Nutritional Care of Infants in the Neonatal Unit Guideline

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Contents		Page
Paragraph	**Executive Summary / Policy Statement / Flowchart**	2
1	**Scope and Purpose**	3
2	**Definitions**	3
3	**Details of Procedure to be followed**	4
4	**Roles and Responsibilities**	15
5	**Related Trust Policies**	16
6	**Implementation (including training and dissemination)**	16
7	**Process for Monitoring Compliance/Effectiveness of this Policy**	16
8	**Arrangements for Review of this Policy**	16
9	**References**	16

Appendices		Page
Appendix A	Nutrient Requirements	15
Appendix B	Nutritional Content of commonly used feeds and stock PN	17
Appendix C	PN flow rates	19
Appendix D	PN Monitoring including lipid adjustment	20
Appendix E	Flow Charts	22
	(1) Starting and increasing feeds – High risk preterm infants	22
	(2) Starting and increasing feeds – Moderate risk preterm infants	23
Appendix F	Preterm Infant Feed Volume Tables	24
Appendix G	Donor Breast Milk Guidance	25
Appendix H	Management of Gastric Residuals/Aspirates and Abdominal Distension	26
Appendix I	Management of Gastro-Oesophageal Reflux (GOR)	27
Appendix J	Management of Cow's Milk Protein Allergy (CMPA)	29
Appendix K	Nutritional Management of Surgical Infants	30
Appendix L	Nutritional Management of Infants with Congenital Heart Disease	31
Appendix M	Nutritional Management of neonates/infants with liver dysfunction	32
Appendix N	Nutritional Management of metabolic bone disease of prematurity	34
Appendix O	Nutritional management of infants with short bowel syndrome	35

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Executive Summary

Good nutrition is important at all stages of life. Babies are born at a time of rapid growth and formation of body tissues and organs, yet immature metabolism means they are unable to cope with either excess or lack of nutrients. Detail in both the quantity and quality of nutrients is critically important.

There is clear evidence that mother's breast milk confers many advantages to both babies and mothers. As well as providing optimal nutrition for human development, breast milk contains many factors which promote immune function and enable healthy intestinal development. Breast milk and breast-feeding should be the preferred milk feed and all mothers should be encouraged and supported to breast feed.

Preterm infants and those with congenital abnormalities or metabolic disorders may require nutrient supplements or special feeds, and may require a period of intravenous nutrition until the gut is able to support their needs.

Measuring growth and monitoring biochemical well-being is crucial to optimising nutrition in high risk individuals.

1 Scope and Purpose

These guidelines aim to provide both practical and theoretical guidance for the optimal nutrition for all sick and preterm infants on the neonatal unit in Southampton.

2 Definitions

AREDF	Absent or Reversed End Diastolic Flow (in umbilical artery, seen on antenatal scans)
AXR	Abdominal X-Ray
Babiven	Babiven start-up – does not contain NaCl and the glucose concentration is 10%
BMF	Breast Milk Fortifier
CPAP	Continuous Positive Airways Pressure
D/C	Discharge
DBM	Donor Breast Milk
DH	Department of Health
ELBW	Extremely Low Birth Weight (birth weight <1000g)
FBC	Full Blood Count
g	grams
IU	International Units
IUGR	Intrauterine Growth Restriction
IV	Intravenous
Kcal	kilocalories
Kg	kilogram
LBW	Low Birth Weight (birth weight <2500g)
LFT	Liver Function Tests
MBM	Maternal Breast Milk
mg	milligram
ml	millilitre
mmol	millimole
NBM	Nil By Mouth
NEC	Necrotising Enterocolitis
NICU	Neonatal Intensive Care Unit
NNU	Neonatal Unit
PBP	Potentially Better Practice
PDA	Patent Ductus Arteriosus
PDF	Post Discharge Formula
PN	Parenteral Nutrition
RCT	Randomised Controlled Trial
SD	Standard Deviation
TAT	Trans-anastamotic Tube
TPN	Total Parenteral Nutrition
U&E	Urea and Electrolytes
VLBW	Very Low Birth Weight (birth weight <1500g)
VON	Vermont Oxford Network

3 Details of procedure to be followed

Assessment and Monitoring of Growth

Growth Measurement

Regular measurements are vital to guide nutritional care and allow subsequent progress to be monitored. Weight measurements alone are not sufficient to determine adequate growth. Changes in weight in the early days of life usually reflect fluid balance: aim for weight loss of no more than 10% from birth weight. Once baby is stable and growing, aim for gain of 15-20 grams/kg/day. Head circumference and length: normally expect increase of 0.75 cm/week. Measurements will populate growth charts on Metavision.

Admission: Measure Weight, Length and Head circumference for ALL babies.

Weekly (Sunday night): Measure Weight, Length and Head circumference for all babies provided they are well enough. Infants on CPAP should have their hats removed and their head measured weekly unless they are very unstable.

Babies are also routinely weighed on Tuesday night and Thursday night to guide clinical care. Daily weights are often required for babies with renal failure.

Nutritional risk assessment

Nutritional screening is important to identify infants at risk of poor growth. There is a nutritional screening tool on Metavision based on the risk criteria below, the results of which guides rates of PN and enteral feeds (see appendix for flow chart). The nutrition team will review all high risk patients in ITU/HDU (Tuesday 9-10:30 neonatal seminar room) and others by request.

High risk

- Preterm <28 weeks
- ELBW < 1000g
- Severe IUGR (weight < 2nd centile with AREDF) <35 weeks
- Infant establishing feeds after episode of NEC or GI perforation
- Infants with severe congenital GI malformation: e.g. gastroschisis
- Infants with complex congenital heart disease

Moderate risk

- Preterm 28-31^{+6} weeks, otherwise well
- VLBW 1000 – 1500g
- Moderate IUGR (weight < 9th centile and AREDF) <35 weeks
- Baby on inotropes
- Baby on indomethacin/ibuprofen (NB avoid concomitant treatment with steroids)
- Baby >1500g with illness or congenital anomaly which may compromise feeding
- Perinatal hypoxia / ischaemia
- Symptomatic polycythaemia, with PCV $\geq$ 70%

Low risk

- Preterm 32-36^{+6} weeks, otherwise well
- AREDF / IUGR $\geq$35 weeks
- Term Infants >37 weeks

Nutrition Support for the Preterm Infant

OVERVIEW - GETTING STARTED - EARLY TPN AND TROPHIC MILK FEEDS

See following appendices for further information

- **Nutrient intake recommendation- Appendix A**
- **Nutritional content of common feeds and stock PN - -Appendix B**
- **Stock PN flow rates- appendix C**
- **PN monitoring including lipid adjustment for triglyceride levels – Appendix D**
- **High and Moderate risk infant flow chart for feeds and PN- Appendix E**
- **Suggested enteral feed volumes – Appendix F**

HIGH AND MODERATE RISK (see appendix E)
Aim to introduce milk feeds gradually while maintaining calorie and nutrient intake with PN Before starting or increasing milk ensure baby is clinically stable and abdomen soft. Small gastric residuals can be tolerated if baby well. Passage of meconium and then changing stools is an important indication of gut motility. Glycerine suppositories may help if no stool passed for 24 hours. Ensure mother has lactation support to start expressing (see breastfeeding care pathway)

High and moderate preterm (<31^{+6}; <1500g; moderate/severe IUGR/AREDFV <35 weeks)

First 24 hours	Start Babiven PN at 60-90 ml/kg/day via UVC or long line, as soon as possible unless baby very unstable. Ideally within 6 hours of birth. Give fresh colostrum as mouth care or as trophic feeds
24-72 hours	Continue colostrum as available until sufficient MBM is supplied to start trophic feeds as MBM 1 ml/kg 2-4 hourly. If at 48 hours there is no MBM as mother is unable or unwilling to provide MBM, then DBM can be used
48-72 hours	Change to Stock Preterm Concentrated. Increase milk by 10-20 ml/kg/day as tolerated (see table in Appendix D); aim to decrease PN flow rates with feeds only once baby on total fluids of 150ml/kg/day. Commence Abidec 0.6ml once daily when tolerating 60ml/kg/day enteral feed to provide additional vitamin A and D.

Special considerations

- If infant is felt to be at especially high risk of NEC (eg congenital cardiac anomaly) or if infants cannot have fortifier for some reason (eg post NEC surgical patients), then an alternative to fortification is a prolonged period on PN until 34 weeks
- Similarly, a higher total volume of fluids of **180ml/kg/day** may be used to enable a prolonged combination of both PN and unfortified/half fortified feeds if appropriate
- Ask for nutrition team review for complex or unusual situations.

LOW RISK
Low risk

First 24 hours	Commence milk feeds 30-60 ml/kg/day, supplemented by IV fluids if necessary
Beyond 72 hours	Increase milk feeds by 30 ml/kg/day as tolerated

Parenteral Nutrition

PN comprises an aqueous solution (glucose, amino acids, electrolytes and trace elements) and a lipid solution (which contains both fat- and water-soluble vitamins). For adequate nutrition it is important that the lipid is always run alongside the aqueous solution (except when well advanced on enteral feeds - see below). It is given via a **central venous line** (UVC, percutaneous longline or other central line). Rarely in cases where vascular access is a problem, lower concentration bespoke PN can be made and given by peripheral line – this is a consultant decision and requires careful consideration of the risks and benefits.

Indications for PN

- High or Moderate risk infants as described above (start within 6 hours)
- Birth weight >1500g – if enteral feeding contra-indicated, start PN by
    - 48 hours in 1500-2500g
    - 72 hours in 2500-3500g if NBM
- Stock PN is available to start at any time
- Term infants >3.5kg without risk factors should not routinely be started on PN until 5 days of inadequate enteral intake (excluding gastroschisis and other surgical problems- see surgical section in appendix K for more info including post-operative timing of PN)

Stock PN

- Babiven – For preterm infants (<37/40 gestation) for the first 48-72 hours.
- Preterm Concentrated- For preterm infants (<37/40 gestation) requiring maintenance sodium. **This should be the PN of choice for the majority of preterm infants after the first few days following birth**, as it contains more protein. Note that this bag may still be appropriate if the serum sodium is high due to a relative fluid deficit.
- Term PN – for Term infants (≥37 weeks gestation) at any point after birth.

Special prescription ('bespoke') PN

- Bespoke PN may also be appropriate where infants have electrolyte requirements than cannot be met with Stock PN and is prescribed in conjunction with the unit pharmacist. It is not available out of normal working hours.

Blood tests required (see appendix E)

First week of PN:

- Full TPN Profile daily (Renal, bone and liver profiles, inorganic phosphate, magnesium on eQuest) this includes U&E's, Calcium, magnesium phosphate and LFTs)
- FBC twice weekly

Second and subsequent weeks of PN:

- Full TPN Profile and FBC twice weekly if stable
- Triglycerides should be measured weekly (ideally Sunday night) when on IV lipid (see appendix E)
- If on PN for 3 weeks or more, measure Trace elements (Zn, Cu, Se, Mn – use special blood bottle in Dr's Office) and Vitamins (A, D and E) and repeat monthly if a baby is still on PN.
- When on enteral feeds, Infants in the High and Medium risk categories need weekly FBC, U&Es, LFTs and Bone profiles, Magnesium and inorganic Phosphate once they are off PN

and fully enterally fed. This can be extended to once fortnightly when babies are moved into Special Care.

Cautions on PN

SEPSIS - may affect lipid metabolism; measure triglycerides and if >3mmol/L adjust lipid (see appendix D)

CHOLESTATIC JAUNDICE – total and prolonged PN increases the risk, so try to give some enteral feed if at all possible; other risk factors include IUGR, sepsis and short bowel syndrome. SMOF lipid solutions may be beneficial in cases of cholestasis, and should be considered in high risk babies if expected to be on PN for 4 weeks or more.

SURGERY – see surgical section below in appendix K

Reducing PN as enteral feeds increase

- **Only once the infant is receiving 150ml/kg/day total fluids should the aqueous PN solution be decreased as enteral feeds increase** (unless there is a clinical decision to restrict fluids).
- Note that if there is no plan to fortify the infant or if fortifier is felt to be contraindicated, high and moderate risk preterm infants will need to work to a total of 180ml/kg/d total feeds rather than 150ml/kg/d. Also, even at 180ml/kg/d unfortified breast milk will not meet the requirements of preterm infants born at <1.8kg, so thought must be given to a longer period on PN or other supplementation in order to maintain growth. Using unfortified breast milk as the only feed is nutritionally inadequate for preterm infants so should only be considered if there are no other viable options
- Once the infant is on 90ml/kg/day enteral feeds, the rate of lipid infusion should be halved, and then stopped when the infant reaches 120ml/kg/day enteral feeds. Any shortfall in total fluid volume due to the reduction in lipid should be made up by increasing the aqueous PN solution, to allow maximum protein to be delivered to the infant (though do not exceed the maximum prescribed rate). This is important when infants are on Stock PN, but for those on bespoke PN, the reduction in lipid may have already been done/accounted for by the pharmacists when the PN was prescribed so may not be necessary (check with the pharmacists first). **Remember that once the lipid is reduced, vitamin intake will be inadequate until vitamin supplements (Abidec or Dalivit) are started.**

Enteral Feeds

Mother's breast milk (MBM) is almost always the feed of first choice, unless contraindicated by maternal illness, drugs or maternal reasons. If no MBM is available pasteurised donor breast milk (DBM) may be used for high and moderate risk babies with parental consent – see **appendix G for DBM guidance**. Preterm formula (Nutriprem 1) is indicated for infants with birth weight <1.8kg grams; Post discharge formula (Nutriprem 2) is indicated for preterm infants either as sole diet or in addition to breast-feeding from around 36 weeks (or discharge) up to 6 months corrected age.

Other formulas which may be used in special circumstances are summarised in the table below. Note that ideally term infant formulas should not routinely be used for preterm infants unless under specialist advice.

Feed name	Characteristic
• Nutriprem 1	**Preterm** infant formula – whole protein nutrient enriched
• Nutriprem 2	**Preterm** discharge formula – whole protein nutrient enriched
• Hydrolysed Nutriprem 1	**Preterm** extensively hydrolysed whey/casein protein, lactose containing
• Infatrini, SMA High Energy, Similac High Energy	High energy nutrient dense feed for **term infants**, whole whey protein, lactose containing
• Infatrini Peptisorb	High energy nutrient dense feed for **term infants** extensively hydrolysed whey protein, MCT 50%, lactose free
• Nutramigen, Peptijunior, Althera, Aptamil Pepti	Extensively hydrolysed **term infant** formula whey/ casein protein, MCT containing, lactose free
• Alfamino, Neocate, PurAmino	Amino acid **term infant** fromulas, MCT containing, lactose free
• Monogen, Kindergen	Specialist **term infant** formula, whole protein, lactose containing

Nutritional supplementation

BREAST MILK FORTIFIER

'Multi-component' fortifier provides additional calories (carbohydrate), extensively hydrolysed protein (cows' milk based), minerals and vitamins in a powder which is added to MBM.

- It should be routine for all moderate and high risk babies together with those in the late preterm group who are less than 1.8kg at birth and who are exclusively breast fed
- It should also be considered for late preterm infants (<35 weeks gestation) whose mother's are intending to breastfeed or if growth is poor.

Once babies are starting to breast feed, the fortifier can be prescribed as a bolus (see below) which can then be continued on discharge until 48-52 weeks CGA. This should be done under dietetic supervision and can be supported by the Neonatal Home Team.

Infants who are fed with a mixture of fortified breast milk and preterm formula do not need fortifier to be added if they are on 50% or greater preterm formula (assuming they are on 180ml/kg/day)

BMF SUPPLEMENTS AT HOME

This is given as 4 sachets BMF mixed in 40mls of freshly expressed breast milk. This should be given via cup or using a 5ml syringe, giving 5ml 8 times a daily with a breastfeed to support weight gain until 48-52 weeks CGA(1). This should be done under dietetic supervision with the support of the Neonatal Home Team. Parents should be given the UHS parent information sheet on how to make up BMF supplements, which can be found here on staffnet.

MUM PLANNING TO FORMULA FEED

- Babies <34 weeks gestation, with birthweight <1.8kg can be considered for discharge on Post-Discharge Formula (PDF) – Nutriprem 2. This should be continued until 3 to 6 months corrected age.
- ELBW and VLBW babies who have been on Nutriprem 1 should be changed to PDF at approximately 36 weeks corrected age, or taking most feeds by bottle. For those with very poor growth, continuing with Nutriprem 1 formula to 40 weeks corrected age may be appropriate.
- Babies discharged on PDF should have **Abidec 0.6 ml, but not Sytron**.
- If changing to term formula, prescribe Abidec 1 ml (continue until at least one year post term) and Sytron 1ml (continue until 6 month post term)

SOLIDS

Can be introduced at 5-8 months chronological age (or 4-6 months corrected gestational age), depending on developmental stage and degree of prematurity.

VITAMINS, IRON, ZINC, TRACE ELEMENTS AND OTHER SUPPLEMENTS

Vitamins and Iron

Breast milk provides insufficient vitamins (particularly vitamin A and D) and iron for preterm infants. Preterm infants have low levels of fat soluble vitamins, particularly A and D.

- Preterm infants <36 weeks should therefore be commenced on Abidec 0.6ml once daily once tolerating 60ml/kg/day enteral feed (different types or amounts of vitamin supplements may be recommended by the nutrition team in special circumstances).
- All preterm infants <36 weeks should then be switched to Abidec 1ml OD once intravenous lipid is stopped or on reaching full feeds, whichever is sooner, in order to ensure adequate vitamin D provision (unless they are on preterm formula, in which case 0.6ml OD will suffice). 1ml Abidec should be continued until 1 year of age and then a standard dose multivitamin preparation containing vitamin D should be continued until 5 years in line with current Department of Health advice.
- Sytron (iron) should be started at 1ml OD from day 28 in preterm infants on breast milk (even if fortified) or term formula until 1 year of age. Preterm formula is fortified with iron, so iron supplements are not required.

Zinc and Trace elements

An enteral intake of Zinc of 1.4 – 2.5mg/kg/day is recommended and a parental intake around 400µg/kg/day (Appendix A). In patients with significant enterostomy fluid losses, plasma zinc should be regularly reviewed, since they have a high risk of zinc deficiency (2).

When infants are gaining weight rapidly and are sequestering nutrients into tissues, intakes of not only zinc but copper and other nutrients will increase. For infants who have serum zinc levels <11.2 with C-reactive protein <10, zinc supplementation should be commenced at a dose of 2mg/kg/day for 4 – 8 weeks (3-5) .

For Preterm Infants

Zinc (trace element) levels should be measured on or around day 21 of life in:

- All babies who are still on PN at day 21 of life
- All babies who are 'high risk' according to the nutrition guidelines (ie <1000g or <28 weeks at birth)

If infants have low zinc levels (below the reference range on eQuest <11.2) then they should start zinc supplements of **2mg/kg/day** for a period of 4 weeks. After the 4 weeks of

supplementation, they do not need their zinc levels rechecking unless they are displaying poor growth or clinical signs of zinc deficiency (e.g. skin lesions)

For Surgical infants
Many surgical infants will fall into the above criteria for zinc monitoring and supplementation. In addition to this, any baby with an ileostomy who is 21 days or older should have their zinc (trace element) levels tested. If they are deficient, the should also start zinc supplements of **2mg/kg/day** for a period of 4 weeks as above.

However, for infants with ileostomies, supplements should only be started once full feeds have been established, other electrolyte supplements have been started where necessary (and tolerated) and Abidec and Sytron have been commenced and tolerated. Once all these things are addressed, zinc supplements can be started, but need to be done so in isolation (e.g. not with a lot of other feed/supplement changes) so it is possible to be sure that infants are tolerating the zinc from a stoma output perspective.

Supplements and Metabolic bone disease of prematurity (MBDP)

Metabolic bone disease of prematurity (MBDP) is caused by the under mineralisation of the preterm infant's skeleton due to inadequate intake calcium and phosphorus due the perinatal period. Poor growth and fragility fractures may be a consequence of inadequate intake of calcium and phosphorus although the appropriate use of breastmilk fortifier to maternal/ donor breastmilk or the use of preterm formula can help to reduce the incidence.

Biochemical screening e.g. monitoring alkaline phosphatase (ALP), calcium, phosphorus, vitamin D and parathyroid hormone allows for early identification and appropriate nutritional support/ mineral supplementation (see Appendix N for Flow diagram for the management of MBD in prematurity).

Management of Common Gut and Feeding Problems

a. **Gastric aspirates / residuals** – preterm infants have immature gut motility, and aspirates/residuals and small vomits are not uncommon. Large volume aspirates or dark green bile stained aspirates, particularly in association with abdominal distension and / or tenderness are a cause for concern. However small milky / yellow aspirates up to 2-3 mls are frequently normal. They can be replaced, and feeds continued (see Appendix H)

b. **Abdominal distension** – this is another common feature in preterm infants, due to poor gut motility. It tends to be more common in babies on CPAP, with high volumes of air flowing into the upper airway and oesophagus. Tenderness, or systemic symptoms and signs such as apnoea, tachycardia or temperature instability should raise concern. If baby is otherwise well, a small glycerol (glycerin) suppository may help to stimulate peristalsis, and enable feeds to be continued (see Appendix H).

c. **Suspected NEC** – classical features are blood and mucous in stools, bile stained aspirates and abdominal tenderness. Systemic signs such as tachycardia and hypotension occur in severe NEC. X-ray might show intramural gas (pneumatosis coli), dilated loops of bowel, free air, or a gas-less bowel. In suspected NEC feeds should be stopped, and urgent attention paid to supporting ventilation, circulation and fluid balance.

d. **Gastro-Oesophageal Reflux (GOR)** – See Appendix I

e. **Cow's Milk Protein Allergy (CMPA)** – See Appendix J

Other Special Cases

a. **Nutritional Management of Surgical Infants** – See Appendix K

b. **Nutritional Management of Infants with Congenital Heart Disease** – See Appendix L

c. **Nutritional management of neonates/infants with liver dysfunction** – See Appendix M

d. **Nutritional management of metabolic bone disease of prematurity** -See Appendix N

e. **Nutritional management of infants with short bowel syndrome** – See Appendix O

4 Roles and Responsibilities

BREAST-FEEDING AND LACTATION SUPPORT

- All staff: awareness of Trust Policy and NNU Guidelines
- NNU lactation support team – Lead Charlotte Oates: expert guidance for mothers breast-feeding and/or expressing milk in NNU

PARENTERAL NUTRITION

- All staff: awareness of need for PN in high risk infants
- Nursing staff: awareness of location of 'stock' PN in NNU and knowledge and skills for PN administration appropriate to nursing skill level
- Medical staff: awareness of PN supplies available and how to prescribe; awareness of potential complications of PN and how to avoid
- Pharmacists: expertise in detailed composition of PN solutions and provision of PN in different situations on NNU

ENTERAL NUTRITION

- All staff: support for mothers in informed choice of feeding, recognising that breast milk is the preferred feed for all infants, particularly those born preterm
- All staff: awareness of choices for enteral nutrition: maternal breast milk / breast-feeding; donor breast milk / milk bank; standard infant formula; formulas for preterm infants; special formulas for infants with specific gut or feeding problems
- Neonatal Dietitian: expert knowledge of composition of breast milk and alternatives and guidance on making appropriate choices
- Surgical team: expert knowledge on potential feeding challenges in infants with congenital or acquired abnormalities of the gut, particularly following surgery.

FEEDING DIFFICULTIES

- All staff: awareness of common feeding difficulties of preterm infants and those with neurological complications
- Speech and language therapist: expert knowledge of structure and function of upper gastro- intestinal tract and how to optimise feeding potential of vulnerable babies

GROWTH MONITORING

- All staff: Awareness of importance of making accurate and regular measurements and plotting them on appropriate charts to monitor growth
- Nursing staff: Weigh babies at intervals as indicated by clinical condition (ideally three times per week) and head circumference and length weekly.

SPECIAL CASES

- Neonatal Nutrition Team: Will review high risk medical, surgical or complex patients on weekly nutrition ward round

5 Related Trust Policies and documents

Lactation and Breastfeeding in the NNU Guideline
Breastfeeding Term Infants: Guideline
PIER Guideline Gastro-Oesophageal Reflux
PIER Guideline Cow's Milk Protein Allergy
Milk free diet for breast feeding mothers - information leaflet

6 Implementation

Information for all staff on induction and regular updates as necessary.

7 Process for Monitoring Compliance/Effectiveness

Key aspects of the procedural document that will be monitored:

What aspects of compliance with the document will be monitored	What will be reviewed to evidence this	How and how often will this be done	Detail sample size (if applicable)	Who will co-ordinate and report findings	Which group or report will receive findings
None required					

8 Arrangements for Review of the Policy

This guideline will be reviewed every 3 years.

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Appendix A: Nutrient Requirements

Nutrient requirements for Term and Preterm infants in the first weeks of life are summarised below. The figures shown below are based on the parenteral requirements for the first week, and the enteral requirements for the subsequent weeks. It should be noted that these are average recommendations and some infants may require additional nutrients such as sodium, potassium and zinc as dictated by the results of blood tests.

Term infants – based on intake in 150 ml/kg breast milk; preterm infants based on recommendations in Koletzko 2014 unless otherwise stated(2).

There are no specific guidelines for those babies born over 1.5kg and under term weight (2.5 kg) but it can be anticipated that their nutritional needs will be between those of preterm infants and term infants. Nutritional support should therefore aim to deliver nutrient intakes in this area.

Nutrient(Unit/kg/day)	Term infant	Preterm VLBW <1500g (enteral)
Energy (kcal)	90-100	110-130 (85-95IV)
Protein (g)	1.5-2.1	3.5-4.5
Nitrogen (g)	0.24-0.34	0.56-0.72
Sodium (mmol)	1.4	2.4-5.0
Potassium (mmol)	2.0	2.0-5.0
Calcium (mmol)	1.25	3.0-5.0
Phosphate (mmol)	1.3	1.9-4.5
Vitamin D IU*	340	400-1100
Vitamin A IU**	1150	1300-3614
Iron (umol)	17.9	35.7-53.6

*Vitamin D = dose quoted is total daily dose (340 IU = 8.5 mcg Vit D)

**Vitamin A = dose quoted is total daily dose (1150 IU = 350 mcg of Vitamin A retinol equivalent)

Recommendations for micronutrient intakes (per/kg/day) in ELBW and VLBW infants (2)

Nutrient	**Enteral (per/kg/day)**	**Parenteral (per/kg/day)**	**Content in 2ml Peditrace**	**Maternal breastmilk**		**Fortified breastmilk**		**Nutriprem 1**		**Alfamino**			**Infatrin/ Infatrini Peptisorb**	
				100ml	**150ml**	**100ml**	**150ml**	**100ml**	**150ml**	**100ml**	**150ml**		**100ml**	**150ml**
Iron (mg)	2 – 3	0 – 0.25	-	0	0	0	0	1.4	2.1	0.7	1		1.0	1.5
Zinc (mg)	**1.4 – 2.5**	**0.4***	**0.5**	**0.3**	**0.45**	**0.9**	**1.35**	**0.9**	**1.35**	**0.7**	**1**		**0.9**	**1.35**
Copper (µg)	100 – 230	40*	40	40	60	75	112.5	80	120	56	84		60	90
Selenium (µg)	5 – 10	5 – 7*	4	2.2	3.3	4	6	1.9	2.85	1.8	2.7		2.0	3
Manganese (µg)	1 – 15	1*	2	0.44	0.66	8.54	12.8	10	15	7	10.5		0.08	0.12
Iodine (µg)	10 – 55	10*	2	16.8	25.2	27.8	41.7	25	37.5	11	16.5		14	21
Chromium (µg)	0.03 – 2.25	0.05 – 0.3*	-	-	-	-	-	-	-	-	-		4	6
Molybdenum (µg)	0.35	0.25*	-	-	-	-	-	-	-	-	-		6	9

*Approximate values. Iodine recommendations assumes no use of iodine containing antiseptic

Appendix B: Nutritional content of common feeds and stock PN

Nutrient Content of Commonly Used Products per 100ml

Typical Values are used and are correct at 06/05/2020

*Based on Cow and Gate Nutriprem Breast Milk Fortifier

Fluid Name / Nutrient	Babiven Stock PN	Preterm concentrated Stock PN	Term Stock PN	Stock Lipid	Dextrose 10%	MBM/DBM	MBM with Full Fortifier*	Alfamino	Peptijunior	LBW Formula (Nutriprem 1)	Post D/C Formula (Nutriprem 2)	Term formula	Infantrini
Energy (kcal)	50.7	84.8	69.8	171	40	69	80	70	66	80	75	66	100
Protein (g)	2.68	4.18	2.5	0	0	1.3	2.6	1.9	1.8	2.6	2	1.3	2.6
Carbohydrate (g)	10	17	14.9	0	0	7.2	**9.6**	7.9	6.8	8.4	7.4	7.3	10.3
Fat (g)	0	0	0	17.1	0	4.1	3.5	3.4	3.5	3.9	4	3.5	5.4
Sodium(mmol)	0	6.05	2.8	0	0	0.7	2.2	1.1	0.9	3	1.2	0.7	1.1
Potassium (mmol)	1	2.4	1.9	0	0	1.5	2.1	2	1.7	2.1	2	1.6	2.4
Calcium(mmol)	1	1.2	0.92	0	0	0.8	2.5	1.4	1.2	2.3	2.2	1.2	2
Phosphorous (mmol)	1	2.7	0.95	1.5	0	0.5	1.7	1.3	0.9	2	1.5	0.9	1.3
Magnesium	0.2	0.25	0.19	0	0	0.12	0.33	0.27	0.21	0.33	0.29	0.21	0.34
Iron (umol)	0	0	0	0	0	1.3	1.3	12.5	13.8	25.1	17.9	9.5	21.5
Zinc	4	3.9	3.6	0	0	4.6	13.8	10.7	7.6	16.8	13.8	7.6	13.8
Vitamin A (IU)	0	0	0	3997.6	0	213	985.6	307	173.2	599.4	269.7	183.2	333
Vitamin D (IU)	0	0	0	695.2	0	0	200	40	52	120	68	48	68
Volume (ml/kg) required to reach recommended protein intake (ELBW infants)	130	82.5	140	Contains no protein	Contains no protein	292	152	195	211	146	190	292	146

Nutritional Content of Stock PN based on ml/kg/day.

Babiven

Fluid ml/kg/day	60	90	120	130
Babiven bag (ml/**kg**/day)	55	82.5	110	117.5
Lipid syringe (ml/**kg**/day)	5	7.5	10	12.5
Provides (per kg):				
Nitrogen (g)	0.24	0.35	0.47	0.5
Protein (g)	1.5	2.2	2.9	3.1
Glucose (g)	5.5	8.3	11	11.8
Fat (g)	1	1.5	2	2.5
Kcal/kg	38	57	75.6	84.6
Sodium (mmol)	0	0	0	0
Potassium (mmol)	0.6	0.8	1.1	1.2
Total Phosphate (mmol)	0.6	0.9	1.3	1.4
Calcium (mmol)	0.6	0.8	1.1	1.2
Magnesium (mmol)	0.1	0.16	0.22	0.23
Total chloride (mmol)	0	0	0	0
Zinc (micromol)	2.2	3.3	4.4	4.7
Acetate (mmol)	0	0	0	0
Cal:1gN ratio	133	138	136	144

Preterm Concentrated

Fluid ml/kg/day	77.5	90	100
Pre-term Concentrated (ml/**kg**/day)	67.5	75	82.5
Lipid syringe (ml/**kg**/day)*	10	15	17.5
Provides (per kg):			
Nitrogen (g)	0.45	0.49	0.55
Protein (g)	2.81	3.09	3.43
Glucose (g)	11.48	12.6	14
Fat (g)	2	3	3.5
Kcal/Kg	77.2	92.8	104.7
Sodium (mmol)	4.09	4.49	4.99
Potassium (mmol)	1.64	1.8	2
Total phosphate (mmol)	1.97	2.23	2.49
Calcium (mmol)	0.81	0.89	0.99
Magnesium (mmol)	0.172	0.19	0.21
Total chloride (mmol)	1.03	1.13	1.25
Peditrace	0.68	0.75	0.83
Acetate (mmol)	1.64	1.8	2
Cal:1g N ratio	147	164	166

Term bags

Fluid requirement ml/kg/day	60	90	120	135
Term bag (ml/**kg**/day)	55	80	105	120
Lipid syringe (ml/**kg**/day)	5	10	15	15
Provides (per kg):				
Nitrogen (g)	0.22	0.32	0.42	0.48
Protein (g)	1.38	2.00	2.63	3.00
Glucose (g)	8.2	11.9	15.7	17.9
Fat (g)	1	2	3	3
Kcal/kg	48.3	75.6	103.3	113.6
Sodium (mmol)	1.53	2.23	2.93	3.34
Potassium (mmol)	1.04	1.51	1.98	2.27
Total phosphate (mmol)	0.6	0.9	1.22	1.36
Calcium (mmol)	0.50	0.73	0.96	1.10
Magnesium (mmol)	0.11	0.15	0.20	0.23
Total chloride (mmol)	1.79	2.60	3.42	3.91
Peditrace	0.51	0.74	0.98	1.12
Acetate (mmol)	1.04	1.51	1.98	2.27
Cal: 1gN ratio	195	211	221	212

*Please note total phosphate is received when the patient is receiving full lipid - Clinoleic 20% contains 1.5mmol PO4/100ml

Appendix C: Flow rates of Stock PN Solutions

The flow rates given in the tables below are per kg and therefore will need to be multiplied by the baby's weight.

Babiven Start-Up Bags (sodium-free)
Suitable for <30/40 weeks gestation

Day of parenteral nutrition	1	2	3	4
Babiven Start-Up (ml/**kg**/day)	55	82.5	110	117.5
Lipid Syringe (ml/**kg**/day)	5	7.5	10	12.5
Total Fluid (ml/**kg**/day)	60	90	120	130

Preterm concentrated can be started from 48 hours onward depending on electrolytes

Preterm concentrated
Suitable for transferring from Babiven Start-up at Day 3

Day of parenteral nutrition	**3**	4	5+
Preterm concentrated (ml/**kg**/day)	67.5	75	82.5
Lipid Syringe (ml/**kg**/day)	10	15	17.5
Total Fluid (ml/**kg**/day)	77.5	90	100

If a larger fluid volume is required additional 5% glucose may be run alongside the PN to bring the total fluids up to the desired total (ensure other infusions are also considered). 5% glucose can also be used to deliver additional electrolytes if required.

Term Bags

Day of parenteral nutrition	1	2	3	4+
Term Bag (ml/**kg**/day)	55	80	105	120
Lipid Syringe (ml/**kg**/day)	5	10	15	15
Total Fluid (ml/**kg**/day)	60	90	120	135

Prescribing
The stock PN should be prescribed, including a maximum rate of infusion, on Metavision. Two prescriptions are required, one for the aqueous nutrition bag and one for the lipid syringe.

Notes

- The lipid infusions should remain at a constant daily rate.
- The rate of the nutrition bag should be adjusted to take into account other continuous infusions.
- "Day of parenteral nutrition" in tables above is a rough guide only. Clinical need and fluid status should be taken into account when deciding on PN regimen.
- No additions should be made to stock PN.
- Each bag may be used for a maximum of 48hours
- Lipid must be changed every 24 hours
- Babiven & Term stock bags - If PN is being started at a rate of 120ml/kg/day or greater, the lipid should be prescribed at half-rate for 24hours, the additional volume may be made up from the aqueous bag
- Preterm concentrated stock bag – If PN is being started for the first time at a rate of 90ml/kg/day or greater, the lipid should be prescribed at half-rate for 24 hours. The additional volume may be made up by infusing additional glucose 5%.

Appendix D: Monitoring Requirements whilst on Parenteral Nutrition

Daily (Until stable and then twice weekly)

	Target levels for preterm infants (NB not same as lab normal range)
Sodium	136-144mmol/l
Potassium	3.5-5mmol/l
Corrected Calcium	2.15-2.6mmol/l
Ionised Calcium (blood gas)	1.0 – 1.3mmol/l
Phosphate	1.6-2.8mmol/l
Creatinine	30-65 micromol/l
Urea	2.9-7.1mmol/l
Albumin	25-45g/l
Bilirubin	<200 micromol/l
Blood Glucose	2.6-5.5mmol/l

Weekly

* Preterm-infants should have their triglyceride levels measured on day 3 of PN.

	Target levels for preterm infants (NB not same as lab normal range)
Magnesium	0.74-1.03mmol/l
Triglycerides*	< 3 mmol/l
Alk. Phos.	150-425 IU/l
ALT	10-40 IU/l
Weight	At least weekly

From day 21 on PN and then Monthly

	Target levels for preterm infants (NB not same as lab normal range)
Zinc	11-24 mol/l
Selenium	0.2-0.9micromol/litre
Copper	3-11 micromol/l
Manganese	120 – 325 nmol/l
Vitamin D	> 50 nmol/l
Vitamin A	0.7-1.5 micromol/l
Vitamin E	7-21 micromol/l

Impact of acute phase response on serum trace elements levels.

Trace Elements	Effect of Acute Phase Response
Copper	Increased
Ferritin	Increased
Iron	Decreased
Zinc	Decreased
Plasma Selenium †	Decreased
Chromium	Decreased
Manganese	No effect
Iodine, Molybdenum	Unknown

† Red cell selenium is not affected by acute phase response.

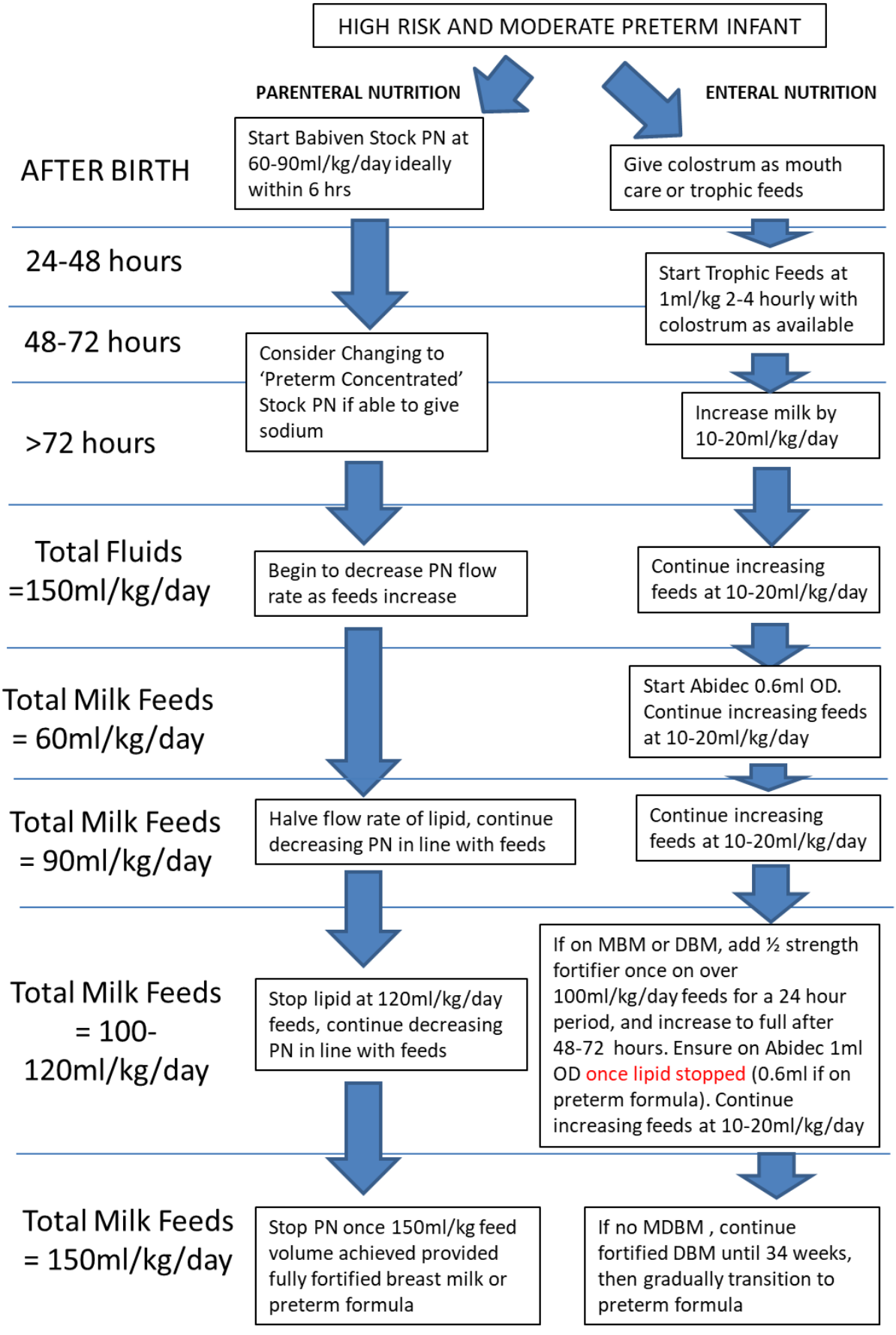
Table from Zemrani B, McCallum Z, Bines JE. Trace Element Provision in Parenteral Nutrition in Children: One Size Does Not Fit All. Nutrients. 2018;10(11).

Triglyceride Monitoring and Management for Neonates receiving PN.

- Triglyceride (TG) levels should be measured at least weekly, preterm babies should have their TG levels measured on day 3 of PN.
- Triglyceride levels may need to be measured more frequently in cases of sepsis, catabolism, hyperglycaemia, thrombocytopenia and liver impairment.
- Hypertriglyceridaemia is defined as > 3mmol/l in neonates.
- If the level is > 3mmol/l do NOT stop the lipid but reduce the rate of the infusion (see recommendations below).
- To prevent essential fatty acid deficiency, pre-term infants require a minimum intake of 1g/kg/day and term infants requires a minimum intake of 0.5g/kg/day.

Triglyceride level	Recommended Action
< 3 mmol/l	Continue with lipid infusion as per guideline.
> 3 – 5 mmol/l	• Reduce lipid infusion by ¼ and recheck TG after 24 hours
> 5 – 8 mmol/l	• Reduce lipid infusion by ½ and recheck TG after 24 hrs
> 8 mmol/l	• Reduce lipid to 1g/kg/day (5ml/kg/day) and recheck TG after 24 hours. If still raised reduce lipid infusion to 2.5ml/kg/day, if pump allows. • Continue to monitor TG and once < 3mmol/l increase lipid to 10ml/kg/day and recheck TG after 24 hours. ○ If this level is > 3mmol/l reduce back to 5ml/kg/day and when the level is < 3mmol increase more cautiously to 7.5ml/kg/day. ○ If level is < 3mmol/l increase lipid to 15ml/kg/day ○ Do not increase lipid further without repeating TG level.

Appendix E: Managing parenteral nutrition and feeds – High and Moderate risk infants



Appendix F: Preterm Infant Feed Volume Tables

a. Starting and Increasing Feeds

i. High Risk Infants (based on increases of 10-20ml/kg/day)

Weight (kg)	Start at (hourly)	Start at (2 hourly)	Increase hourly feed volume by*	Increase 2hourly feed volume by
less than 0.6	N/A	0.5	0.25ml every 24 hours	0.5ml every 24 hours
0.6-0.9	0.5	1	0.5ml every 24 hours	1ml every 24 hours
0.9-1.2	0.75	1.5	0.5ml every 12 hours	1ml every 12 hours
1.2-1.5	1	2	0.5ml every 8 hours	1ml every 8 hours
1.5-1.8	1.25	2.5	0.5ml every 6 hours	1ml every 6 hours
1.8-2	1.5	3	1ml every 12 hours	2ml every 12 hours

*Note that this refers to the actual feed volume based on 1 hourly feeds. Therefore if baby is 2 hourly fed then multiply the amount on this table by 2 to give the increase on the feed volume, if on 3 hourly feeds multiply by 3 and so on.

Appendix G: Donor Breast Milk Guidelines

A mother's own breast milk is always preferable to infant formula or donor breast milk (except in very rare circumstances for example maternal HIV or chemotherapy) and every effort should be made to support the mother in producing milk for her baby. Infants who are at risk of gut complications

Donor breast milk (DBM) is a human body fluid and, as such, carries risks of transmission of infective agents. Donors are screened and the milk is pasteurised to minimise risk. Written consent must be obtained for the use of donor breast milk. Handling, testing and documentation of the milk in the donor milk bank and specialist feed unit is carried out according to Food Standards Agency Guidelines 2007

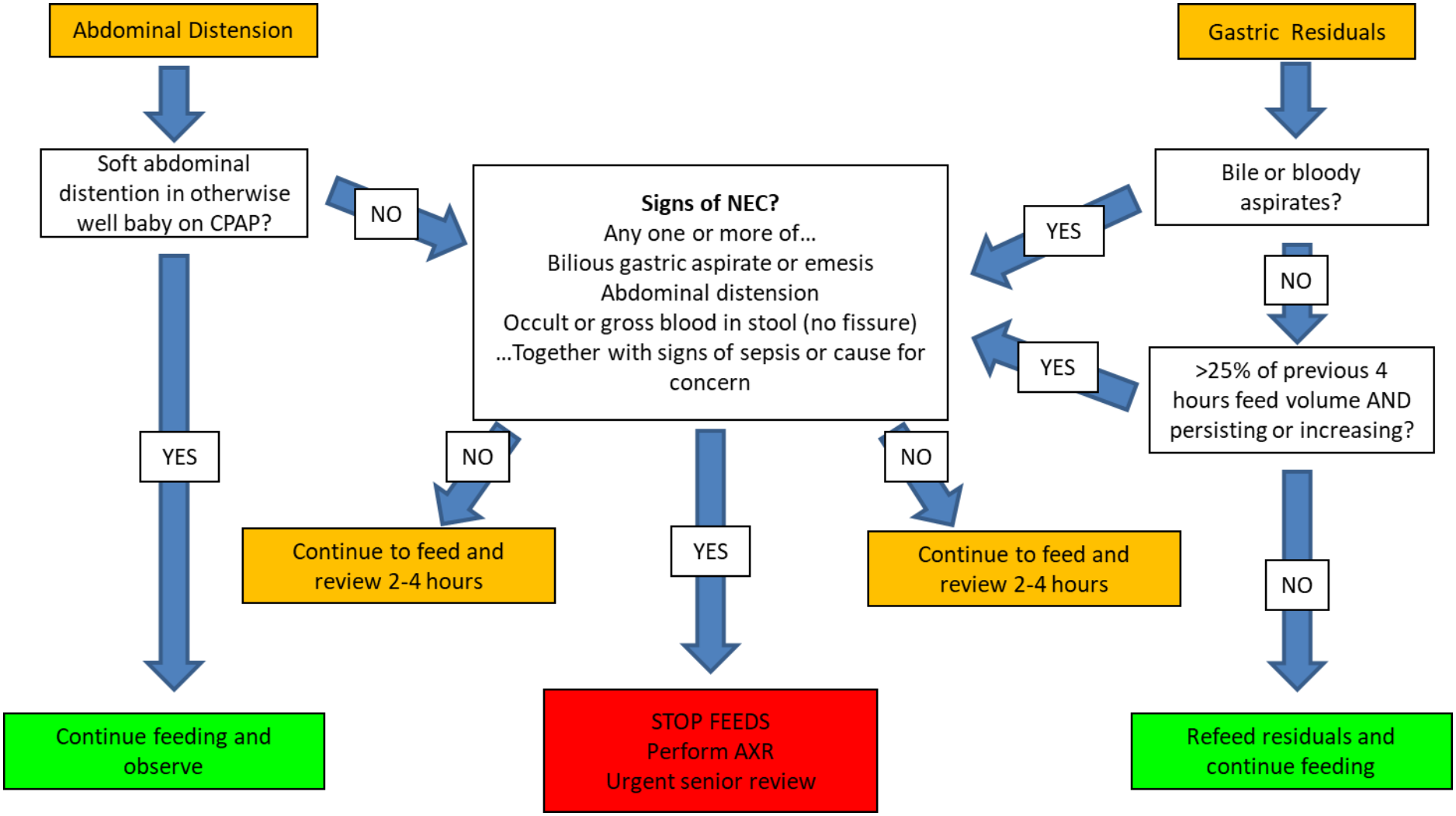
Indications for use

- High or moderate risk infants (as assessed by nutritional screening tool)
- Any infant with surgical pathology
- Any infant with cardiac pathology
- Consultant decision to use

Duration of Use

Although donor breast milk may have reduced nutritional content because of the processing required, breast milk fortifier and/or additional supplementation may ameliorate this and support adequate growth until such a time that the risk of NEC has reduced. Fortified DBM can therefore be continued until 34 weeks when a gradual change to preterm formula can take place. If fortification is contra-indicated (for example, in a baby with a stoma) then DBM can be continued as part of a nutrition plan with parenteral nutrition making up the shortfall. These complex cases will be managed by the nutrition team.

Appendix H: Management of Gastric Residuals/Aspirates and Abdominal Distension



Appendix I: Management of Gastro-Oesophageal Reflux (GOR) in Infants

This guidance is informed by NICE Guideline: Gastro-oesophageal reflux disease in children and young people: diagnosis and management. The PIER guideline for term infants can be accessed here

GOR is a **normal physiological phenomenon.** It is very common and manifests as effortless milky vomiting with no discomfort. It does not affect growth and development and resolves spontaneously. GOR disease (GORD) exists when GOR results in frequent regurgitation with significant distress and at its most extreme leads to faltering growth. It needs to be distinguished from vomiting due to non-GORD disorders such as pyloric stenosis, metabolic causes, infections, and so on. Some conditions are associated with an increased risk of GORD including: congenital diaphragmatic hernia and history of oesophageal atresia. GORD **only rarely** causes apnoea or acute life threatening events. Significant weight loss or faltering of growth in any age group is a red flag and should prompt further evaluation. Rarely, Cow's milk protein allergy may be suspected.

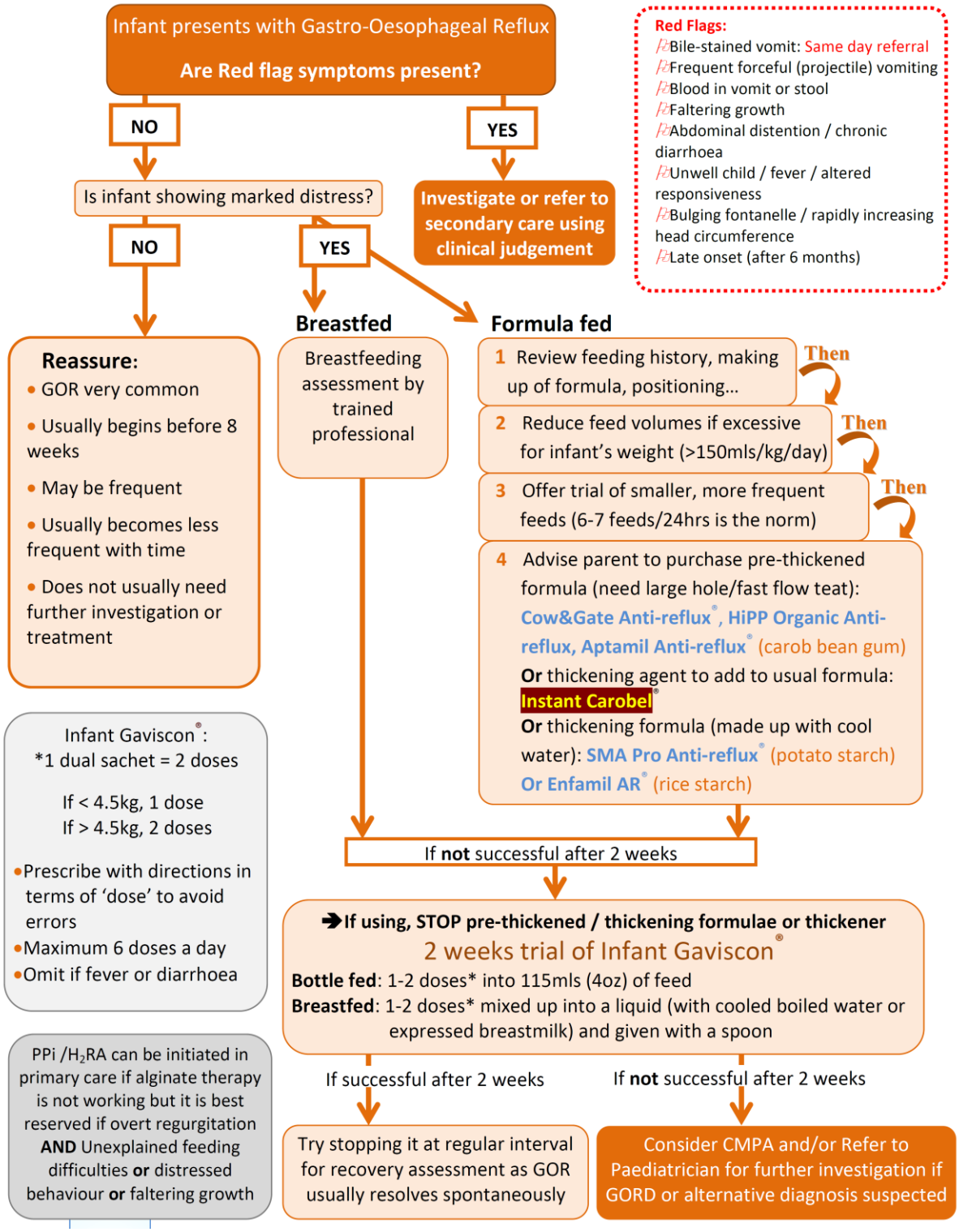
Preterm Babies with suspected GORD:
Preterm babies are at increased risk of GORD and benefit from positioning including elevated side-lying for feeding and raising the head end of the bed to 30° (6). Parental reassurance should be given.

- GORD only rarely causes apnoea or acute life threatening events. For preterm babies where GORD is thought to be having a major adverse impact on the babies clinical condition, continuous NG feeds or nasojejunal feeds may be used.
- Pharmacological treatments used in children and adults (prokinetics, alginates and sucralfate) have **not** shown to be of any benefit in preterm infants and there is evidence of harm (increased risk of NEC and late onset sepsis with the use of PPIs (Omeprazole) and H2 receptor antagonists (Ranitidine)) so these are **contra-indicated** (7, 8).
- PPIs have also been associated with an increased risk of vitamin and mineral deficiencies including calcium, phosphorous, iron and magnesium. For these reasons, if these drugs are used, they should be regularly reviewed.
- A trial of gaviscon can be considered for a short period but should not be used where milk is already fortified, thickened or the baby is at risk of bowel obstruction.
- Feed thickeners such as carobel should **not be used**

Role of PPI/H2RA and jejunal feeding:

- Under the advice of gastroenterology, Ranitidine or Omeprazole can be offered for a period of 4 weeks if one or more of the following are present in term infants without another explanation: unexplained feeding difficulties, distressed behaviour, faltering growth.
- Continuous jejunal feeding is recommended if the baby is at risk of reflux-related pulmonary aspiration.
- The prokinetics **metoclopramide, domperidone or erythromycin should not be offered** in view of the risks of serious side effects. These drugs are contra-indicated in symptoms of neurological origin as they may worsen symptoms.

Term infants (>36 weeks) with suspected GORD (adapted from PIER guidance- see here)



Appendix J: Suspected Cow's Milk Protein Allergy (CMPA)

A link to the PIER guidelines can be found here

Incidence of CPMA in infants is rare - estimated is 2.4% for IgE mediated and 1.7% for non-IgE mediated (9). CMPA can occur in young infants either breast fed or formula fed. Symptoms may include severe regurgitation, vomiting, constipation, peri-anal rash and macroscopic blood in stools, with the latter being most significant (as the others can occur normally in infants) and suggestive of a need to try a cow's milk free feed. Whilst microscopic haematuria is associated with CMPA, it is less sensitive. Note that **urine dipsticks should not be used to test for microscopic blood in stools** (faecal occult blood, FOB) as they are subject to high levels of false positives. An approved bedside test for faecal blood should be used if this is required. Non-intestinal features may include skin rash – atopic eczema, and colic.

If CMPA is thought to be the cause of symptoms, it is recommended that cow's milk protein be excluded from diet:

- If breast feeding, mother should exclude both cows' milk and egg products from her diet for two – four weeks, while continuing to breast feed. Mothers should be encouraged to continue breastfeeding. A parent information leaflet is available here
- Formula fed term infants should be tried on extensively hydrolysed infant formula as per the PIER Wessex Infant Feeding Guidelines. : NB: Amino acid infant formula is **not** the first line treatment.
- Preterm infants - hydrolysed Nutriprem 1 should be used in preterm infants in the first instance, moving to extensively hydrolysed infant formula (e.g. Nutramigen 1 or Peptijunior) only if symptoms persist and are felt to be due to CMPA. Amino acid formula is nutritionally inadequate for these patients.

If improvement is seen, national guidance is that a staged reintroduction should be carried out after 2-4 weeks in order to formally make the diagnosis of CMPA. However, in high risk or nutritionally compromised infants, the need for and timing of this can be done on an outpatient basis. If no improvement is seen on definite exclusion diet, CMPA is unlikely. If exclusion diet is difficult to maintain, a trial of extensively hydrolysed formula may be appropriate for breast fed infants, but where possible breastfeeding should be continued as this is associated with lower risk of food allergy particularly when introducing complementary food. See review by Venter C et al. (10, 11)

Note that any infant on a non-standard formula should have a paediatric dietician involved in their management.

Appendix K: Nutritional Management of Surgical Neonates

The neonatal unit cares for babies with a wide range of surgical pathology. For those with additional co-morbidities such as prematurity and congenital cardiac disease, nutritional care can be complex as, while there are well established recommended nutritional intakes, there is a lack of robust data on which to base recommendation about different strategies. However, the overarching aim is to meet the nutritional needs of this group of patients to maximise their growth and neurodevelopmental outcomes and avoid complications associated with malnutrition.

Options for delivering nutritional requirements include parenteral nutrition alone, combination of parenteral nutrition and enteral feed, supplemented breast milk or preterm formula. There is no evidence to support one of these approaches over another, and such decisions should be made in a multidisciplinary setting as part of the weekly nutrition ward round. Specialist prescription formula may be required. These babies will be reviewed weekly during a combined surgical/gastro/nutrition team MDT meeting.

Nutrient requirements
It is important to note that these infants have the same nutritional requirements as other infants of the same gestation, so have the same targets laid out above on page 6.
It should be noted that these are just recommendations, and some infants may require more of certain nutrients such as sodium and potassium as dictated by the results of blood and urine tests.

Parenteral nutrition around the time of surgery:
Term infants, have a brief hypermetabolic response, which peaks at 6 hours post operatively(12). Compared to healthy term controls, infants undergoing surgery do not show increased energy expenditure, so do not need additional calories. Administering excess calories in this group may therefore lead to excess fat deposition (13). More recently the PEPaNIC study (14, 15) has shown that infants in paediatric intensive care who receive PN during the immediate post-operative period, are more at risk of morbidity such as prolonged ventilation and risk of infection. Conversely, in preterm infants the metabolic responses to surgery are attenuated. As preterm infants have limited reserves, evidence suggests they may benefit from having full nutrition support continued throughout the perioperative period. We therefore recommend the following for infants undergoing surgery:

- Term infants>3.5kg without risk factors should not routinely be started on PN following major surgery before day 5 (this is based on data from the PEPaNIC study). ‘Major surgery’ is defined as that which is likely to induce a significant systemic inflammatory response post-operatively (and would for example, not include a routine gastroschisis closure).
- Preterm infants, smaller term infants (<3.5kg) and term infants who have undergone minor surgery or where it is felt stopping PN is contraindicated, should continue to receive full parenteral nutrition (16-19), during the perioperative period. If post-operatively there are concerns regarding hyperglycaemia then a 6 – 12 hour reduction by 25 - 50% of the previous PN could be considered.

Appendix L: Nutritional Management of Cardiac Infants

Congenital Heart Disease (CHD) – nutritional requirements

Growth failure in CHD is likely to be multi-factorial arising from low levels of growth hormone and other growth factors, undefined genetic polymorphisms, insufficient nutrition support, feeding difficulties including gastro-oesophageal reflux disease, vocal cord palsy and feeding aversions (20-22).

1. **Nutritional requirements;** pre-surgical requirements are estimated at being 10% higher than otherwise healthy infants. The amount of energy a term infant requires is dependent on the type of cardiac lesion and ranges 110 – 130kcal/kg day, but occasionally up to 150kcal/kg is required to support growth. Although additional calories and protein are often prescribed it is common for infants not to achieve feeding targets either due to feeding difficulties or fluid restrictions leading to growth failure. Post-surgery catch up growth may be required. To achieved 10g/kg per day 128kcal/kg and 2.8g/ kg of protein is required until weight/ length gain goals are met (23). It is important to ensure micronutrient and electrolytes are given in sufficient amounts to support lean body mass acquisition and growth (4) and as such vitamin supplementation should be given to all CHD infants. Medication particularly diuretics reduces total body stores, particularly sodium, affecting growth and as such supplementation may be required (22, 24).
2. **Breast milk is best;** where possible breast milk should be used. It is usual for most infants with heart failure to be on some fluid restriction and combination feeding of fortified breast milk and energy/nutrient dense formula feeds may help promote growth (24, 25). Where there are feeding issues, such as reflux, a ready to feed extensively hydrolysed protein/energy/nutrient dense feed may be better tolerated. Where possible amino acid infant feeds should not be used as these are associated with poor weight gain and hypophosphatemia(26).
3. **Start nutrition support early;** in those infants with CHD lesion requiring pulmonary artery banding or staged surgical repair, early nutrition support in the form of nutrient-energy dense feeds and breastmilk is important in order to prevent growth faltering. Please refer to the pre-surgical CHD pathway (here) or contact a cardiac dietitian to provide an appropriate nutrition care plan e.g. A, B or C (27)
4. **Refer ALL infants with CHD (excluding neonatal PDA ligations) to the Paediatric Cardiac Dietitians**; to ensure they are included in the nutrition home monitoring program before discharge and that the Cardiac dietitian is able to meet the parents(27).
5. **Methods of feed administration;** where infants are not able to breast feed or finish bottles easily the following can be tried;
   - Offer smaller oral feeds more frequently i.e. 2 – 3 hourly
   - Put the remainder of an oral feed via an nasogastric tube (NGT) – always try to give some feed orally to maintain oral feeding skills
   - Provide an overnight feed via an enteral feeding pump and small day time boluses orally

If weight gain remains poor then give feeds continuously over 20 – 22 hours via an enteral feeding pump, if vomiting is an issue then consider feeding via a nasojejunal tube (24).

Appendix M: Nutritional management of neonates/ infants with liver dysfunction (28-40)

<table>
<tr><td>Background</td><td colspan="3">• Liver dysfunction occurs as an acute episodes arising from a previously undiagnosed disease e.g. inborn error of metabolism (IMD) or as a result of prematurity or medical management.
• Jaundice results in dark urine and pale stools; occurs when there is an increase total bilirubin of which more than 20% is conjugated (normal = 5 %).
• Associated with this is decreased fat emulsification and digestion resulting in; malabsorption of fat, fat-soluble vitamins and some minerals.
• In severe cases of liver disease steatorrhea may occur leading to growth failure and metabolic bone disease.
• The use of medium chain triglyceride (MCT) containing infant formula in infants with liver dysfunction should be considered as MCT do not require emulsification. Supplementation with fat soluble vitamins including vitamin K is essential.</td></tr>
<tr><td>Nutrition requirements</td><td colspan="3">Depending on gestational age and previous growth trajectory:
• Energy 90 – 130kcal/kg
• Protein 2.5 – 4g/kg
• Fat should not be restricted and a percentage of the total fat as MCT’s e.g. 30-50 % may be required</td></tr>
<tr><td>Management of fat soluble vitamin deficiency</td><td colspan="3"><table>
<tr><th>Vitamin A</th><th>Vitamin D</th><th>Vitamin E</th><th>Vitamin K</th></tr>
<tr><td colspan="4">Laboratory marker of micronutrient status</td></tr>
<tr><td>• Serum retinol</td><td>• Serum 25-OHD</td><td>• Serum tocopherol</td><td>• Prothrombin/INR</td></tr>
<tr><td colspan="4">Recommendations for supplementation based on serum levels</td></tr>
<tr><td>• 1000IU/kg/day up to 25,000IU water miscible formulation.
• <10kg start with 5,000IU/day (0.6ml OD Dalavit)
• >10kg start with 10,000IU/day</td><td>• Cholecalciferol
• Serum levels – provide the following IU/day
• <10ng/ml:5000
• 11-19ng/ml:4000
• 20-29ng/ml:3000</td><td>• α-tocopheryl acetate 10mg/kg/day</td><td>• Give 1mg vitamin K OD and monitor INR</td></tr>
</table></td></tr>
<tr><td>Questions</td><td colspan="2">Decision guide</td><td>Nutrition recommendations</td></tr>
<tr><td rowspan="3">Is galactosaemia suspected/ diagnosed?</td><td colspan="2">• No – and the infants is growing well</td><td>• Continue with breastmilk/ standard infant formula breastmilk (& fortifier for infants <1.8kg at birth) and Dalavit 0.6ml</td></tr>
<tr><td colspan="2">• Yes – and the infant is growing well - change to a lactose free infant milk</td><td>• Stop standard infant formula/ breastmilk (& fortifier)
• Change infant feed to Wysoy
• Provide Dalavit 0.6ml</td></tr>
<tr><td colspan="2">• Yes – but the infant is growth faltering – provide an MCT containing lactose free feed until the liver dysfunction has resolved</td><td>• Stop standard infant formula/ breastmilk (& fortifier)
• Start Alfamino (43% MCT) (38-40) and start Ketovite Liquid and Ketovite tablets (Both must be used together to provide all vitamin requirements)</td></tr>
<tr><td rowspan="2">For prolonged jaundice is the infant breastfeed?</td><td colspan="2">• No – and the infant is growing well</td><td>• Continue with usual preterm infant formula or standard term formula & Dalivit 0.6ml, Sytron 1ml</td></tr>
<tr><td colspan="2">• No – but the infant is growth faltering provide</td><td>• Change to Pepti Junior -provide Dalivit</td></tr>
</table>

	150-180 ml/kg MCT containing infant milk	0.6ml, Sytron 1ml. Consider vitamin K – if deranged INR. Monitor ALP if preterm
	• **Yes – and** the infant is growing well aim to provide 150-180 ml/kg	• Continue with **breastmilk/ fortified breastmilk** and provide Dalavit 0.6ml/ (Sytron 1ml – if pre-term)
	• **Yes – but the** infant is growth faltering aim to provide 75-100 ml/kg of a MCT containing infant formula and 75-100 ml/kg of breastmilk	• Provide 50% **breastmilk/ fortified breastmilk** and **50% Pepti Junior** & Dalavit 0.6ml/ Sytron 1ml. Monitor ALP if preterm
Is cholestasis resolving?	• **No – but the** infant is growing well- continue current mix of MCT containing feed/ and breastmilk	• Continue with **50% Pepti Junior / 50% breastmilk** at 150 – 180ml/kg or age appropriate infant formula & Dalivit 0.6ml/ Sytron 1ml
	• **No – and** infant is continuing to have growth faltering – change to nutrient energy dense feed	• Change to nutrient energy dense infant feed - **Infatrini Peptisorb** (90 - 100ml/kg) and **breastmilk** (30 – 50ml/kg) breastmilk or infant formula & change to Ketovite Liquid and Ketovite tablets (Both must be used together to provide all vitamin requirements)
	• **Yes** - **resume** all breastmilk/ fortified breastmilk or standard infant formula	• **Breastmilk / preterm/ term formula 150ml – 180ml/kg** & change to Dalavit 0.6ml/ Sytron 1ml
Are blood glucose levels maintained?	• **Yes -** continue with current nutrition plan	• Breastmilk or preterm/standard infant formula
	• **No -** aim to provide a nutrient energy dense MCT containing feed with 10 g per 100 ml of carbohydrate and 10 % energy from protein	• Infatrini/ Infatrini Peptisorb
	• **If this does not** resolve the issue glucose polymers may be used to increase this further in increments of 12 g per 100 ml in infants < 6 months and 15 g per 100 ml in infants > 6 months	• Ensure protein: energy ratio is maintained (10 – 12%) and sufficient fat soluble vitamins/ micronutrients are provided
Is there faltering growth with an adequate feed volume?	• **No -** continue with current nutritional feed plan	• Infant's usual feed
	• **Yes** - measure trace elements & vitamins and supplement where necessary	• Review Zinc, copper, selenium, vitamin A, D, and E levels – supplement if inadequate serum levels

Appendix N: Nutritional Management of metabolic bone disease of prematurity

Considerations for the prevention of metabolic bone disease of prematurity (MBDP)

- MBDP is characterised by under mineralisation of the skeleton of **preterm**
- **Before stating supplementation: review contributory factors to aberrant serum mineral status.**

Infants with raised alkaline phosphatase (ALP) >500, low phosphate(PO_4) <1.8

1. Check whether there any contributory factors for abnormal biochemistry?
   - Drugs (especially diuretics, steroids)- stop or rationalise if able
   - Prolonged PN > 28 days
2. Ensure milk feeds are being tolerated and absorbed
3. Ensure milk feeds are providing adequate amounts of calcium / phosphorus and in the correct ratio and address any under or over- provision before further tests

	Magnesium (mmol)	Calcium (mmol)	Phosphate (mmol)	Ca:PO4 ratio
Requirements				
Preterm VLBW <1500g (enteral)	0.3 – 0.6	3 - 5	1.9 – 4.5	1.5 -1.7 : 1
Growing preterm <1500g (PN)	0.2 - 0.3	1.6 – 3.5	1.6 – 3.5	1.3 : 1
Content in feed				
Fully fortified MBM (100ml/kg)	0.3	2.2	1.7	1.9: 1
Nutriprem 1 (100ml/kg)	0.3	2.4	2	1.2:1
Preterm conc PN (100ml/kg)	0.21	0.99	2.49	1 : 2.5

4. **Measure vit D** (25OH-D) **if <50** provide 1,000 IU vit D e.g.Abidec 0.6ml=400iu, cholecalciferol, 1 drop=200iu

If vitamin D level is > 50 & biochemical abnormalities persist measure parathyroid hormone levels (PTH)

PTH raised: likely calcium deficiency

1. Start calcium supplements
   - Calcium carbonate (Calvive 1 tablet =25mmol)
   - Stop PO_4 supplements, review Ca:P ratio
2. Infants at particular risk are those on diuretics / steroids or unfortified breastmilk or term formula will have increased electrolyte losses
   - Fortified with breastmilk fortifier –which will ensure Ca:P ratio is 1.5:1 – 1.7:1
3. If no breastmilk is available (including donor), ensure preterm infant formula is provide in adequate amounts e.g. NP1/Hydrolysed NP1
4. Where infants only on PN optimise Ca:P ratio

PTH normal: likely PO_4 deficiency

1. Start PO_4 supplements
   - Start with 1mmol/kg/day (in divided doses unless surgical patient, in which case add to 24hr feed volume), and titrate according to response
   - Give either Sodium glycerophosphate 1mmol/ml of phosphate and 2mmol/ml of sodium or
   - Phosphate Sandoz – 1 tablet = 16mmol
2. Infants at particular risk are those on diuretics / steroids or unfortified breastmilk or term formula will have increased electrolyte losses
3. Fortified with breastmilk fortifier –which will ensure Ca:P ratio is 1.5:1 – 1.7:1
4. Where infants only on PN optimise Ca:P ratio
5. Provide calcium supplements in ionised calcium levels/ Ca:P ratio is low - continue vitamin D

Re-assess Ca, PO4, ALP and PTH in 2 weeks

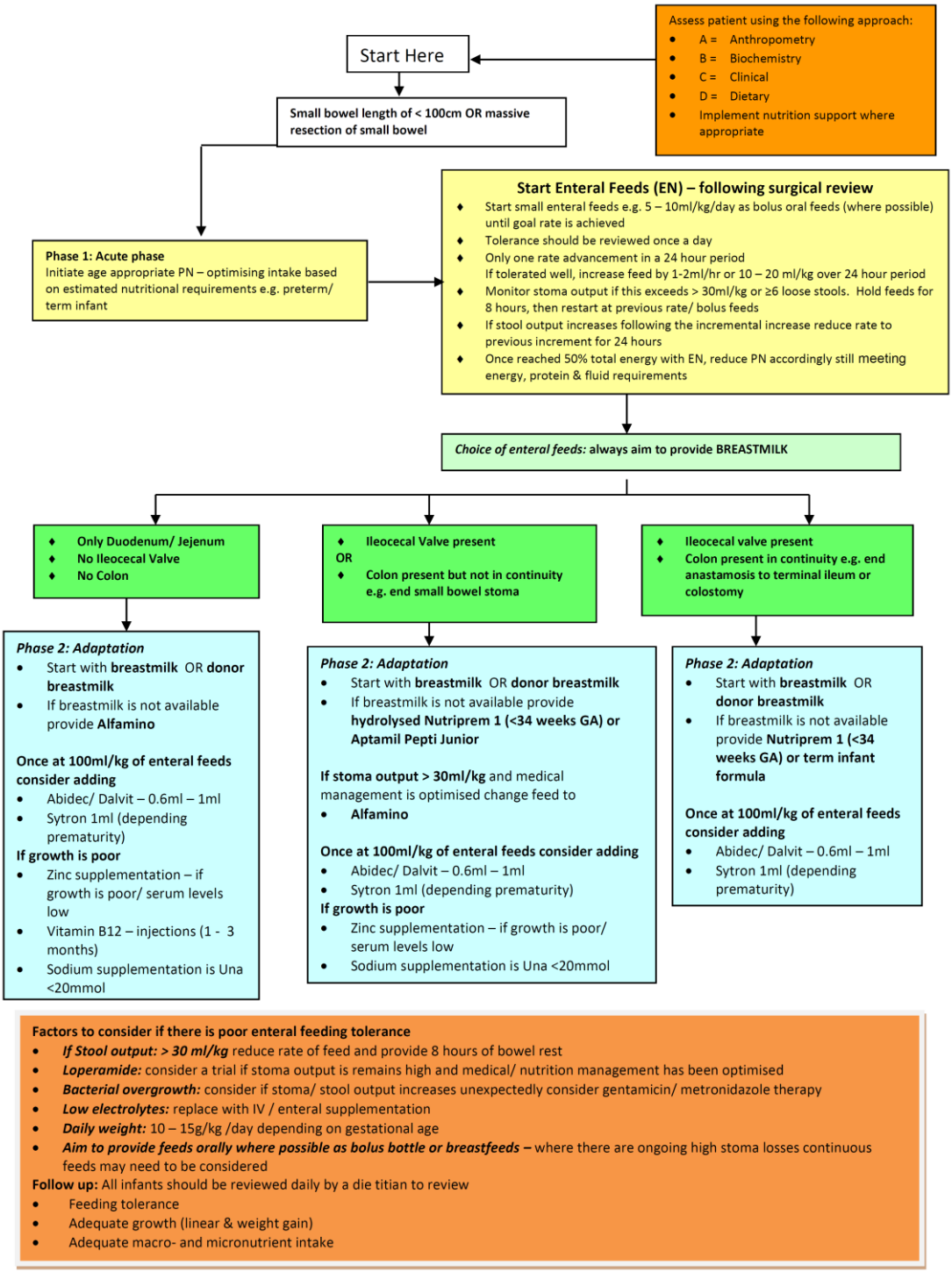
Figure 1: Flow chart of recommended management of metabolic bone disease of prematurity

References: 1.Chinoy A, Mughal MZ, Padidela R. Metabolic bone disease of prematurity: causes, recognition, prevention, treatment and long-term consequences. Archives of disease in childhood Fetal and neonatal edition. 2019. 2. Vuralli D Clinical Approach to Hypocalcemia in Newborn Period and Infancy: Who Should Be Treated? International Journal of Pediatrics 2019. ESPGHAN Parenteral Nutrition 2020, Agostino ESPGHAN 2010, NICE PN 2020

Appendix O – Nutritional management of infants with short bowel syndrome

Short bowel syndrome (SBS) is a global malabsorption syndrome that results from massive resections. In SBS there is loss of absorption function, inability to secrete adequate amounts of gastrointestinal (GI) regulatory peptides, trophic hormones and loss of GI immune function, which is most severe when there, is resection of the ileocecal valve and colon.

The aim of medical and nutritional management is promote adaptation of the remaining bowel. The time period for each infant to achieve adaptation varies depending on numerous factors. A multidisciplinary approach is required to ensure good growth is maintained and the adaptation phase is successfully managed.



Nutritional Care of Infants in the Neonatal Unit Guideline

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