UHL Neonatal Parenteral Nutrition (PN) Guideline

University Hospitals of Leicester NHS Trust

C28/2018

Contents

Introduction and Who Guideline applies to

This guideline is aimed at all health care professionals involved in the care of infants within the Neonatal Service at UHL.

Key Points

- This guideline includes information on the indications for Parenteral Nutrition (PN) for infants on the neonatal unit.
- For most patients it should be possible to select an appropriate standardised PN bag.
- In infants less than 30^{+6} weeks, PN should be started at birth as soon as central IV access is established.
- If additional electrolytes are required, a side arm with 10% glucose will be required (nothing should be added to the PN bag)
- The aqueous component is changed every 48 hours, while the lipid component must be changed every 24 hours.

Related UHL documents:

- Feeding Babies of Less than 30 Weeks Gestation UHL Neonatal Guideline C105/2005
- Hypoglycaemia - Neonatal UHL Neonatal Guideline C22/2008

1. Indications for PN

Eligibility for PN:

- Any neonate born less than30^{+6} weeks gestation (PN to start as soon after birth as possible and within 8 hours: supply of UHL stock bag 1 available on the NNU for new admissions)

- Any neonate born between 31^{+0} to 36^{+6}
    - where sufficient progress with feeding is not achieved within 72 hours of birth

- Any neonate less than 36^{+6} CGA
    - where established enteral feeds have to be stopped and are unlikely to restart within 48 hours

  OR
    - where established enteral feeds have stopped for over 24 hours and there is unlikely to be sufficient progress with feeding within a further 48 hours

- Any neonate born over 37^{+0}
    - where established enteral feeds have to be stopped and are unlikely to restart within 72 hours

  OR
    - where established enteral feeds have stopped for over 48 hours

and there is unlikely to be sufficient progress with feeding within a further 48 hours

- Any neonate unlikely to establish sufficient enteral feeding due to e.g. congenital gut disorder, critical illness

The hazards of therapy include line complications and infection, cholestatic jaundice and metabolic disturbance. The benefits require PN to be used for at least 5 to7 days and so PN should not be used unless full enteral feeding is unlikely to be achieved within 5-7 days.

The intention to start PN and indication should be documented in the clinical notes.

PN should start as soon as possible once indicated, and within 8 hours at the latest.

2. Standardised concentrated neonatal PN regimens

The UHL NN standard PN formulation is introduced as early as possible and increased in steps until nutritionally adequate PN is reached by day 5 in 105ml/kg/day by day 5 (plus up to 45ml/kg/day supplementary infusion of 10% glucose). This prevents nutrition being compromised during periods of fluid restriction or multiple drug infusions.

For example:

A 1 kg infant on day 5 of PN with a daily fluid requirement of 150ml/kg/day on 0.5ml/hour morphine infusion would be prescribed:

PN:	105ml/day (90ml aqueous PN and 15ml Intralipid 20%)
10% glucose:	33ml/day
Morphine:	12ml/day (in 10% glucose)

2.1 Choosing a Standard Bag

There are 3 standard formulations, nutritionally identical except for electrolyte contents. All bags are kept in the fridges on NNU. Please check expiry date on bag prior to use. All should be infused through a 0.22 micron filter, **via a central line only and expire after 48 hours in use.**

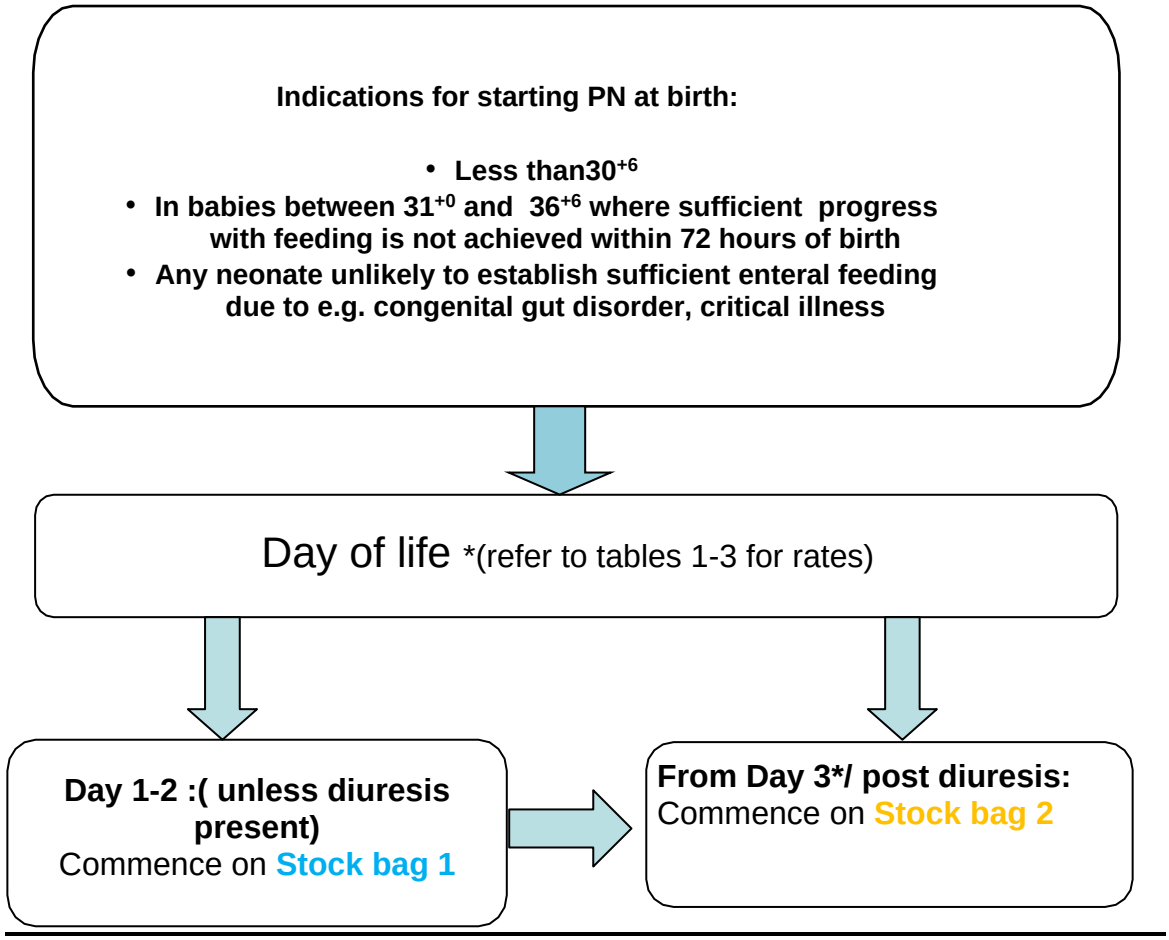
Bags available:

Stock Bag 1: No electrolyte additions

Stock Bag 2: Preterm daily maintenance electrolytes

Stock Bag 3: Maintenance electrolytes with additional sodium

Flow Chart 1: Selecting Standard Neonatal PN aqueous bags



Monitoring:

1-2 hours after starting and after a change in PN glucose content:
Blood glucose

When starting and increasing PN
Daily: blood pH, urea and electrolytes, calcium, triglycerides, phosphate

Twice weekly: liver function, magnesium

When on maintenance PN
Twice weekly: blood pH, urea and electrolytes, calcium

Weekly: triglycerides (may not be needed when transitioning to enteral feeds), phosphate, liver function, magnesium

When on PN for >28days measure ferritin, iron and transferrin saturation in preterms

Increase monitoring frequency when results are out of expected range

Table 1 – Stock Bag 1, daily dosing (select UHL NN Stock Bag 1)

- To be used in the first 2 days of life and when sodium intake needs to be minimised.
- In first 2 days of life use alongside **Intralipid 20% bags** (**do not contain vitamins)**
- Beyond day 2 of life use alongside '**UHL NN Stock Lipid + Vits**' syringe.
- Potassium/phosphate supplementary infusions may be required from day 2.
- Can be used in patients with hyperkalemia.

Day of life	PN solution (ml/kg)	Lipid (ml/kg)	Na^{+} (mmol/kg)	K^{+} (mmol/kg)	Ca^{2+} (mmol/kg)	PO_4^{3-} (mmol/kg)	Mg^{2+} (mmol/kg)
1-2	50	5	0	0	0	0	0
3-4	75	10	0	0	0	0	0
5-6	90	15	0	0	0	0	0
*7	100	20	0	0	0	0	0

***<1.5kg birth weight only**

Table 2- Stock Bag 2, daily dosing (select UHL NN Stock Bag 2)

- Maintenance bag contains trace elements.
- Term babies will go up to 90 ml/kg/day of aqueous PN which delivers 3.6 mmol/kg/day of sodium. Sodium levels need to be monitored.
- To be run alongside premade '**UHL NN Stock Lipid + Vits**' syringe.

Day of life	PN solution (ml/kg)	Lipid (ml/kg)	Na^{+} (mmol/kg)	K^{+} (mmol/kg)	Ca^{2+} (mmol/kg)	PO_4^{3-} (mmol/kg)	Mg^{2+} (mmol/kg)
1-2	50	5	2	1	0.75	1	0.1
3-4	75	10	3	1.5	1.13	1.5	0.15
5-6	90	15	3.6	1.8	1.35	1.8	0.18
*7+	100	20	4	2	1.5	2	0.2

***<1.5kg birth weight only**

Table 3 -Stock Bag 3, daily dosing (select UHL NN Stock Bag 3)

- For infants with high sodium losses. Contains trace elements.
- Sodium content on full PN is 8mmol/kg/day (7.2mmol/kg/day in infants
- ≥1.5kg).
- To be run alongside **'UHL NN Stock Lipids + Vits**' syringe.

Day of life	PN solution (ml/kg)	Lipid (ml/kg)	Na^{+} (mmol/kg)	K^{+} (mmol/kg)	Ca^{2+} (mmol/kg)	PO_4^{3-} (mmol/kg)	Mg^{2+} (mmol/kg)
4	75	10	6	1.5	1.13	1.5	0.15
5-6	90	15	7.2	1.8	1.35	1.8	0.18
*7+	100	20	8	2	1.5	2	0.2

<1.5kg birth weight only

- The aqueous phase of PN is v=changed every 48 hors
- The lipid phase every 24 hours
- If additional electrolytes are required, a side arm with 10% glucose will be required
- **DO NOT ADD ANYTHING TO PN BAG**

2.2 Supplementary glucose infusion

- Supplementary 10% glucose infusions may be required to make up fluid volumes.
- Additional electrolytes may be added to the supplemental 10% glucose infusion if required with close monitoring.
- **Do not** add any electrolytes or fluid to the stock PN (aqueous or lipid phases).
- In order to ensure adequate calorie delivery, drug infusions should be prescribed in 10% glucose wherever possible.
- **In fluid restricted infants, reduce the supplementary glucose infusion rate prior to altering PN rates.**

2.3 Intravenous lipid

Intravenous lipid is available as:

- Intralipid 20% as a 100ml bag (with no vitamins) to run alongside **stock bag 1**.
    - DO NOT transfer into a syringe, run from bag only.
- 50ml syringe containing fat and water soluble vitamins (select **UHL NN Stock Lipid + Vits**) to run alongside **stock bag 2** or **stock bag 3**.

The lipid infusion should be run through a 1.2 micron filter, and changed for a fresh supply every 24 hours.

If PN is administered beyond 14 days, or if conjugated bilirubin rises above 50µmol/l, consider changing lipid source to SMOFLipid (select **UHL NN SMOFLipid + Vits**).
This is run at the same rates as indicated for Intralipid 20% in tables 2-3. Please inform the ward pharmacist so a supply can be ordered.

Caution: For babies with a working weight of **> 4.55kg**, the 50ml Intralipid 20% and SMOFLipid with vitamin syringes are only suitable at doses up to 15ml/kg/day lipid. Beyond this a bespoke lipid syringe should be requested via the neonatal pharmacist to prevent excess infusion of vitamins.

3. Prescribing and administering

PN should be prescribed in the fluid section of the drug chart as follows:

Safety check: The infusion rate of the aqueous stock bags (mls/hr) should always exceed that of the lipid bags and syringes. (Aqueous PN pumps to go on top, lipid pumps to go below the supplementary glucose pumps).

Example 1: 0.5 kg baby day 1 PN, on 100ml/kg/day fluids:

Date	Time	Type of fluid	Volume	Additives & Amount (Batch/Blood Bag No.)	Route	mls/hr	Equivalent dose
1/1/18	22:00	NN PN STOCK BAG 1	500ML	over 48 hours	UVC	1	50ml/kg/day
1/1/18	22:00	INTRALIPID 20%	100ML	over 24 hours	UVC	0.1	5ml/kg/day
1/1/18	22:00	GLUCOSE 10%.	50 ML	—	UVC	0.9	45ml/kg/day
2/1/18	22:00	INTRALIPID 20%	100ML	over 24 hours	UVC	0.1	5ml/kg/day

Example 2: 1.2 kg baby day 7 PN on 150ml/kg/day fluids:

Date	Time	Type of fluid	Volume	Additives & Amount (Batch/Blood Bag No.)	Route	mls/hr	Equivalent dose
1/1/18	22:00	NN PN STOCK BAG 2	500ML	over 48 hours	UVC	5	100ml/kg/day
1/1/18	22:00	NN STOCK LIPID +VITS	50ML	over 24 hours	UVC	1	20ml/kg/day
1/1/18	22:00	GLUCOSE 10%.	50 ML	—	UVC	1.5	30ml/kg/day
2/1/18	22:00	NN STOCK LIPID + VITS.	50ML	over 24 hours	UVC	1	20ml/kg/day

The 3 separate PN components (aqueous bag, lipid infusion and supplementary glucose infusion) are continuously infused at the prescribed rates (given in tables 1-3).

Please complete the patient details on the paperwork enclosed with each aqueous stock bag and stock lipid syringe (see Appendix 4 for an example). Record patient specific batch numbers (unlicensed medicine) in the patient PN record kept in the PN folder.

In situations where fluid, electrolyte and nutrition requirements cannot be managed using stock bags, discuss with ward pharmacist to be assessed for bespoke PN. Any orders of bespoke PN must be made by 10:00 hrs.

PN should be prescribed at a rate according to the day of life and daily fluid requirements, with careful attention to electrolytes and other requirements (e.g. an infant transferred/started on day 3 of life should start on the day 3 PN regimen at 75ml/kg/day, NOT the day 1 PN regimen).

All PN components should be allowed to reach room temperature before administration. They should be clearly over-labelled to identify aqueous and lipid phases using the stickers provided. Line labels should also be used to differentiate between aqueous and lipid infusions.

Light protection: Aqueous and lipid components should be protected from light. Aqueous and lipid bags should be covered with the PN over bags provided. Lipid with vitamin infusions are provided in amber syringes to provide light protection. Amber infusion sets should be used for infusion of both aqueous and lipid parenteral nutrition solutions.

3.1 Starting PN

PN should be started as soon as possible once indicated and within 8 hours at the latest.

3.1.1 Starting PN at birth

- **Stock Bag 1** PN is available in the PN fridge on the neonatal unit.
- Commence PN as soon as possible once central access has been achieved.
- DO NOT delay starting PN.

3.1.2 Starting PN after day 3 or restarting PN

- Infants not starting PN on day one (due to NEC or surgical needs) will require maintenance electrolytes from day 3 of life.
- Start on **stock bag 2** at the higher infusion rate as demonstrated previously, based on the infant's daily fluid allowance.
- This accelerated introduction of PN should also be used when restarting PN in infants who have stopped enteral feeds (e.g. NEC, sepsis).
- In prolonged starvation (lack of adequate nutrition – milk or PN for 5 days or more) consider starting **stock bag 2** or **stock bag 3** at a maximum of 75ml/kg/day and the lipid phase at a maximum of 10ml/kg/day. Electrolytes will need to be monitored closely including magnesium, phosphate and potassium levels.

3.1.3 PN and growth beyond day 7 for infants born <1.5kg

- Infants receiving ANY enteral feed should have their total fluids increased to 175ml/kg/day on day 8 (if fluids not already at this level) when clinically appropriate.
- This allows greater volumes of enteral feed to be given before reducing PN infusion rate.
- In infants whose condition does not allow an increase in fluid (e.g. fluid overload, renal failure) increase of fluid volumes should be deferred until the infant's condition allows.

4. Monitoring and complications of PN administration

4.1 Monitoring

The monitoring suggested below is purely for evaluating PN and additional monitoring according to the clinical condition of the baby may be required.

1-2 hours after starting and after a change in PN glucose content: blood glucose

When starting and increasing PN:

Daily: blood pH, urea and electrolytes, calcium, triglycerides, phosphate

Twice weekly: liver function, magnesium

When on maintenance PN:

Twice weekly: blood pH, urea and electrolytes, calcium

Weekly: triglycerides (may not be needed when transitioning to enteral feeds), phosphate, liver function, magnesium
Monitor head circumference, weight
Review by Neonatal Nutrition MDT

When on PN for >28days
Measure ferritin, iron and transferrin saturation in preterms

Where iron deficiency arises on PN, and there is insufficient enteral intake to supplement, discuss switching to bespoke PN with additional iron with the consultant and pharmacist (up to 1.79 micromol/kg/day iron can be added).

When on PN for >3 months
Measure ferritin, iron, zinc, selenium, copper, chromium, molybdenum and fat soluble vitamins after seeking advice from the neonatal nutrition multi-disciplinary team.

Table 4. Complications of increasing nutrients in PN

Protein	Glucose	Lipids
Acidosis Elevated urea/nitrogen Hyperammonaemia	Hyperglycaemia Glycosuria Osmotic diuresis	Hyperlipidaemia Worsening of unconjugated Hyperbilirubinaemia Potential worsening of lung disease Thrombocytopenia
Cholestasis and conjugated hyperbilirubinaemia is a complication of prolonged PN particularly in the absence of enteral feeding and can be worsened by increase in any macronutrient.		

Additional complications of PN associated with the use of a central line include infection, thrombosis and extravasation injury.

5. Managing metabolic disturbances during PN administration

GLUCOSE

5.1 Hyperglycaemia

Very preterm infants may need insulin to achieve adequate caloric intake without hyperglycaemia (blood glucose >12mmol/l).

Hyperglycaemia should be controlled with an insulin infusion as indicated in the separate Hyperglycaemia on NNU UHL Neonatal Guideline.
Occasionally it may also be necessary to reduce the concentration of any supplementary glucose infusion and any drug infusions to 5%.

5.2 Hypoglycaemia

See separate Hypoglycaemia - Neonatal UHL Neonatal Guideline for prevention and management of symptomatic or significant hypoglycaemia in neonates for definition, management and target blood glucose levels

After acute treatment of hypoglycaemia in neonates on PN, strategies to increase the glucose administration rate infusion include:

- Increasing the concentration of the supplementary glucose infusion in a stepwise manner from 10%, to 15%, 20% etc.
  (Glucose concentrations > 12.5% should be infused via a central line).
- When considering whether to decrease the stock PN bag infusion rate, and increase the supplementary glucose rate to compensate, be aware that the concentration of glucose in NN Stock bags is 12%.
- Please consult the neonatal pharmacist where downward titration of stock PN has been required.

TRIGLYCERIDES

5.3 Hypertriglyceridemia

Although the benefits of routine monitoring of triglycerides are not established, it may help to guide lipid prescribing:

- <3mmol/l - current lipid prescription continued
- 3 – 4mmol/l - current lipid prescription reduced by 50%
- >4mmol/l - current lipid prescription reduced to 0.5-1g/kg/day (2.5- 5ml/kg/d) to ensure some essential fatty acids and vitamins are delivered.

Once triglyceride level has returned to below 3mmol/l, lipid infusion rates should be increased gradually in increments of 1g/kg/day (5ml/kg/day).

Hypertriglyceridaemia (may show lipaemic sample on iLab) can interfere with split bilirubin measurement and cause spurious hyponatraemia, particularly on blood gas analyser.

SODIUM

5.4 Hypernatraemia (>148mmol/l)

- Assess fluid balance, weight and hydration.
- If clinically dehydrated, both sodium and water are usually in deficit and so both need replacing.
- Do not rehydrate using salt poor fluids as this can cause rapid onset hyponatraemia.
- True sodium overload is uncommon and is usually due to over- supplementation (reduce supplements) or renal insufficiency (use PN **Stock bag 1**).

5.5 Hyponatraemia (<132mmol/l)

- Assess fluid balance, weight and hydration.
- Water overload must be considered before sodium supplementation is prescribed. In these cases fluid restriction is usually required and can be achieved by reducing the supplementary glucose infusion rate.
- In true sodium deficit not corrected by current PN regimen, sodium losses should be calculated and replaced by:
    1. Using the standard sodium infusion (below) to supplement sodium - adjust the supplemental sodium dose by altering the rate (0.1ml/kg/hr = 1mmol/kg/day)
    2. Considering stock PN bags with higher sodium content: **Stock bag 2** (4mmol/100ml) or **Stock bag 3** (8 mmol/100ml)

IV SODIUM SUPPLEMENT via CENTRAL LINE

- Add 21mmol sodium chloride (4.2ml of 30% sodium chloride) to 45.8ml 10% glucose to make up 50ml infusion containing 0.42mmol/ml of sodium chloride.
- Infusion rate 0.5ml/kg/hr (0.21mmol/kg/hr) gives sodium supplementation of 5mmol/kg/day

Sodium level	Sodium supplement infusion rate	Next PN prescription
132-142	No supplement required	**Stock bag 2**
128-131	Small deficit. 0.3-0.4ml/kg/hour (3-4mmol/kg/day)	Consider **stock bag 3**
124-127	Medium deficit 0.5-0.6ml/kg/hour (5-6mmol/kg/day)	**Stock bag 3**
<124	Large deficit 0.7-0.8ml/kg/hour (7-8mmol/kg/day)	**Stock bag 3**
<120	Required rate >0.9ml/kg/hour (>9mmol/kg/day). Discuss with consultant	**Stock bag 3**

POTASSIUM

5.6 Hyperkalaemia (≥6.5mmol/l)

- Stop any potassium supplements and manage hyperkalemia
- Switch PN to **stock bag 1** (potassium-free) immediately
- Consider sodium supplementation as stock bag 1 is also sodium-free.

Refer to separate policy, Hyperkalaemia on NNU UHL Neonatal Guideline, for details on the treatment of hyperkalaemia.

5.7 Hypokalaemia (<3mmol/l)

Replace deficit by using supplementary potassium infusion. Aim to correct over 24 hours. Potassium deficiency may arise rapidly on Stock Bag 1 PN regimens especially on day 2-4 of life.

IV standard POTASSIUM SUPPLEMENT via CENTRAL LINE with ECG monitoring

- Add 10mmol potassium chloride (5ml of 15% potassium chloride) to 45ml 10% glucose to make up 50ml infusion containing 0.2mmol/ml of potassium chloride.
- Infusion rate of 0.5ml/kg/hour (0.1mmol/kg/hr) gives potassium supplementation of 2.4mmol/kg/day

If potassium <2mmol/l and/or cardiac rhythm disturbances present, and where larger potassium requirements are required (e.g. stoma losses, diuretics) then higher potassium infusion rates will be required. These should be met by using the standard solution above and increasing the RATE of infusion as described below.
Rates greater than 1ml/kg/hour = 0.2mmol/kg/hour require consultant approval.

For LARGE Potassium deficits higher infusion rates should be used:
IV increased POTASSIUM SUPPLEMENT via CENTRAL LINE with ECG monitoring

- Add 10mmol potassium chloride (5ml of 15% potassium chloride) to 45ml 10% glucose to make up 50ml infusion containing 0.2mmol/ml of potassium chloride.
- Infusion rate of 1ml/kg/hr (0.2mmol/kg/hour) gives potassium of 4.8mmol/kg/day

With consultant approval only infusion rate 1.5ml/kg/hr (0.3mmol/kg/hr) gives potassium supplementation of 7.2mmol/kg/day.

CALCIUM

5.8 Hypercalcaemia (corrected calcium >3mmol/l)

- Stop any supplementary infusions and PN (Stock bags 2 & 3) containing calcium.
- Rehydrate if indicated.
- Discuss PN prescription with consultant and pharmacist.
- HOWEVER, hypercalcaemia may be secondary to hypophosphataemia. The treatment in these cases is to supplement phosphate not to stop calcium.

5.9 Hypocalcaemia (ionised calcium <1 mmol/l)

- Replace deficit using supplementary calcium infusion via central line.
- Aim to correct over 24 hours.
- **Run in separate line/lumen to PN**. If ionised calcium <0.8mmol/l and/or cardiac rhythm disturbances convulsions/tetany present then urgent correction required (see IV policy calcium gluconate policy under electrolyte management).
- If repeated calcium infusions are required (very rare) then non- glass vial supplies of calcium gluconate must be used to limit aluminium exposure.
- Correct any hypomagnesaemia.

IV CALCIUM SUPPLEMENT via CENTRAL line (Do not co-infuse via same lumen as PN, phosphate, or magnesium)

- Add 5.5mmol calcium gluconate (25ml of 10% Calcium Gluconate) to 25ml 10% glucose to make up 50ml infusion containing 0.11mmol/ml of calcium gluconate
- Infusion rate 0.45ml/kg/hr (0.05mmol/kg/hr) gives calcium supplementation of 1.2mmol/kg/day

5.10 Hyperphosphataemia (>3mmol/l)

- Stop any supplementary infusions containing phosphate.
- Discuss PN prescription with consultant and pharmacist.

5.11 Hypophosphataemia (<1.5mmol/l)

- Replace deficit using supplementary phosphate infusion.
- Aim to correct over 24 hours. Run in separate line/lumen to PN.
- If phosphate <0.3mmol/l then a more urgent replacement regime is required- please refer to Neonatal Significant Hypophosphataemia Management in Neonates UHL Neonatal Guideline for management of Significant Hypophosphataemia. Phosphate deficiency may arise rapidly on **stock bag 1** PN regimens. This may be accompanied by hypercalcaemia.

IV PHOSPHATE SUPPLEMENT, via CENTRAL line (Do not co-infuse via same lumen as PN, magnesium or calcium)

- Add 10mmol phosphate =10ml sodium glycerophosphate 21.6% to 40ml 10% glucose to make up 50ml infusion containing 0.2mmol/ml of sodium glycerophosphate
- Infusion rate 0.25ml/kg/hr (0.05mmol/kg/hr) gives phosphate supplementation of 1.2mmol/kg/day (and sodium 2.4mmol/kg/day).
- If higher dose required discuss with pharmacist.

MAGNESIUM

5.12 Hypomagnesaemia (<0.6mmol/l)

- Replace deficit using supplementary magnesium infusion.
- Aim to correct over 24 hours.
- If convulsions/tetany present then urgent replacement regime required, please see neonatal IV monograph (hypomagnesaemia) for details

IV MAGNESIUM SUPPLEMENT (Do not co-infuse via same lumen as calcium, phosphate or PN)

- Add 2.5mmol magnesium sulphate (1.25ml of 50% magnesium sulphate) to 48.75ml 10% glucose to make up 50ml infusion containing 0.05mmol/ml of magnesium sulphate
- Infusion rate 0.25ml/kg/hr (0.0125mmol/kg/hr) gives 0.3mmol/kg/day magnesium

5.13 Hypermagnesaemia (>1.25mmol/l)

- Stop any supplementary infusions containing magnesium (unless using magnesium as a second line agent for PPHN).
- Discuss PN prescription with consultant and pharmacist.

5.14 Miscellaneous

- Care should be taken to minimise the volume of drug infusions (by concentrating them) so that maximal volumes of PN can be delivered.
- Poor handling of the amino acid load can lead to persistent metabolic acidosis especially in the very preterm in the first 2 weeks.
- Review possible causes of metabolic acidosis before considering sodium bicarbonate correction.
- This must be discussed with consultant on service/call prior to administration.
- **Stock bag 2** contains 2mmol acetate (metabolised to bicarbonate), and 0 mmol chloride per 100ml.
- **Stock bag 3** contains 4mmol acetate, and 2 mmol chloride per 100ml.
- Babies receiving PN should be reviewed weekly by a multi-disciplinary nutrition team

6. Vascular access

PN should be given through a UVC, percutaneous long line or surgical central line.

Only consider surgical insertion of a central venous catheter if non-surgical insertion is not possible or if long-term PN is anticipated.

A UVC may be used for up to 10 days after birth. A definitive long line should be inserted at the earliest opportunity.

There must be vigilance towards infection in infants on PN particularly in those with central venous access (low threshold for infection screen).

7. Introducing enteral feeds

Introduction of enteral feeding should follow the neonatal feeding guidelines. Enteral feeds should be included in total fluid calculations once infants have reached 20ml/kg/day of milk.

When introducing enteral feeds to infants on PN:

- Reduce supplementary infusion of 10% glucose first.
- Once all supplemental glucose infusion has been replaced by enteral feed, start reducing PN rates proportionately (maintaining the aqueous: lipid rate ratios) as enteral feed volumes continue to increase.

Drug infusions (including supplementary electrolyte infusions) should not be reduced as enteral feeds are introduced, unless clinically indicated.

8. Stopping PN

- Enteral feed tolerance and risk of venous catheter sepsis should be considered when planning to stop PN
- For preterms born at <28^{+0} consider stopping PN within 24 hours once the enteral feed volume tolerated reaches 140-150ml/kg/day
- For preterms born at ≥28^{+0} consider stopping PN within 24 hours once the enteral feed volume tolerated reaches 120-140ml/kg/day

9. Education and Training

None

10. References

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11. Key Words

Calcium, Feeds, Glucose, Lipid,PN, Magnesium, Phosphate, PN Bag, Potassium, Sodium, Triglycerides

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The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.
As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

Contact and review details			
Guideline Lead (Name and Title) Lucy Stachow – Clinical Pharmacist Dr Deepa Panjwani - Consultant S Mittal – Consultant guidelines lead			**Executive Lead** Chief Medical Officer
Details of Changes made during review:			
Date	**Issue Number**	**Reviewed By**	**Description Of Changes (If Any)**
Dec 2017	**1**	Neonatal Guidelines Neonatal Governance	**New guideline**
April 2018	**2**		Minor editorial changes
Nov 2019	**3**	Guidelines meeting	
Mar 2020	**4**		Reviewed in line with NICE guideline 154
May 2022	**5**	Neonatal Guidelines Neonatal Governance	Reviewed in line with NICE guideline 154 Added light protection for administration Added monitoring for when on PN >3 months
April 2024	**6**		Section 5.11 amended in line with hypophosphataemia guideline, appendix 2c replaced with updated details sheet from manufacturer

Appendix 1 – Daily macronutrient delivery from stock PN bags 1, 2 & 3.

Day of PN	PN solution (ml/kg)	Nitrogen (g/kg)	Glucose (g/kg)	Lipid (ml/kg)	Lipid (g/kg)	Calories exclusive of suppl glucose infusions (kcal/kg)
1-2	50	0.31	6+suppl	5	1	41
3-4	75	0.46	9+ suppl	10	1.9	67
5-6	90	0.55	10.8+suppl	15	2.8	85
*7+	100	0.61	12+suppl	20	3.7	100

***<1.5kg (birth weight) only**

Appendix 2 – Formulation details aqueous stock PN

2a UHL NN Stock Bag 1, formulation name ITH00000585

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Details Sheet for Neonate/Paediatric PN

Name: _____ **Hospital No:** _____ **Date of Infusion:** _____

Hospital: Leicester Royal Inf. **Regimen Name:** UHL NN Stock Bag 1

Batch No: T170913585 **Formulation No.:** ITH00000585

Product Volumes			
Water for Injection	52.04 ml	Glucose 50%	120 ml
Vaminolact	327.96 ml		

Volume: 500 ml Overage: 0 ml

Glucose Concentration: 12 % Osmolarity Concentration: 987.4 mOsm/L

***** Administer via CENTRAL LINE Only *****

MAJOR constituents per bag volume (excluding overage)		
Nitrogen	3.05	gram
Glucose	60	gram
Total Calories	319	KCal
Non-Nitrogen Calories	240	KCal
Sodium	0	millimol
Potassium	0	millimol
Calcium	0	millimol
Magnesium	0	millimol
Phosphate	0	millimol
Acetate	0	millimol
Chloride	0	millimol
Zinc	0	micromol
Selenium	0	nanomol
Copper	0	micromol
Iron	0	micromol
Total Volume (excluding overage)	500	ml

2b: UHL NN Stock Bag 2, formulation name ITH00000587

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Details Sheet for Neonate/Paediatric PN

Name: _____ **Hospital No:** _____ **Date of Infusion:** _____

Hospital: Leicester Royal Inf. **Regimen Name:** UHL NN Stock Bag 2

Batch No: T170913587 **Formulation No.:** ITH00000587

Product Volumes

Water for Injection	1.45 ml	Glucose 50%	120 ml
Vaminolact	327.96 ml	Magnesium Sulfate 50%	0.5 ml
Sodium Glycerophos. 21.6%	10 ml	Peditrace	4 ml
Calcium Gluconate 10%	34.09 ml	Potassium Acetate 49%	2 ml

Volume: 500 ml Overage: 0 ml

Glucose Concentration: 12 % Osmolarity Concentration: 1105.5 mOsm/L

***** Administer via CENTRAL LINE Only *****

MAJOR constituents per bag volume (excluding overage)

Nitrogen	3.05	gram
Glucose	60	gram
Total Calories	319	KCal
Non-Nitrogen Calories	240	KCal
Sodium	20	millimol
Potassium	10	millimol
Calcium	7.5	millimol
Magnesium	1	millimol
Phosphate	10	millimol
Acetate	10	millimol
Chloride	0	millimol
Zinc	15.32	micromol
Selenium	101.2	nanomol
Copper	1.26	micromol
Iron	0	micromol
Total Volume (excluding overage)	500	ml

2c: UHL NN Stock Bag 3, formulation name ITH00001194

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Details Sheet for Neonate/Paediatric PN

Name:		**Hospital No:**	**Date of Infusion:**
Hospital:	Leicester Royal Infirmary	**Regimen:**	UHL NN Stock Bag 3 (Jan 2024)
Batch Number:	T240307001	**Formulation No:**	ITH00001194
Container:	Aqueous Bag	**Expiry:**	14/03/2024

Product Volumes

Calcium Gluconate 10%	34.09 ml	Glucose 50%	120 ml
Magnesium Sulfate 50%	0.5 ml	Peditrace	4 ml
Potassium Acetate 49%	2 ml	Sodium Acetate 30%	4.55 ml
Sodium Chloride 30%	1.95 ml	Sodium Glycerophos. 21.6%	10 ml
Vaminolact	327.96 ml		

Volume:	505.05ml	Overage:	0ml
Glucose Concentration:	11.9%	Osmolarity Concentration:	1169.1mOsm/L

*****Administer via Central Intravenous Infusion*****

MAJOR constituents per product volume (excluding overage)

Nitrogen	3.05 gram
Glucose	60 gram
Lipid	0 gram
Total Calories	319 KCal
Non-Nitrogen Calories	240 KCal
Sodium	40 millimol
Potassium	10 millimol
Calcium	7.5 millimol
Magnesium	1 millimol
Phosphate	10 millimol
Acetate	20 millimol
Chloride	10 millimol
Zinc	15.32 micromol
Selenium	101.2 nanomol
Copper	1.26 micromol
Iron	0 micromol
Total Volume	505.05 ml

Appendix 3 – Formulation details lipid stock PN

3a UHL NN Stock Lipid + Vits, formulation name ITH00000591

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Details Sheet for Neonate/Paediatric PN

Name: _____ **Hospital No:** _____ **Date of Infusion:** _____

Hospital: Leicester Royal Inf. **Regimen Name:** UHL NN Stock Lipid + Vits 48.7ml

Batch No: T200122807 **Formulation No.:** ITH00000807

Product Volumes

Intralipid 20%	41.56 ml	Vitlipid N Infant	4.75 ml
Solivito(Vitlipid Infant)	2.38 ml		

Volume: 48.7 ml Overage: 0 ml

Glucose Concentration: 0 % Osmolarity Concentration: 284.9 mOsm/L

***** Administer via CENTRAL LINE Only *****

MAJOR constituents per bag volume (excluding overage)

Nitrogen	0	gram
Glucose	0	gram
Lipid	9.03	gram
Total Calories	91	KCal
Non-Nitrogen Calories	91	KCal
Sodium	0	millimol
Potassium	0	millimol
Calcium	0	millimol
Magnesium	0	millimol
Phosphate	0.73	millimol
Acetate	0	millimol
Chloride	0	millimol
Zinc	0	micromol
Selenium	0	nanomol
Copper	0	micromol
Iron	0	micromol
Total Volume (excluding overage)	48.69	ml

3b: UHL NN Stock SMOFLipid + Vits, formulation name ITH00000626

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Details Sheet for Neonate/Paediatric PN

Name: _____ **Hospital No:** _____ **Date of Infusion:** _____

Hospital: Leicester Royal Inf. **Regimen Name:** UHL NN Stock SMOFLipid + Vits 48.7ml

Batch No: T200122806 **Formulation No.:** ITH00000806

Product Volumes

Vitlipid N Infant	4.75 ml	Solivito(Vitlipid Infant)	2.38 ml
SMOFlipid 20%	41.56 ml		

Volume: 48.7 ml Overage: 0 ml

Glucose Concentration: 0 % Osmolarity Concentration: 306.2 mOsm/L

***** Administer via CENTRAL LINE Only *****

MAJOR constituents per bag volume (excluding overage)

Nitrogen	0	gram
Glucose	0	gram
Lipid	9.03	gram
Total Calories	91	KCal
Non-Nitrogen Calories	91	KCal
Sodium	0	millimol
Potassium	0	millimol
Calcium	0	millimol
Magnesium	0	millimol
Phosphate	0.73	millimol
Acetate	0	millimol
Chloride	0	millimol
Zinc	0	micromol
Selenium	0	nanomol
Copper	0	micromol
Iron	0	micromol
Total Volume (excluding overage)	48.69	ml

Appendix 4 – Example details sheet for stock aqueous and lipid PN

- Details sheet is enclosed in each aqueous PN bag and lipid syringe
- Patient details to be completed by prescriber before returning a copy to the neonatal pharmacist.

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Details Sheet for Neonate/Paediatric PN

Name: _____ **Hospital No:** _____ **Date of Infusion:** _____

Hospital: Leicester Royal Inf. **Regimen Name:** UHL NN Stock Bag 1

Batch No: T170913585 **Formulation No.:** ITH00000585

Product Volumes			
Water for Injection	52.04 ml	Glucose 50%	120 ml
Vaminolact	327.96 ml		
Volume: 500 ml		Overage: 0 ml	

Glucose Concentration: 12 %	Osmolarity Concentration: 987.4 mOsm/L

***** Administer via CENTRAL LINE Only *****

MAJOR constituents per bag volume (excluding overage)		
Nitrogen	3.05	gram
Glucose	60	gram
Total Calories	319	KCal
Non-Nitrogen Calories	240	KCal
Sodium	0	millimol
Potassium	0	millimol
Calcium	0	millimol
Magnesium	0	millimol
Phosphate	0	millimol
Acetate	0	millimol
Chloride	0	millimol
Zinc	0	micromol
Selenium	0	nanomol
Copper	0	micromol
Iron	0	micromol
Total Volume (excluding overage)	500	ml