Worcestershire Acute Hospitals NHS Trust

Worcestershire Royal Hospital Neonatal Parenteral Nutrition Guideline Based on SWMNN guidance May 17

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Key Amendment

Date	Amendment	Approved by
July 2019	Document approved	Paediatric QI Meeting
Oct 19	Alteration to lipid filtering on manufacturers advice	Dr Kamalarajan CD
Oct 19	European medicine agency advice on light protection added	Dr Kamalarajan CD
Oct 19	Removal of SMOF lipid details as not used at WRH	Dr Kamalarajan CD
July 20	PM12 not to be used peripherally	Dr Kamalarajan CD
Oct 20	Reinforce that in a baby who was on enteral feeds TPM can start full Vamin & Lipid	Dr West CD

Introduction

The National Confidential Enquiry into Patient Outcome and Death (NCEPOD) enquiry published in 2010[4] indicated that only 24% of neonates included in the survey were judged to have parenteral nutrition care that was considered good practice. The components of this guideline have been written to try and ensure that the local practices meet the NCEPOD definitions of 'good practice' in relation to parenteral nutrition care.

The British Association of Perinatal Medicine (BAPM) published 'The Provision of Parenteral Nutrition within Neonatal Services A Framework for Practice' in April 2016 with the aim of describing best practice for the administration of neonatal PN. The paucity of evidence is acknowledged within this document and many of the recommendations are based on expert evaluation of the limited evidence.

Neonatal parenteral nutrition typically comprises of 2 components, vamin and lipid, which are designed to run simultaneously as separate infusions. The vamin component (containing carbohydrate, protein, electrolytes +/-trace elements) has been carefully formulated as 'standard' bags designed for use in units across the Southern West Midlands Newborn Network (SWMNN).

There are 2 different lipid preparations formulated as 'standard' syringes, containing lipid and vitamins, designed for the SWMNN. These utilise Intralipid 20% and SMOFlipid®. Intralipid

20% is derived from soya beans and is primarily made up of omega-6 polyunsaturated fatty acids, which are pro-inflammatory and can result in the production of free radicals, which in turn can cause oxidative damage to cells. It also contains phytosterols which are directly hepatotoxic. It is thought that it is these properties of the lipid that contribute to parenteral nutrition associated liver disease (PNALD).

SMOFlipid® is a blend of soybean oil, medium chain triglycerides, olive oil and fish oils. Fish oil contains primarily omega-3 polyunsaturated fatty acids, which are anti-inflammatory and potentially hepatoprotective, and no phytosterols. SMOFlipid® has been shown to be safe to use in preterm infants, but currently there is no evidence to suggest any benefits of its routine use over Intralipid 20%[6,7] in non-cholestatic infants (direct bilirubin <50 µmol/L). There is a recent study showing that the use of SMOFlipid® improves the liver function tests in those with cholestasis, but does not prevent the development of PNALD. SMOFlipid® should only be considered in babies with a direct bilirubin >50 µmol/L and rising trend.

Cycling -infusing the total daily dose of lipid over 20 hours, rather than 24 hours, in cholestatic infants may be considered hepatoprotective but is not practised at WRH

Details of Guideline

Indications for Use

- all babies ≤30 weeks gestation and all babies ≤1000g should be commenced on PN as soon as possible after birth but certainly within 24 hours of birth/ admission
- babies who are 1001g – 1500g should commence PN if it is anticipated that they will not achieve enteral feeds of at least 100mls/kg/day by day 5 of life
- all babies receiving conservative treatment for Necrotising Enterocolitis
- all babies who have undergone surgery for a congenital abnormality or acquired gut anomaly should receive PN whilst establishing enteral feeds
- all babies likely to be fasted for more than any 5 day period for any medical or surgical reason

Mode of Delivery

Peripheral PN
It is recommended that all PN is run centrally. In the absence of central access Start Up Vamin (electrolyte free and comprising 10% glucose and amino acids) and lipid may be run peripherally, for example on day of birth or when central access is temporarily unavailable in a baby already established on PN. There is some evidence to suggest running lipid peripherally in addition to the Vamin component may prolong the life of the peripheral cannula.[9]

Central PN
Central access should be sought as soon as possible
All Parenteral Nutrition with glucose concentration >12% should be administered centrally via an umbilical venous catheter (UVC), percutaneous long line or surgically inserted central venous catheter in view of the high concentration of glucose and calcium. Due to the increasing reports of PN extravasation when administered via a UVC, prolonged infusion (over a week) via a UVC is not recommended[10]

PN must always be infused via a dedicated lumen whether this is a single lumen or double lumen line. In exceptional circumstances where the baby has a single lumen line but requires additional infusions/ drugs and obtaining additional access is impossible, discuss with your unit pharmacist. Note that calcium, magnesium and phosphate containing fluids must never be administered simultaneously with PN.

If venous access is difficult the TPN line can be flushed, intravenous drugs given and the line flushed again before recommencing the TPN infusion.

PN Preparations

The SWMNN PN formulations have been developed to provide adequate nutrition at the maximum prescription rate (see appendix).

Vamin Bags

There are 4 types of standard vamin bags specifically formulated for Southern West Midlands Newborn Network (SWMNN). A bag may be infused for a maximum of 48hours. Please see appendix for compositions.

Start Up – Use as initial infusion fluid until a postnatal diuresis has occurred – this is usually evidenced by a 5% + weight loss. Fluid intake should be restricted, usually to 60ml/Kg/day until postnatal diuresis has commenced. Can also be given peripherally. Start up contains no sodium and glucose is at a 10% concentration.

Preterm Maintenance 12 - initial maintenance PN to be infused for at least 48 hours before increasing glucose concentration; when glucose tolerance established move to Preterm Maintenance 15 (see below). Prolonged use may be required in infants with glucose intolerance or acidosis (contains some acetate salts rather than chloride salts). Please note this does not provide adequate nutrition for long term growth. Sodium concentration is 5 mmol/100ml and glucose concentration 12%. Due to high osmotic concentration PM12 should not be given peripherally.

Preterm Maintenance 15 - standard maintenance PN for all preterm infants. Sodium concentration is 5mmol/100ml and glucose concentration is 15% - it should not be given peripherally.

Term Baby – for use in preterm infants over 2.5kg and/or infants born from 37 weeks onwards. Not stocked at WRH – can be ordered in.

If Parenteral Nutrition is being commenced after a baby has previously tolerated enteral feeds they do not require a start up bag and should commence on the appropriate maintenance bag of vamin. They can start at maximum volume of vamin & lipid.

For infants likely to require PN for longer than 7 days- consider ordering bags with Peditrace (a mixture of trace elements. The addition of these reduce fridge life to 7 days) to ensure recommended micronutrient intakes are met. Discuss with Nutrition Lead, Pharmacist or Dietitian.

Vamin bags can be used for a maximum of 48 hours.

Maximum Vamin infusion rate is 103ml/kg/day

Always give vamin through a pump programmed to display “vamin startup” or “vamin maintenance” – these have a set maximum infusion rate of 8.25 and 11.0 ml/hr respectively. (This is done to help prevent staff running vamin and lipid through the wrong pumps at the wrong infusion rates)

Lipid Types

Intralipid 20%

This is commercially available in bags with a 24 month manufacturer expiry. It should never be withdrawn from a bag into a syringe on the NNU.

Intralipid syringes formulated for SWMNN contain intralipid 20% with added fat and water soluble vitamins. These syringes have a 7 day expiry from the date of manufacture.

All lipid (bag or syringe) may be infused for a maximum of 24 hours.
All lipid should be infused though a filter.

Start with intralipid 20% from a bag. If it seems likely that TPN will continue for more than a few days ask pharmacy to order the syringes plus added vitamins – these are not a stock item and need to be ordered in for each baby that needs them. It is acceptable for a baby to receive lipid with no added vitamins for up to 7 days.

How much lipid should I prescribe?

The amount of intralipid 20% prescribed is increased each day that TPN is given:

Day 1 of TPN	2g/kg/day equivalent to 10ml/kg/day of 20% intralipid
Day 2 of TPN	3g/kg/day equivalent to 15ml/kg/day of 20% intralipid
Day 3 of TPN	3.4g/kg/day equivalent to 17ml/kg/day of 20% intralipid

At WRH we calculate total daily TPN volume (vamin and lipid combined) and dividing by 24 hours find the total rate of TPN per hour. Once baby is on full lipid prescription of 3.4g/kg/day we give 1/7th of this total rate as lipid and the rest as vamin glucose – this means that as TPN is reduced the lipid to Vamin ratio is always optimal. Whilst lipid is being increased the ratio of vamin:lipid will be different and can be ignored.

There have been deaths due to intralipid being run too fast. It should rarely be necessary to run lipid at a rate more than1.5 ml/hr in any baby on our NNU. Always question lipid prescribed at more than 1.5 ml/hr.

Always give lipid through a pump programmed to display “Intralipd” – these have a set maximum infusion rate of 1.56ml/Hr, to prevent massive overdose of lipid (although a lesser degree of overdose could still be caused by inadvertently running lipid faster than 17ml/kg/day)

Prescribing and Administration

All TPN should be prescribed on a prescription chart. Birth weight should be used for the calculations of PN until birth weight is regained. Thereafter, the most recent weight or working weight as appropriate should be used.

SWMNN maintenance PN delivered at maximum rate will provide 120 ml/kg/day (vamin 103 + lipid 17 ml/kg/day) this may not provide adequate fluid, particularly in the first week of life. It may be necessary to provide extra fluid, which can be given alongside the parenteral nutrition as clinically necessary (see Mode of Delivery).

Prior to administering any infusion of parenteral nutrition, 2 registered practitioners should independently ensure that:

- The prescription is legal and clinically correct
- The type of vamin bag and lipid obtained are the same as that prescribed
- The product will not expire for at least 24 hours
- The vamin bag has reached room temperature. (During warming small gas bubbles form, which then dissipate when the bags reach room temperature. Whilst they are reportedly not large enough to cause any harm to the patient they may set off pump alarms. In addition patients may get cold shock from infusion of chilled fluid)
- The calculated infusion rates are correct and do not exceed maximum allowed
- The batch number for both the vamin bag and lipid syringe/bag are documented in the baby's paperwork as per unit policy.
- A dedicated lumen of a central line is available and designated for PN (see mode of delivery)
- PN infusions are administered via a rate controlled pump
- Vamin is administered via a 0.2 micron filter
- All lipid is administered through a 1.2 micron filter
- All TPN (Vamin and Lipid, with or without added vitamins or trace elements) should be protected from light during storage and administration. All bags and syringes should be covered and all infusion lines should be opaque and light protective or covered with light protective plastic. This is a recommendation of the European Medicines Agency August 2019- see references

How to prescribe TPN

Which bag do I choose ?

If the baby is newborn and has not yet had a postnatal diuresis (you will know this has happened when baby has lost >5% birth weight) then choose Start Up

Once postnatal diuresis has occurred change to Preterm Maintenance 12. Once Preterm Maintenance 12 has been tolerated for 48hrs with normoglycaemia change to Preterm Maintenance 15

If baby is not newborn but needs to start TPN ie the postnatal diuresis has occurred then choose Preterm Maintenance 12 and change to Preterm Maintenance 15 after 48 hrs

If a term baby needs TPN use TERM baby TPN as per SWMNN TPN guideline.

What volume should I prescribe?

If Parenteral Nutrition is being commenced after a baby has previously tolerated enteral feeds they do not require a start up bag and should commence on the appropriate maintenance bag of vamin. They can start at maximum volume of vamin & lipid.

Start Total daily Fluid at 60 ml/kg/day , increase to max of 150 ml/kg/day iv with a maximum of 120ml/kg/day of TPN (combined vamin and lipid), start milk as early as possible and increase as tolerated without weaning iv fluids until you reach 180 ml/kg/day.

Then keep increasing milk but wean iv fluids as you do so – 10% glucose first then TPN.

When weaning TPN keep lipid:vamin ratio approximately 1:6. The vamin:lipid ratio need only be calculated once weaning of TPN has commenced i.e. not calculated during introduction and escalation to full TPN.

The baby's total daily fluid prescription will be decided each day on the morning ward round.

Typically a newborn will start on 60ml/kg/day total fluid, this will comprise vamin-glucose, intralipid and any other fluids given such as UAC & drug infusions. As the baby diureses and loses weight the total daily fluid prescription can be increased.

Start Up ,Preterm Maintenance 12 and Preterm Maintenance 15 must not be run at greater than 103ml/kg day.

Intralipid 20% must not be run at a rate greater than 17ml/kg/day

If the baby is only receiving vamin-glucose and lipid even at maximal rates they will only be receiving 120ml/kg/day of fluid. If the total daily fluid requirement is greater than this then the additional fluid can be given as 10% glucose running with the TPN or it can be given as milk if enteral feeds are established.

Maximal iv fluid is usually 150ml/kg/day but maximal total daily fluid (iv plus oral) is 180 ml/kg/day. Total daily fluids should be increased to 180 ml/kg/day by increasing milk feeds before TPN or any other iv fluids are weaned.

For example on day 2 of life a 1.1 Kg baby is prescribed total fluid of 90ml/kg/day. She is tolerating 1ml of milk every 2 hours. She has a UAC running at 1ml/hr.
Total daily fluid = 90 x 1.1 = 99ml/day
Milk = not included as minimal (only include when more than 1ml x2hrly ie > 12 ml/day)
UAC = 1 x 24 = 24ml/day
Hence iv fluid requirement is 99 - 24 = 75 ml/day at a rate of 75/24 = 3.13ml/hr
Lipid (day 2) is 15ml/kg/day = 15 x 1.1 = 16.5 ml/day = 0.69 ml/hr

Preterm Maintenance 12 runs at 3.13 – 0.69 = 2.44 ml/hr

The doctor/ANNP should prescribe :

Preterm maintenance 12 to run at a rate of 2.44 ml/hr
Intralipid 20 % to run at a rate of 0.69 ml/hr

On day 3 of life our 1.1 Kg baby is tolerating 2 ml of milk every 2 hours. Her UAC has been removed. Her total daily fluid prescription is 150ml/kg iv plus an additional 30ml/kg/day of milk if tolerated.

Total daily iv fluid = 150 x 1.1 = 165ml/day but as TPN (vamin and lipid combined) never runs at more than 120ml/kg/day and iv fluids never greater than 150ml/kg/day this is given as TPN at 120 ml/kg/day
Milk = 24ml/day (21.8ml/kg/day)
Hence TPN vamin requirement is 103 x 1.1 = 113 ml/day at a rate of 113/24= 4.72ml/hr
Lipid requirement 17 x1.1 = 18.7ml/day = 0.78ml/hr

The doctor/ANNP should prescribe :

Preterm maintenance 12 to run at a rate of 4.72 ml/hr
Intralipid 20 % to run at a rate of 0.78 ml/hr
NOTE baby is getting 120ml/kg/day iv and 21.8 ml/kg/day of milk so total fluids are 141.8 ml/kg/day – if the baby needs more fluid than this additional 10 % glucose would have to be run iv

With the next milk increase to 3ml every 2 hours = 36ml/day = 32.7ml/kg/day we don't need to reduce iv fluid

With the next milk increase to 4 ml every 2 hours = 48ml/day = 43.64ml/kg/day then we don't need to reduce iv fluids:

With the next milk increase to 5 ml every 2 hours = 60ml/day and we don't need to reduce iv fluids

With the next milk increase to 6 ml every 2 hours = 72ml/day and we **do** need to recalculate iv fluids:

TDF at 180 ml/kg/day = 198 ml
Milk = 72 ml
TPN at 120 = 132 ml

198 – 72 = 126 ml of TPN per day = 126/24 = 5.25 ml/hr given as
Lipid 5.25/7 = 0.75ml/hr
Vamin as 5.25 – 0.75 = 4.5ml/hr

Note when we reduce TPN we are reducing lipid and vamin proportionately to keep ratio of 1part lipid to 6 parts vamin

On day 5 of life our 1.1 Kg baby is tolerating 7ml of milk every 2 hours.
Her total daily fluid prescription is 150ml/kg iv plus an additional 30ml/kg/day of milk if tolerated.

Total daily fluid = 180 x 1.1 = 198 ml/day
Milk = 84 ml /day
Hence TPN fluid requirement is 198 – 84 = 114 ml/day

114 ml/day at a rate of 114/24= 4.75 ml/hr
Lipid runs at 4.75/7 = 0.68 ml/hr
Preterm Maintenance 15 runs at 4.75 – 0.68=4.07ml/hr

The doctor/ANNP should prescribe :

Vamin to run at a rate of 4.07 ml/hr
Intralipid 20 % to run at a rate of 0.68 ml/hr

With the next milk increase to 8 ml every 2 hours = 96 ml/day and we need to recalculate iv fluids:

TDF at 180 ml/kg/day = 198 ml
Milk = 96 ml
198 – 96 = 102ml
TPN at 102 ml/day = 4.25ml/hr
4.25ml/hr divided by 7 = 0.61ml/hr
Hence lipid runs at 0.61ml/hr and Preterm maintenance 15 to run at 4.25 – 0.61 = 3.64ml/hr

Or a quick way to adjust TPN is to remember that once iv 10% glucose is no longer running each 1ml increase in 2 hourly feeds reduces lipid by 0.07ml/hr and Preterm maintenance by 0.42 ml/hr. This gives the same figures as our formal calculation.

What do I need to be careful about?

There have been deaths due to intralipid being run too fast. It should rarely be necessary to run lipid at a rate more than1.5 ml/hr in any baby on our NNU. Always question lipid prescribed at more than 1.5 ml/hr.

As feeds are introduced and increased do not wean TPN until a combined total enteral and IV fluid volume of 180ml/kg/day has been reached. Once the baby is on TPN +/- 10% glucose + feeds at 180ml/kg/day then the iv fluids can be weaned – 10% glucose first and then TPN.

When weaning (but not whilst increasing) TPN the vamin and lipid have to be weaned at a proportional rate so that the vamin to lipid ratio remains roughly 6:1 If you work out the combined vamin and lipid infusion rate then divide by 7 this gives the lipid rate. The rest of the combined infusion rate is then given as vamin.

Weaning PN

Enteral feeds should be commenced as soon as possible and increased as per WRH Enteral Feeding Guideline.

To ensure the provision of adequate nutrition during the introduction of enteral feeds the volume of parenteral nutrition delivered should not be reduced until the baby is receiving a total volume of 180mls/kg/day (Enteral plus Parenteral : unless fluid restricted). Once this volume is reached the vamin and lipid components of the parenteral nutrition should be weaned in proportion to ensure the ratio of calorie provision by fat and carbohydrate remains appropriate.

Feeds are given every 2 hours initially

Start weaning TPN when baby is receiving 180ml/kg/day of fluid, typically this will be 103ml/kg/day of Vamin, 17ml/kg/day of lipid and 60ml/kg/day of milk

For a 1ml increase in 2 hrly milk feed volume Vamin should be reduced by 0.42ml/hr and Lipid by 0.07ml/hr

For a 1.5ml increase in 2 hrly milk feed volume Vamin should be reduced by 0.63 ml/hr and Lipid by 0.10 ml/hr

For a 2 ml increase in 2 hrly milk feed volume Vamin should be reduced by 0.84 ml/hr and Lipid by 0.14 ml/hr

Enteral vitamins and milk fortifier should only be commenced as per feeding policy.

Monitoring and Review

All babies who are receiving parenteral nutrition should:

- Be reviewed by the local Nutrition Team weekly (ideally comprising as a minimum of a doctor, dietician, pharmacist and nurse).
- Be weighed at least three times a week and plotted on a neonatal and infant close monitoring growth chart.
- Have length and head circumference measured weekly and plotted on a neonatal and infant close monitoring growth chart.
- Have daily U+Es, LFT, CRP and glucose monitoring.
- Have twice weekly FBC, bone profile, Mg++and blood gas
- Have nutrition bloods performed 4 weekly. Stop the lipid infusion 4 hours prior to taking the bloods. Triglycerides Fat soluble vitamins A D E Zinc Copper Manganese Selenium B12 and folate Ferritin.

Ordering of PN

Order from pharmacy WRH.

Storage

Vamin bags and lipid syringes should be refrigerated immediately after delivery.
Vamin and the lipid syringes should be refrigerated between 2 – 8^{o}C.
Intralipid 20% bags can be stored at room temperature.
All stored TPN products should be protected from light at all times.

Review, Monitoring, and Revision Arrangements

Regular audit should be conducted to ensure all the aspects of PN administration are being adhered to

Nursing Process for Safe Administration of Neonatal TPN.

Any prescribed medications/fluids should be administered following the Aseptic Non-Touch Technique Policy and Drug Administration Guidelines.

1. Staff should wear a red *'Do Not Disturb'* apron as they would during a scheduled drug administration round.
2. Prepare a sterile field. Clean the top of patient's bedside trolley with a Clinell wipe.
3. Hands should be washed for 30 seconds as per the Hand Hygiene Guideline using an appropriate hand-washing agent and dried thoroughly using hand towels.
4. Immediately before use, a blue plastic tray should be thoroughly inspected for cleanliness and wiped with a 2% chlorhexidine/70% alcohol wipe (e.g. Chloraprep). Disinfect all surfaces of the tray internally and then externally. Once clean, allow to dry naturally.
5. Collect all necessary equipment: Vamin Bag (Kept in Drug Fridge in Treatment Room), intralipid 20% bag or pre-filled lipid syringe with added vitamins, 2 x Fluid administration set, Triple Lumen 0.2 micron filter (red) connection set, 1.2 micron filter (blue), Chlorhexidine Wipes. Check that you have the correct type of Vamin (Start-Up, Maintenance 12 or 15)
6. Wash hands for 30 seconds as per Hand Hygiene Policy, and use alcohol rub.
7. Put on a well-fitting pair of non-sterile gloves straight from the box.
8. Open equipment by carefully peeling back packaging, place syringes in the blue tray, ensuring that key parts are uppermost and not in contact with the tray.
9. Clean the inlet of the Intralipid bag with a Chlorhexidine Wipe. Introduce the fluid administration set spike, prime the line to the end, clamp. Attach the line to a 1.2 micron filter and then connect the filter to the triple lumen connection set using a non-filtered lumen, unclamp and run through until Lipid exits the bung.
10. Lipid will have to be changed every 24 hours, including the lipid filter (blue), due to risk of infection from the Lipid section of the line.
    If at any point there is a risk that a piece of equipment has become contaminated, dispose of it immediately and use a new piece.
11. Clean the inlet of the Vamin bag with a chlorhexidine wipe, attach to administration set and prime..
12. Attach the vamin to one of the filtered arms of the triple lumen connection set.

13. Vamin bag, administration set and the triple lumen (with red filter) connection set will need to be changed at least every 48 hours
14. When TPN has been fully prepared, place untouched sterile pieces in blue tray and vamin and Lipid bags on sterile field, then move trolley to side of incubator.
15. Second member of staff to open incubator door and make line/cannula tip available to aseptic nurse for attachment.
16. Aseptic nurse to clean port of line/cannula with two chlorhexidine wipes for 30 seconds and air dry, clamp and disconnect any old infusion sets.
17. If at any point during the preparation of the TPN, your gloves have become contaminated, remove them, perform hand hygiene and put on a fresh pair of gloves.
18. Before the Aseptic nurse attaches the new giving set to the hub of the line, second nurse to set up pumps/remove any giving sets previously in use and dispose of in yellow cardboard syringe bins. Only when the TPN giving sets are placed in the pumps, vamin or lipid selected and rates of infusion set, can the TPN be attached to the baby.*see below
19. Once fluids are connected, both nursing staff to independently check flow rates against prescription chart and titrate with feeds if necessary. All fluid changes MUST be signed on the appropriate fluid balance chart by two members of staff.
20. Please programme each pump and label infusion line to show clear indicators of the fluid being administered through each line. (This is to prevent errors of over infusion Lipid in particular, as per NPSA alert. For more information on this, click on the link below:
    https://improvement.nhs.uk/documents/1756/Patient_Safety_Alert_-_TPN_in_babies_FINAL.pdf)
    21.Further information regarding ANTT can be found here:
    http://www.treatmentpathways.worcsacute.nhs.uk/referenceguides/paediatrics-information-portal/paediatrics-information-portal/ or by searching treatment pathways, selecting Paediatrics, Neonatal and clicking the link for the ANTT guideline.

*A further warning relating to over-infusion of TPN was issued by NHS improvement in March 2019. It describes a fatal case:

"*In this case, a new bag of PN was hung and attached to the patient, **before** the giving set had been attached to the pump and **before** the previous bag had been taken down. The second bag was then taken down, but the member of staff involved forgot to attach the giving set to the pump; as a result, the PN bag was running as free-flow. The significance of this was that the baby, instead of receiving the aqueous component at a rate of 2mls per hour, received 150mls in 1 hour.*
The rapid infusion produced significant clinical consequences, including severe hyperglycaemia, severe metabolic acidosis and severe bradycardia, and the baby suffered a fatal cardiorespiratory arrest.
The lessons learnt by the organisation included;

- *Remove old bag before hanging new bag*
- *All fluids must have the giving set attached to the pump **before** attaching to the patient*
- *Consider the use and number of octopus extensions in use and the potential for error"*

This table shows typical example values for TPN and fluid increases and weaning:

Total fluid volume	Total TPN	vamin	lipid	crystalloid	milk
ml/kg/day	ml/kg/day	ml/kg/day	ml/kg/day	ml/kg/day	ml/kg/day
60	60	50	10*	0	0
90	90	75	15*	0	0
120	120	103	17	0	0
150	120	103	17	30	0
150	120	103	17	0	30
160	120	103	17	0	40
170	120	103	17	0	50
180	120	103	17	0	60
180	110	94	16	0	70
180	100	86	14	0	80
180	90	77	13	0	90
180	80	69	11	0	100
180	70	60	10	0	110
180	60	52	8	0	120
180	50	43	7	0	130
180	40	34	6	0	140
180	30	26	4	0	150
180	20	17	3	0	160
180	10	8	2	0	170
180	0	0	0	0	180

* vamin : lipid ratio not 6:1as lipid being introduced gradually over first days of TPN

Composition (ml)	**Start up**	**Preterm Maintenance 12**	**Preterm Maintenance 15**	**Term baby**	**Preterm Maintenance 12 + peditrace**	**Preterm Maintenance 15 + peditrace**	**Term baby + peditrace**
Vaminolact	158.1	240.86	240.86	316.13	240.86	240.86	316.13
Glucose 50%	54	96	120	180	96	120	180
WFI	57.9	11.19	27.87	42.08	8.65	24.53	37.1
Calcium gluconate 10%		36.65	36.65	41.36	36.65	36.65	41.36
Potassium phosphate 13.6% (1mmol/ml PO4 and K)		1.6			1.6		
NaAc 30% (2.2mmol/ml Na and Ac)		3.28			3.28		
MgSO4 50% (2mmol/ml)		0.4	0.4	0.6	0.4	0.4	0.6
ZnSO4 100micromol/ml		0.16	0.16	0.24			
Sodium glycerophosphate 21.6% (2mmol/ml Na and 1mmol/ml PO4)		6	7.6	9	6	7.6	9
Sodium selenite 0.2micromol/ml		0.5	0.5	0.75			
Sodium chloride 30%		0.16	0.96	2.34	0.16	0.96	2.34
Potassium chloride 15%		3.2	5	7.5	3.2	5	7.5
Peditrace					3.2	4	4
Total volume	270	400	440	600	400	440	600
Stability	90 days	90 days	90 days	90 days	7 days	7 days	7 days

Composition (ml)	**Start up**	**Preterm Maintenance 12**	**Preterm Maintenance 15**	**Term baby**	**Preterm Maintenance 12 + peditrace**	**Preterm Maintenance 15 + peditrace**	**Term baby + peditrace**
Per volume (ml)/kg	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Nitrogen (g)	0.54	0.56	0.51	0.49	0.56	0.56	0.49
Protein(g)	3.40	3.49	3.17	3.06	3.49	3.49	3.06
Glucose (g)	10	12	13.65	15	12	15	15
Nitrogen calories (Kcal)	13.58	13.97	12.71	12.23	13.97	13.97	12.23
Non-nitrogen calories (Kcal)	40	48	54.6	60	48	60	60
Total calories (Kcal)	53.58	61.97	67.31	72.23	61.97	73.97	72.23
Sodium (mmol)	0	5	4.5	4.95	5.004	5	4.95
Potassium (mmol)	0	2	2.25	2.5	2	2.5	2.5
Calcium (mmol)		2.02	1.84	1.52	2.02	2.02	1.52
Magnesium (mmol)		0.2	0.18	0.2	0.2	0.2	0.2
Phosphate (mmol)		1.9	1.56	1.5	1.9	1.9	1.5
Acetate (mmol)		1.8	0		1.804		
Chloride (mmol)		1.8	3.37	4.45	1.8	3.7	4.45
Zinc (micromol)		4	3.64	4	3.06	3.82	3.82
Selenium (nanomol)		25	22.75	25	20.24	25.3	25.3
Copper (micromol)					0.25	0.32	0.32
Manganese (nmol)					14.56	18.2	18.2
Fluoride (micromol)					2.4	3	3
Iodide (nmol)					6.3	7.88	7.88

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Contribution List

This key document has been circulated to the following individuals for consultation;

Designation
All Consultant paediatricians WRH
All members of the Paediatric clinical Governance Team
All attendees of the Paediatric Quality Improvement Meetings
All senior Neonatal Nursing staff
Sarah Scott – Paediatric Pharmacist WRH
Sara Clarke – Neonatal Network Dietician

This key document has been circulated to the chair(s) of the following committee's / groups for comments;

Committee
Medicines Safety Committee WAHNHST

Supporting Document 1 - Equality Impact Assessment Tool

To be completed by the key document author and attached to key document when submitted to the appropriate committee for consideration and approval.

		Yes/No	Comments
1.	**Does the policy/guidance affect one group less or more favourably than another on the basis of:**		
	Race	no	
	Ethnic origins (including gypsies and travellers)	no	
	Nationality	no	
	Gender	no	
	Culture	no	
	Religion or belief	no	
	Sexual orientation including lesbian, gay and bisexual people	no	
	Age	no	
2.	**Is there any evidence that some groups are affected differently?**	no	
3.	**If you have identified potential discrimination, are any exceptions valid, legal and/or justifiable?**	no	
4.	**Is the impact of the policy/guidance likely to be negative?**	no	
5.	**If so can the impact be avoided?**	n/a	
6.	**What alternatives are there to achieving the policy/guidance without the impact?**	n/a	
7.	**Can we reduce the impact by taking different action?**	n/a	

If you have identified a potential discriminatory impact of this key document, please refer it to Human Resources, together with any suggestions as to the action required to avoid/reduce this impact.

For advice in respect of answering the above questions, please contact Human Resources.

Supporting Document 2 – Financial Impact Assessment

To be completed by the key document author and attached to key document when submitted to the appropriate committee for consideration and approval.

	Title of document:	Yes/No
1.	Does the implementation of this document require any additional Capital resources	no
2.	Does the implementation of this document require additional revenue	no
3.	Does the implementation of this document require additional manpower	no
4.	Does the implementation of this document release any manpower costs through a change in practice	no
5.	Are there additional staff training costs associated with implementing this document which cannot be delivered through current training programmes or allocated training times for staff	no
	Other comments:	

If the response to any of the above is yes, please complete a business case and which is signed by your Finance Manager and Directorate Manager for consideration by the Accountable Director before progressing to the relevant committee for approval.