag and the lipid syringe on EPMA.

Lipid syringes are unlicensed and made in-house under section 10. As such we need to record the batch number and expiry of each lipid syringe that a baby receives. An additional label will be packed with the lipid syringe and must be attached to the patients infusion chart. The neonatal pharmacist will retrospectively provide technical services with the batch numbers of the lipid syringes administered to each baby.

### 2.8 Weaning PN

As enteral feeds increase, wean all glucose infusions (5% and 10%) to zero. Then follow the table below:

<table>
<thead>
<tr>
<th>When Enteral feeds at</th>
<th>Wean Lipid infusion to</th>
<th>Aqueous phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>30ml/kg/day</td>
<td>15ml/kg/day</td>
<td>Titrate to total fluid allowance</td>
</tr>
<tr>
<td>60ml/kg/day</td>
<td>10ml/kg/day</td>
<td>Titrate to total fluid allowance</td>
</tr>
<tr>
<td>90ml/kg/day</td>
<td>*zero</td>
<td>Titrate to total fluid allowance</td>
</tr>
<tr>
<td>120ml/kg/day</td>
<td>*zero</td>
<td>Titrate to total fluid allowance</td>
</tr>
</tbody>
</table>

*unless running peripherally, in which case keep lipid at 10ml/kg/day.

The aqueous phase can be stopped once tolerating 120ml/kg/day enteral feeds, or continued at 30ml/kg/day and weaned until tolerating 150ml/kg/day enteral feeds. **NB:** some high risk infants may continue on a small amount of aqueous PN and lipid to support growth.
2.9 Monitoring

Routine biochemical monitoring should take place in all infants on PN as it is crucial to prevent and treat instabilities potentially caused by PN. Below is a suggested schedule of monitoring however requirements may differ for individual infants and situations.

<table>
<thead>
<tr>
<th></th>
<th>First Week</th>
<th>Stable PN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
<td>Twice Weekly</td>
</tr>
<tr>
<td>Infusion Site (hourly)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Fluid balance</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Blood glucose*</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Urine glucose</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Urine electrolytes*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrolytes (Na, K, Cl)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Urea, creatinine</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Phosphate</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Triglyceride*</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>LFTs, Alkaline Phosphatase</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Albumin</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Bilirubin</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Conj. Bilirubin</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Acid base balance</td>
<td>✓</td>
<td></td>
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<tr>
<td>Full blood count</td>
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<td></td>
</tr>
<tr>
<td>Trace elements*</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Vitamin A, D, E*</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Weight</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Head Circumference</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

*see special considerations
3. Monitoring compliance and effectiveness

<table>
<thead>
<tr>
<th>Element to be monitored</th>
<th>Key Changes to Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>Dr Chris Warren</td>
</tr>
<tr>
<td>Tool</td>
<td>Audit</td>
</tr>
<tr>
<td>Frequency</td>
<td>As dictated by audit findings</td>
</tr>
<tr>
<td>Reporting arrangements</td>
<td>Child Health Directorate Audit and Neonatal Guidelines Group</td>
</tr>
<tr>
<td>Acting on recommendations and Lead(s)</td>
<td>Dr Chris Warren Consultant Paediatrician</td>
</tr>
</tbody>
</table>

| Change in practice and lessons to be shared | Required Changes in Practice will be identified and actioned within 3 months |

4. Equality and Diversity

4.1. This document complies with the Royal Cornwall Hospitals NHS Trust service Equality and Diversity statement which can be found in the 'Equality, Diversity & Human Rights Policy' or the Equality and Diversity website.

4.2. Equality Impact Assessment

The Initial Equality Impact Assessment Screening Form is at Appendix 2.
# Appendix 1. Governance Information

<table>
<thead>
<tr>
<th>Document Title</th>
<th>Standardised Concentrated Neonatal Parenteral Nutrition Clinical Guideline V1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Issued/Approved:</td>
<td>16&lt;sup&gt;th&lt;/sup&gt; March 2018</td>
</tr>
<tr>
<td>Date Valid From:</td>
<td>16&lt;sup&gt;th&lt;/sup&gt; March 2018</td>
</tr>
<tr>
<td>Date Valid To:</td>
<td>16&lt;sup&gt;th&lt;/sup&gt; March 2021</td>
</tr>
<tr>
<td>Directorate / Department responsible (author/owner):</td>
<td>Chris Warren, Consultant Paediatrician Jackie Pope, Lead Paediatric/Neonatal Pharmacist</td>
</tr>
<tr>
<td>Contact details:</td>
<td>01872 252590</td>
</tr>
<tr>
<td>Brief summary of contents</td>
<td>Guidelines on the use of Neonatal Parenteral Nutrition (PN) at RCH</td>
</tr>
<tr>
<td>Suggested Keywords:</td>
<td>Neonatal Parenteral Nutrition, Neonatal PN.</td>
</tr>
<tr>
<td>Target Audience</td>
<td>RCHT</td>
</tr>
<tr>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Executive Director responsible for Policy:</td>
<td>Medical Director</td>
</tr>
<tr>
<td>Date revised:</td>
<td>Initial version</td>
</tr>
<tr>
<td>This document replaces (exact title of previous version):</td>
<td>New Document</td>
</tr>
<tr>
<td>Approval route (names of committees)/consultation:</td>
<td>Neonatal Guidelines Group MPC</td>
</tr>
<tr>
<td>Divisional Manager confirming approval processes</td>
<td>David Smith</td>
</tr>
<tr>
<td>Name and Post Title of additional signatories</td>
<td>Not Required</td>
</tr>
<tr>
<td>Name and Signature of Divisional/Directorate Governance Lead confirming approval by specialty and divisional management meetings</td>
<td>{Original Copy Signed} Name: Caroline Amukusana</td>
</tr>
<tr>
<td>Signature of Executive Director giving approval</td>
<td>{Original Copy Signed}</td>
</tr>
<tr>
<td>Publication Location (refer to Policy on Policies – Approvals and Ratification):</td>
<td>Internet &amp; Intranet ✓ Intranet Only</td>
</tr>
</tbody>
</table>
Training Need Identified?  Yes, teaching sessions delivered on neonatal unit to medical and nursing staff.

Version Control Table

<table>
<thead>
<tr>
<th>Date</th>
<th>Version No</th>
<th>Summary of Changes</th>
<th>Changes Made by (Name and Job Title)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/12/2017</td>
<td>V1.0</td>
<td>Initial Issue</td>
<td>Dr Chris Warren, Consultant Paediatrician Jackie Pope Pharmacist</td>
</tr>
</tbody>
</table>

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This document is to be retained for 10 years from the date of expiry. This document is only valid on the day of printing

Controlled Document
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**Appendix 2. Initial Equality Impact Assessment Form**

<table>
<thead>
<tr>
<th>Name of Name of the strategy / policy / proposal / service function to be assessed</th>
<th>Standardised Concentrated Neonatal Parenteral Nutrition Clinical Guideline V1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directorate and service area:</td>
<td>Child Health</td>
</tr>
<tr>
<td>Is this a new or existing document:</td>
<td>New</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of individual completing assessment:</th>
<th>Jackie Pope, Lead Paediatric/Neonatal Pharmacist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone:</td>
<td>01752 252590</td>
</tr>
</tbody>
</table>

1. **Policy Aim***

   **Who is the strategy / policy / proposal / service function aimed at?**
   - Standardisation of neonatal PN across the SW Neonatal Network.
   - Safe administration and management of neonatal patients requiring parenteral nutrition at RCH.

2. **Policy Objectives***

   To provide clear guidance on the initiation of PN and to ensure appropriate monitoring of patients.

3. **Policy – intended Outcomes***

   Standardised safe practice

4. **How will you measure the outcome?***

   Audit and DATIX review

5. **Who is intended to benefit from the policy?***

   Neonates and their families. Medical, Pharmacy and Nursing staff.

6a Who did you consult with?

   Workforce | Patients | Local groups | External organisations | Other |
   --- | --- | --- | --- | --- |
   x | | | x |

   **Please record specific names of groups**
   - RCH neonatal team
   - RCH pharmacy technical services
   - SW neonatal network

   What was the outcome of the consultation?
   - Localisation of Regional Guideline

7. **The Impact**

   Please complete the following table. **If you are unsure/don’t know if there is a negative impact you need to repeat the consultation step.**

   | Equality Strands: | Yes | No | Unsure | Rationale for Assessment / Existing Evidence |
   --- | --- | --- | --- | --- |
   Age | x | | | |
   Sex (male, female, trans-gender / gender reassignment) | x | | | |
<table>
<thead>
<tr>
<th>Race / Ethnic communities /groups</th>
<th>x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability -</td>
<td>x</td>
</tr>
<tr>
<td>Learning disability, physical</td>
<td></td>
</tr>
<tr>
<td>impairment, sensory impairment,</td>
<td></td>
</tr>
<tr>
<td>mental health conditions and</td>
<td></td>
</tr>
<tr>
<td>some long term health conditions.</td>
<td></td>
</tr>
<tr>
<td>Religion / other beliefs</td>
<td>x</td>
</tr>
<tr>
<td>Marriage and Civil partnership</td>
<td>x</td>
</tr>
<tr>
<td>Pregnancy and maternity</td>
<td>x</td>
</tr>
<tr>
<td>Sexual Orientation,</td>
<td>x</td>
</tr>
<tr>
<td>Bisexual, Gay,</td>
<td></td>
</tr>
<tr>
<td>heterosexual, Lesbian</td>
<td></td>
</tr>
</tbody>
</table>

You will need to continue to a full Equality Impact Assessment if the following have been highlighted:

- You have ticked “Yes” in any column above and
- No consultation or evidence of there being consultation - this excludes any policies which have been identified as not requiring consultation. or
- Major this relates to service redesign or development

8. Please indicate if a full equality analysis is recommended.  

| Yes | No | x |

9. If you are not recommending a Full Impact assessment please explain why.

Not required.

<table>
<thead>
<tr>
<th>Signature of policy developer / lead manager / director</th>
<th>Date of completion and submission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Chris Warren Consultant Paediatrician</td>
<td>16th March 2018</td>
</tr>
</tbody>
</table>

Names and signatures of members carrying out the Screening Assessment

1. Dr Chris Warren  
2. Human Rights, Equality & Inclusion Lead

Keep one copy and send a copy to the Human Rights, Equality and Inclusion Lead  
c/o Royal Cornwall Hospitals NHS Trust, Human Resources Department, Knowledge Spa,  
Truro, Cornwall, TR1 3HD

This EIA will not be uploaded to the Trust website without the signature of the Human Rights, Equality & Inclusion Lead.

A summary of the results will be published on the Trust’s web site.

Signed Dr Chris Warren Date 16th March 2018
Appendix 3: Managing metabolic complications

Hyperglycaemia (Blood glucose level x2 >11mmol/L – one must be peripheral)
1) Ensure all additional glucose infusions are reduced to 5% glucose, including drug infusions if compatible
2) If still hyperglycaemic, decrease aqueous PN rate by 30ml/kg/day and supplement volume with 5% glucose
3) If still hyperglycaemic, consider insulin after discussion with the level 3 unit (see insulin guideline) (Ensure minimum glucose infusion rate is no less than 6mg/kg/min). Glucose infusion rate (GIR) can be calculated as follows:

\[
\text{GIR (mg/kg/min)} = \frac{\% \text{ glucose being infused} \times \text{rate of infusion (mls/hour)}}{\text{body weight (kg) } \times 6}
\]

Hypoglycaemia
1) Increase the concentration of all additional glucose infusions in a step wise manner from 10% to 15% to 20%. Ensure all drug infusions are in 10% glucose if compatible.
2) If still hypoglycaemic, decrease aqueous PN by 30ml/kg/day and supplement with 20% glucose
3) If still hypoglycaemic, stop PN and replace fluid volume with glucose 20% with electrolytes, where required

Hypernatraemia
1) Assess fluid balance, weight and hydration status.
2) Ensure arterial line is kept patent with heparinised 0.45% sodium chloride (not 0.9%)
3) For immediate action, consider changing aqueous PN to SW Neonatal PN Bag 1. If true sodium over supplementation discuss with the Consultant and the Neonatal Pharmacist.

Hyponatraemia
1) Assess fluid balance, weight and hydration status.
Water overload must be considered before supplementation of sodium is prescribed. In these cases fluid restriction is usually required and can be achieved by reducing the supplementary glucose 5% infusion rate.
2) If it is felt there is a true sodium deficit and this is not being corrected by the current PN regimen (ensure aqueous PN is not sodium free) then sodium losses should be calculated and replaced by using the standard sodium concentrations in the table below to supplement sodium.
3) Ensure arterial line is kept patent with heparinised 0.9% sodium chloride (not 0.45%)

There are 5 standard sodium concentrations made up in glucose 5%. For central use only. These supplementary sodium infusions allow replacement of sodium in addition to the sodium prescribed in the PN.
Guidance for sodium replacement (exclude fluid overload before supplementing sodium)

<table>
<thead>
<tr>
<th>Sodium level (mmol/l)</th>
<th>Supplementary sodium infusion required</th>
</tr>
</thead>
<tbody>
<tr>
<td>132-135 Small deficit</td>
<td>Add 10mmol Sodium Chloride (2ml of 30% Sodium Chloride) to 48ml glucose 10% to make up 50ml infusion containing 0.2mmol/ml of Sodium Chloride. Infusion rate 0.1mmol/kg/hr (0.5ml/kg/hr) gives sodium supplementation of 2.4mmol/kg/day</td>
</tr>
<tr>
<td>128-131 Medium deficit</td>
<td>Add 20mmol Sodium Chloride (4ml of 30% Sodium Chloride) to 46ml glucose 10% to make up 50ml infusion containing 0.4mmol/ml of Sodium Chloride. Infusion rate 0.2mmol/kg/hr (0.5ml/kg/hr) gives sodium supplementation of 4.8mmol/kg/day</td>
</tr>
<tr>
<td>124-127 Large deficit</td>
<td>Add 30mmol Sodium Chloride (6ml of 30% Sodium Chloride) to 44ml glucose 10% to make up 50ml infusion containing 0.6mmol/ml of Sodium Chloride. Infusion rate 0.3mmol/kg/hr (0.5ml/kg/hr) gives sodium supplementation of 7.2mmol/kg/day</td>
</tr>
<tr>
<td>&lt;124 Very large deficit</td>
<td>Add 40mmol Sodium Chloride (8ml of 30% Sodium Chloride) to 42ml glucose 10% to make up 50ml infusion containing 0.8mmol/ml of Sodium Chloride. Infusion rate 0.4mmol/kg/hr (0.5ml/kg/hr) gives sodium supplementation of 9.6mmol/kg/day</td>
</tr>
<tr>
<td>&lt;120 Discuss with consultant</td>
<td>Add 50mmol Sodium Chloride (10ml of 30% Sodium Chloride) to 40ml glucose 10% to make up 50ml infusion containing 1mmol/ml of Sodium Chloride. Infusion rate 0.5mmol/kg/hr (0.5ml/kg/hr) gives sodium supplementation of 12mmol/kg/day</td>
</tr>
</tbody>
</table>

NB: Glucose 5% can be used as the diluent in cases of hyperglycaemia.

**Hyperkalaemia**
1) Ensure that the hyperkalaemia result is true, i.e. not haemolysed.
2) Stop any additional potassium infusions.
3) For immediate action, consider changing aqueous PN to SW Neonatal PN Bag 1. If true potassium over supplementation discuss with the Consultant and the Neonatal Pharmacist.

**Hypokalaemia (<3mmol/L)**
1) Ensure aqueous PN bag contains potassium.
2) Replace deficit by using supplementary potassium infusion. Aim to correct over 24 hours. **For central use only.**
3) Magnesium levels should also be checked and corrected if required

Add 10mmol Potassium Chloride (5ml of 15% Potassium Chloride) to 45ml glucose 10% to make up 50ml infusion containing 0.2mmol/ml of Potassium Chloride. Infusion rate 0.1mmol/kg/hr (0.5ml/kg/hr) gives potassium supplementation of 2.4mmol/kg/day
NB: Glucose 5% can be used as the diluent in cases of hyperglycaemia.

Occasionally, larger potassium requirements are needed (eg stoma losses, diuretics). These should be met by using the standard solution above and increasing the RATE of infusion as described below.

| Infusion rate 0.2mmol/kg/hr (1ml/kg/hr) gives potassium supplementation of 4.8mmol/kg/day |
| Infusion rate 0.3mmol/kg/hr (1.5ml/kg/hr) gives potassium supplementation of 7.2mmol/kg/day |

**Hypercalcaemia (corrected calcium >3mmol/l)**
1) Check serum phosphate levels. Hypercalcaemia may be secondary to hypophosphataemia particularly if the latter is severe or persistent. The treatment in these cases is to supplement phosphate.
2) If the phosphate level is within range then any infusion containing calcium may need to be stopped, including PN. NB: all SW Neonatal PN bags contain calcium.
3) Discuss with the Consultant and the Neonatal Pharmacist.

**Hypocalcaemia (corrected calcium <1.5mmol/l, or ionised calcium <1mmol/L)**
1) Check acid-base balance as metabolic alkalosis decreases ionised calcium levels.
2) Magnesium levels should also be checked and corrected if required
3) Change to SW Neonatal PN Bag 2 (if not already prescribed, and suitable for the patient), as it contains more calcium than the SW Neonatal PN Bags 1 and 3, and optimise rates if possible.
4) If serum calcium level is still low, then administer 2ml/kg calcium gluconate 10% (0.46mmol/kg) intravenously over 10minutes. Do NOT administer down the same intravenous line as the PN.
4) If higher amounts of calcium are required in the PN, discuss with the Consultant and the Neonatal Pharmacist.

**Hyperphosphataemia**
1) Calcium levels should also be checked and corrected if required
2) If true hyperphosphataemia and immediate action is required then stop aqueous PN and change to SW Neonatal PN Bag 1.
3) Discuss with the Consultant and the Neonatal Pharmacist.

**Hypophosphataemia (<1.5mmol/L)**
1) Potassium levels should be checked and corrected if required
2) Check acid-base balance as metabolic acidosis increases urinary excretion of phosphate
3) Change to SW Neonatal PN Bag 2 (if not already prescribed and suitable for the patient), as it contains more phosphate than the SW Neonatal PN Bags 1 and 3, and optimise rates if possible.
4) Discuss with the Consultant and the Neonatal Pharmacist.
5) If infant tolerating more than half enteral feeds then consider enteral phosphate supplementation.

**Hypermagnesaemia**
1) If immediate action is required then stop aqueous PN and change to SW Neonatal PN Bag 1.
2) Discuss with the Consultant and the Neonatal Pharmacist.
Hypomagnesaemia
1) Ensure potassium and calcium serum levels are within the normal range
2) Change to SW Neonatal PN Bag 2 or 3 (if not already prescribed, and suitable for the patient), as it contains more magnesium than SW Neonatal PN Bag 1, and optimise rates if possible.
3) Consider magnesium supplementation with 0.4mmol/kg magnesium sulphate intravenously over 10minutes.

Hyperlipidaemia (>2.8mmol/L)
For infants <26/40 CGA, or those that are severely septic, then triglycerides should be monitored once they are receiving 10ml/kg/day lipid (1.5g/kg/day), and then again at 20ml/kg/day (3g/kg/day). From then on it should be routinely on a Sunday.

All other infants should have triglycerides measured weekly on a Sunday.

More frequent monitoring may be required in certain circumstances, for example if an infant has had previously high triglyceride levels, is septic, catabolic or critically ill, or has severe and unexplained thrombocytopenia. If infant is severely septic consider stopping the lipid infusion and discuss with the Consultant and the Neonatal Pharmacist.

<table>
<thead>
<tr>
<th>Triglyceride level (mmol/L)</th>
<th>Action required</th>
<th>When to re-measure triglyceride</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2.8mmol/L</td>
<td>None</td>
<td>Weekly on a Sunday</td>
</tr>
<tr>
<td>2.9-3.5mmol/L</td>
<td>Reduce lipid infusion by 5ml/kg/day</td>
<td>In 3 days</td>
</tr>
<tr>
<td>3.5-4mmol/L</td>
<td>Reduce lipid infusion by 10ml/kg/day</td>
<td>In 2 days</td>
</tr>
<tr>
<td>&gt;4mmol/L</td>
<td>Reduce lipid infusion to 5ml/kg/day or consider stopping</td>
<td>In 2 days</td>
</tr>
</tbody>
</table>

Once repeat triglyceride measurement is <2.8mmol/L increase lipid infusion rate by 5ml/kg/day and repeat measurement every 2 days until target lipid infusion rate is reached. If the level >2.8mmol/L on a repeated test then repeat according to the table above then reduce the rate.
## Appendix 4. Nutritional content of PN bags

### Concentrated PN for pre-term infants

<table>
<thead>
<tr>
<th>Flow rates</th>
<th>SW Neonatal PN Bag 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueous bag</td>
<td>50 ml/kg/day 65 ml/kg/day 80 ml/kg/day</td>
</tr>
<tr>
<td>Lipid syringe</td>
<td>5 ml/kg/day 10 ml/kg/day 15 ml/kg/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Contents per kg/day at above rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>0.32 g 0.42 g 0.51 g</td>
</tr>
<tr>
<td>Protein</td>
<td>2 g 2.6 g 3.2 g</td>
</tr>
<tr>
<td>Amino acids</td>
<td>2.4 g 3.12 g 3.84 g</td>
</tr>
<tr>
<td>Glucose</td>
<td>5.79 g 7.53 g 9.26 g</td>
</tr>
<tr>
<td>Glucose (mg/kg/min)</td>
<td>4.02 mg/kg/min 5.23 mg/kg/min 6.43 mg/kg/min</td>
</tr>
<tr>
<td>Sodium</td>
<td>0 mmol 0 mmol 0 mmol</td>
</tr>
<tr>
<td>Potassium</td>
<td>0 mmol 0 mmol 0 mmol</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.42 mmol 0.55 mmol 0.67 mmol</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0 mmol 0 mmol 0 mmol</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.06 mmol 0.08 mmol 0.1 mmol</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.41 mmol 0.53 mmol 0.65 mmol</td>
</tr>
<tr>
<td>Acetate</td>
<td>0 mmol 0 mmol 0 mmol</td>
</tr>
<tr>
<td>Lipid</td>
<td>0.75 g 1.5 g 2.25 g</td>
</tr>
<tr>
<td>Vitlipid Infant</td>
<td>1 ml 2 ml 3 ml</td>
</tr>
<tr>
<td>Solivito N</td>
<td>0.25 ml 0.5 ml 0.75 ml</td>
</tr>
<tr>
<td>Non-nitrogen calories (kcal/kg/day)</td>
<td>31.7 kcal 47.1 kcal 62.6 kcal</td>
</tr>
<tr>
<td>Kcal/g protein</td>
<td>15.8 18.1 19.5</td>
</tr>
</tbody>
</table>

Glucose 5% or 10% should be prescribed to make up any deficit in fluid volumes.
Glucose 5% or 10% should be prescribed to make up any deficit in fluid volumes

<table>
<thead>
<tr>
<th>Flow rates</th>
<th>SW Neonatal PN Bag 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueous bag</td>
<td>65 ml/kg/day</td>
</tr>
<tr>
<td></td>
<td>80 ml/kg/day</td>
</tr>
<tr>
<td></td>
<td>100 ml/kg/day</td>
</tr>
<tr>
<td>Lipid syringe</td>
<td>10 ml/kg/day</td>
</tr>
<tr>
<td></td>
<td>15 ml/kg/day</td>
</tr>
<tr>
<td></td>
<td>20 ml/kg/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contents per kg/day at above rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
</tr>
<tr>
<td>Protein</td>
</tr>
<tr>
<td>Amino acids</td>
</tr>
<tr>
<td>Glucose</td>
</tr>
<tr>
<td>Glucose (mg/kg/min)</td>
</tr>
<tr>
<td>Sodium</td>
</tr>
<tr>
<td>Potassium</td>
</tr>
<tr>
<td>Calcium</td>
</tr>
<tr>
<td>Phosphate</td>
</tr>
<tr>
<td>Magnesium</td>
</tr>
<tr>
<td>Chloride</td>
</tr>
<tr>
<td>Acetate</td>
</tr>
<tr>
<td>Lipid</td>
</tr>
<tr>
<td>Vitlipid Infant</td>
</tr>
<tr>
<td>Solivito N</td>
</tr>
<tr>
<td>Non-nitrogen calories (kcal/kg/day)</td>
</tr>
<tr>
<td>Kcal/g protein</td>
</tr>
</tbody>
</table>
**Concentrated PN for term infants**

<table>
<thead>
<tr>
<th>Flow rates</th>
<th>SW Neonatal PN Bag 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueous bag</td>
<td>40 ml/kg/day</td>
</tr>
<tr>
<td>Lipid syringe</td>
<td>5 ml/kg/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Nitrogen</td>
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</tr>
<tr>
<td>Magnesium</td>
</tr>
<tr>
<td>Chloride</td>
</tr>
<tr>
<td>Acetate</td>
</tr>
<tr>
<td>Lipid</td>
</tr>
<tr>
<td>Vitlipid Infant</td>
</tr>
<tr>
<td>Solivito N</td>
</tr>
<tr>
<td>Non-nitrogen calories</td>
</tr>
<tr>
<td>Kcal/g protein</td>
</tr>
</tbody>
</table>

Glucose 5% or 10% should be prescribed to make up any deficit in fluid volumes
### Concentrated PN for **term** Infants

<table>
<thead>
<tr>
<th>Flow rates</th>
<th>SW Neonatal PN Bag 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 ml/kg/day</td>
</tr>
<tr>
<td><strong>Aqueous bag</strong></td>
<td>40 ml/kg/day</td>
</tr>
<tr>
<td><strong>Lipid syringe</strong></td>
<td>5 ml/kg/day</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Contents per kg/day at above rates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nitrogen</strong></td>
<td>0.18 g</td>
</tr>
<tr>
<td><strong>Protein</strong></td>
<td>1.12 g</td>
</tr>
<tr>
<td><strong>Amino acids</strong></td>
<td>1.35 g</td>
</tr>
<tr>
<td><strong>Glucose</strong></td>
<td>4.2 g</td>
</tr>
<tr>
<td><strong>Glucose (mg/kg/min)</strong></td>
<td>2.92 mg/kg/min</td>
</tr>
<tr>
<td><strong>Sodium</strong></td>
<td>1.6 mmol</td>
</tr>
<tr>
<td><strong>Potassium</strong></td>
<td>0.8 mmol</td>
</tr>
<tr>
<td><strong>Calcium</strong></td>
<td>0.4 mmol</td>
</tr>
<tr>
<td><strong>Phosphate</strong></td>
<td>0.52 mmol</td>
</tr>
<tr>
<td><strong>Magnesium</strong></td>
<td>0.08 mmol</td>
</tr>
<tr>
<td><strong>Chloride</strong></td>
<td>1.08 mmol</td>
</tr>
<tr>
<td><strong>Acetate</strong></td>
<td>1.08 mmol</td>
</tr>
<tr>
<td><strong>Lipid</strong></td>
<td>0.75 g</td>
</tr>
<tr>
<td><strong>Vitlipid Infant</strong></td>
<td>1 ml</td>
</tr>
<tr>
<td><strong>Solivito N</strong></td>
<td>0.25 ml</td>
</tr>
<tr>
<td><strong>Non-nitrogen calories</strong></td>
<td>25.3 kcal</td>
</tr>
<tr>
<td><strong>Kcal/g protein</strong></td>
<td>22.5</td>
</tr>
</tbody>
</table>

**Glucose 5% or 10% should be prescribed to make up any deficit in fluid volumes**