# D10 - Feeding Neonates with Surgical Problems

<table>
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<tr>
<th>Title of Guideline:</th>
<th>D10 - Feeding Neonates with Surgical Problems</th>
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</table>
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| Directorate & Speciality: | Family Health - Neonatology |
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| Explicit definition of patient group to which it applies | Infants admitted to neonatal unit who have had gut surgery |
| Version | 5 |
| If this version supersedes another clinical guideline please be explicit about which version it replaces (not applicable if this is a new guideline, enter below if extensive): | V3 – main changes:  
- renamed and reformulated SMA PRO Gold Prem 1 & 2®  
- use of hydrolysed formula for infants born with gastroschisis where breast milk is not available, until first surgical review (appended parent leaflet and GP letter) |
| Statement of the evidence base of the guideline – has the guideline been peer reviewed by colleagues? | Use of maternal expressed breast milk for safer tolerance of enteral feeds - 2b, 4  
Use of hydrolysed protein/MCT in shortened bowel – 2b, 4  
Whole guideline – 5, 6 |

| 1 | NICE Guidance, Royal College Guideline, SIGN (please state source) |
| 2a | Meta analysis of randomised controlled trials |
| 2b | At least one randomised controlled trial |
| 3a | At least one well-designed controlled study without randomisation |
| 3b | At least one other type of well-designed quasi-experimental study |
| 4 | Well-designed non-experimental descriptive studies (ie comparative/correlation and case studies) |
| 5 | Expert committee reports or opinions and/or clinical experience of respected authorities |
| 6 | Recommended best practise based on the clinical experience of the guideline developer |

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<th>Consultation Process</th>
<th>Circulation to Staff of Neonatal Service</th>
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| Ratified by: | Nottingham Neonatal Service Guideline  
Task and Finish Group  
July 2017 |
| Review Date: (to be applied by the Integrated Governance Team) | Staff of the Nottingham Neonatal Service, Paediatric wards and PICU  
July 2022 |

This guideline has been registered with NUH Trust. However, clinical guidelines are guidelines only. The interpretation and application of clinical guidelines will remain the responsibility of the individual clinician. If in doubt contact a senior colleague or expert. Caution is advised when using guidelines after the review date or outside of the Trust.
1. Background

Nutrition & growth are vital to the quality of outcomes following neonatal surgery. Breast milk is believed to be the best form of enteral nutrition for babies. The incidence of necrotising enterocolitis (NEC) is considerably less in babies breast fed or fed with maternal expressed breast milk (EBM).[1] Mothers of all preterm babies particularly babies with antenatally detected surgical problems should be actively encouraged to express milk and also to progress to breast feeding as appropriate.

Our approach to introducing and advancing feeds (Nottingham Neonatal Service Guideline D3) and the choice of milk when breast milk is unavailable (Nottingham Neonatal Service Guideline D4), serve as the basis for this guideline and a summary of these is given as Appendix 1. This guideline offers guidance on choice of milk, feeding regimen and management of specific surgical conditions. Appendices 2 and 3 contain additional useful information on the comparable content of available milks.

Breast-feeding/EBM should be encouraged in all babies especially premature babies and babies with surgical problems.

2. Choice of enteral feed for surgical babies in NICU (Appendices 2 and 3)

2.1 Special circumstances influencing choice of enteral feed for surgical babies in NICU

Occasionally, in some abdominal surgical conditions, feeding with breast milk may need to be temporarily suspended. Parents must be consulted and mothers supported to maintain lactation by expressing and freezing breast milk for future use. Frequency of expression should not be reduced even though breast milk is not currently being fed to the baby or future supply may be affected. The decision to feed with a milk-substitute where maternal breast milk is available should only be made following review by Consultant Paediatric Surgeon and Attending Consultant Neonatologist. The Neonatal Dietitian should be consulted. Certain considerations may be necessary for some babies with surgical conditions of the bowel:

- **Lactose tolerance**
  
  Whilst breast milk contains lactose, it is unlikely that lactose intolerance will be clinically significant in the majority of babies, although it is a theoretical possibility in injured or shortened bowel. Therefore, breast milk or a lactose containing formula may be tried in the first instance and reviewed closely. If lactose intolerance is thought to be a significant issue, the use of a minimal lactose formula containing glucose polymer (Pepti-Junior) may be necessary after review by Consultant Paediatric Surgeon and Attending Consultant Neonatologist. Advice should also be sought from the Neonatal Dietitian.

- **Fat absorption**
  
  Fat absorption may be affected in some conditions (ongoing cholestatic jaundice, short bowel and/or high stoma). Breast milk and normal formulas contain long chain triglycerides (LCT) which are dependent upon bile salt emulsification for absorption. Where bile salt metabolism is thought to be substantially impaired, a formula containing medium chain triglycerides (MCT) may be beneficial. As the provision of long chain polyunsaturated fatty acids (LCOs), naturally present in breast milk, is important, all the formulas recommended are supplemented with LCPs.

- **Protein tolerance**
  
  Breast milk contains readily absorbed whole protein and is usually well tolerated. In the occasional circumstances when protein intolerance becomes a feature of short bowel and high stomas, a hydrolysed protein formula may be beneficial.
  
  **Pepti-Junior** is a hydrolysed protein formula designed to meet requirements of infants born at term.
  
  **Aptamil Pepti 1** is a hydrolysed protein formula that we use for babies with gastroschisis due to the better palatability than Pepti-Junior, while not needing the MCT or low lactose levels of Pepti-Junior.
  
  **Neocate LCP** is an amino acid containing formula that is rarely required, but may be useful where partially hydrolysed formulas have failed. It is designed to meet requirements of infants born at term.
  
  None of the above formulas meet the nutritional requirements of preterm infants nor are they available as ready to feed (RTF) preparations.
  
  **SMA PRO Gold Prem 1®** is a RTF preterm formula containing hydrolysed protein, 40% less lactose than Nutriprem 1 and 33% of fat as MCT. It may be used as indicated in section 3.1.1.
Summary of enteral feeding decision making for small or preterm surgical babies
(<34 weeks and BW <2kg)

Neonatal patient with abdominal surgery, BW < 2kg
    Consider PN support early
    ‘High’ stoma, short bowel (or gastroschisis)?
    No
    Breast milk
        If breast milk not available
        Nutriprem 1
        Use 2 hourly boluses for first feeds
        Monitor losses, fluid balance & weight gain
    Yes
    Breast milk
        If breast milk not available
        SMA PRO Gold Prem 1®
        Use 2 hourly boluses for first feeds
        Monitor losses, fluid balance & weight gain
        In infants with short bowel consider continuous feeds
    Neonatal dietitian should be involved if babies have on-going problems

Summary of enteral feeding decision making for near term surgical babies
(≥34 weeks, BW ≥2kg)

Neonatal patient with abdominal surgery, BW > 2kg
    Consider PN support early
    ‘High’ stoma, short bowel (or gastroschisis)?
    No
    Breast milk
        If breast milk not available
        Standard term formula
        Use 2 hourly boluses for first feeds
        Monitor losses, fluid balance & weight gain
    Yes
    Breast milk
        If breast milk not available
        Pepti-Junior
            (Aptamil Pepti 1 for gastroschisis)
        Use 2 hourly boluses for first feeds
        Monitor losses, fluid balance & weight gain
        In infants with short bowel consider continuous feeds
    Neonatal dietitian should be involved if babies have on-going problems
3. Enteral feeding in specific surgical conditions

PN should be considered early and used to avoid periods of suboptimal nutrition. The stepwise approach to introducing milk outlined in Appendix 1 serves as a good starting point and guide. However, following NEC and gastroschisis it may be necessary to progress more slowly.

The proportion of the intestine remaining should be clearly documented by the surgical team in the operation notes as length of small intestine remaining is a major factor in the likelihood of weaning PN and establishing full enteral nutrition. It can be used as a predictor of feed choice. (see 3.1.1). This should be recorded in the surgical notes as cm resected and remaining and the approximate proportion or percentage remaining. The presence of the ileocaecal valve, although not necessarily a predictor of ultimate enteral tolerance, may be a factor and is important in preventing bacterial overgrowth, so should also be documented. However, as the length of intestine remaining can only be an estimate, clinical assessment (including weight gain, hydration, electrolytes, stool frequency and size) must be taken into account.

3.1 Enteral Feeding following NEC

In NEC requiring surgery, starting feeds depends on operative findings and clinical condition post-surgery:-

- if there is no residual disease or no proximal disease between the stomach and the stoma and a good post-operative recovery, feeds can be commenced from the 7th post-operative day with EBM.

- in conservatively managed NEC (without surgery), or where there is residual disease and/or clinical evidence of ongoing NEC at operation, the baby will require 10 days nil enteral from operation to allow recovery before a joint decision regarding commencing feeds is made between the Consultant Paediatric Surgeon and Attending Consultant Neonatologist. Feeds should be commenced with EBM where possible. Antibiotics are needed for this 10-day period (Guideline C1).

These differences in the length of nil enteraly recommended in NEC above relate to the presence or removal of diseased intestine which will come in contact with the milk.

Starting feeds post-surgery or following medical management of NEC after surgical opinion, will be a combined decision between the Consultant Paediatric Surgeon and Consultant Neonatologist and will be assessed daily with clear guidance given. Modifications to this guidance should only be made where change to clinical condition or tolerance occurs between the daily reviews.

3.1.1 Choice of feed (see Summary Algorithm on page 2)

EBM is the milk of first choice

When EBM is unavailable the following can be used as a guide:

- in babies where birthweight <2kg with ≥½ of small intestine up to stoma/anus: Nutriprem 1
- in babies where birthweight <2kg with <½ of small intestine up to stoma/anus: SMA PRO Gold Prem 1® (standard dilution)
- in babies where birthweight >2kg, with ≥½ of small intestine up to stoma/anus: standard term formula
- in babies where birthweight >2kg, with <½ of small intestine up to stoma/anus: Pepti-Junior

This can only ever be a guide as the actual type of bowel remaining – jejunum, ileum, colon will partially determine likely tolerance of feeds.

For infants with gastroschisis where insufficient maternal EBM is available, but there is a preference to avoid whole cow's milk protein, Aptamil Pepti 1 is the initial feed of choice. (Section 3.3)

Infants with ongoing conjugated jaundice, usually due to prolonged PN, may benefit from a formula containing MCT if growth is poor on a standard formula – options include SMA PRO Gold Prem 1® or Pepti-Junior birth.

3.1.2 Preparation of powdered infant formulas (PIF)

When EBM is unavailable or there is insufficient supply, the choice of formula is suggested above.

Nutriprem 1, SMA PRO Gold Prem 1® and standard term formulas are available as ready to feed (RTF).

However, Pepti-Junior and Aptamil Pepti 1 are only available as powder, requiring reconstitution with water.

12.8% Pepti-Junior (standard dilution) as per manufacturer’s instructions – 1 level scoop + 30ml water
(15% Pepti-Junior gives an enriched profile if ever required for preterm infants – 1 level scoop + 25ml water)

13.6% Aptamil Pepti 1 (standard dilution) as per manufacturer’s instructions - 1 level scoop + 30ml water
16% Aptamil Pepti 1 gives an enriched profile if ever required for preterm infants – 1 level scoop + 25ml water

A neonatal standard operating procedure is available for reconstituting feeds and must be followed carefully to ensure safe and accurate reconstitution.
Nottingham Neonatal Service – Clinical Guideline

Guideline D10

3.2 Stomas

Babies may have stomas sited for a variety of reasons including congenital obstruction and NEC. Those infants with ≥ ⅔ of healthy small intestine between mouth and stoma, so called “low stomas”, should usually be managed according to the standard enteral feeding guideline (Nottingham Neonatal Guidelines D3, D4).

3.2.1 Managing babies with jejunal/ high ileal stomas (<⅔ small intestine proximal to stoma)

Babies with jejunal/ high ileal stomas are liable to high losses of fluid initially and should be carefully managed with the following principles:

- aim to support nutrition with PN and start gut priming as soon as possible
- start with a trial of 1ml/kg as 2 hourly bolus feeds with EBM if it is available
- if EBM is not available, consider starting SMA PRO Gold Prem® (for preterm infants) or Pepti-Junior (for term infants).

Enteral feeding should be slowly increased when tolerated, observing hydration, weight, stoma output and serum and urine electrolytes. Where feed intolerance is suspected or likely, changes should be made daily based on the previous day’s tolerance. Detailed records should be transferred to a flow chart (Appendix 4).

Continuous enteral feeding may be considered in short bowel syndrome where bolus feeds aren’t tolerated, as this may improve tolerance of enteral feeds and growth [7].

3.2.2 High volume stoma losses

In babies where a “high” stoma has been formed with only a short length of bowel between mouth and stoma and those with short bowel following surgical resection, feed absorption is suboptimal and they are likely to need a prolonged period of partial enteral nutrition supported by PN.

Patients with “high” stomas, often have large volume stoma losses. Ideally, stoma losses should be less than 20ml/kg/day when on enteral feeds at 150ml/kg/day. Stoma losses >50ml/kg/day are usually excessive.

3.2.3 Intravenous “Replacement” Fluids

‘Replacement’ of fluid losses should be considered in infants with high stoma losses and a guide will be suggested by the Consultant Paediatric Surgeon and Attending Consultant Neonatologist.

Commonly, this may be an instruction such as “losses greater than 30ml/kg/day should be ‘replaced’ with an equal volume of IV fluids. However, the actual decision to ‘replace’ stoma losses should consider the need in that individual infant so that intravenous ‘replacement’ of small volumes does not occur.

For example:-

1) Under the standing order of “losses greater than 30ml/kg/day should be ‘replaced’ with an equal volume of intravenous fluids”, stoma losses of 35ml/kg/day would lead to an additional 5ml/kg/day intravenous fluid which is unlikely to be clinically indicated.

2) A baby on full enteral feeds in a significant positive fluid balance is unlikely to need replacement.

IV fluid replacement would usually be made using 0.9% NaCl with 10mmol KCl in 500ml.

3.2.4 Urinary Electrolyte Measurement

Where stoma losses of 20ml/kg/day do occur, urinary electrolytes should be measured weekly.

A low urine sodium (<20 mmol/l) even with normal serum sodium, suggests the baby is trying to conserve sodium and implies that stoma Na losses are significant. Such babies require careful reconsideration of the enteral feeding regimen with the Attending Consultant Neonatologist and Consultant Paediatric Surgeon, as well as sodium supplementation. The Neonatal Dietitian will also advise as required. Sodium supplements are usually required where an infant has an ileostomy.

Urine potassium should be measured on the same urine sample. If it is higher than the sodium level, then this is evidence of compensatory/secondary hyperaldosteronism, as the body is conserving sodium at the expense of losing potassium.

In both these circumstances, sodium supplements should usually be started at 3mmol/kg/day or increased by approximately 50% if the infant is already receiving additional supplements. These should be given in divided doses. Sodium supplements should not be discontinued solely on normal serum sodium if losses continue as total body sodium may still be low.

If potassium supplements are required due to low serum levels, they should be continued for a week after serum level returns to normal in order to allow intracellular levels to normalise.
3.2.5 Recycling stoma losses

There are case reports to suggest that collecting losses from a proximal stoma and repassing them into the distal mucous fistula is beneficial in terms of stimulating mucosal growth, preventing atrophy of the bowel and increased nutrient and electrolyte absorption thereby reducing need for PN which may reduce risk of cholestatic jaundice. [8, 9] This practice will be requested by the surgeon if required and detailed guidance given. The surgical team should do at least the first three attempts before requesting that the NICU nursing staff take this on. The fluid replaced into the distal stoma must not be recorded as stoma loss on the fluid balance charts as this will risk “double counting” and the baby receiving unnecessary additional fluids.

3.2.6 Loperamide

As the feed volume increases in a baby with high volume stoma losses, loperamide may be considered in order to inhibit intestinal secretion. [10] Loperamide binds to the opiate receptor in the gut wall, reducing propulsive peristalsis and increasing intestinal transit time, as well as increasing tone of the anal sphincter.[11]

The need for loperamide should be made as a joint decision between the Consultant Paediatric Surgeon and the Attending Consultant Neonatologist. When it is indicated, loperamide (1mg/ml as sugar-free, sorbitol-free version manufactured as a special product in pharmacy) should be commenced at 400 micrograms/kg/day (100 micrograms/kg/dose 4 times a day), given 30 minutes before feeds where possible. As changes in loperamide dose take a little time to result in altered stool volumes, dosage should be reviewed no more than twice per week. Where stoma losses remain excessive on review, it is recommended that total daily dose of loperamide should usually be increased as below.

<table>
<thead>
<tr>
<th>DAILY Loperamide dose</th>
<th>QDS Loperamide dose</th>
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<tr>
<td>400 micrograms/kg/day</td>
<td>= 100 micrograms/kg/dose</td>
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<tr>
<td>1000 micrograms/kg/day</td>
<td>= 250 micrograms/kg/dose</td>
</tr>
<tr>
<td>1600 micrograms/kg/day</td>
<td>= 400 micrograms/kg/dose</td>
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Allow 3-4 days between increases for loperamide to have an effect

The maximum dose of loperamide is unknown but for chronic diarrhoea in infants 1m-1y a total daily dose of 2mg/kg/day may occasionally be required (BNF for Children). (500micrograms/kg/dose 4 times per day)

Loperamide should be used with caution in severe hepatic impairment – discuss with Attending Consultant Neonatologist and Neonatal Pharmacist.

Following stoma closure where a good length of bowel remains, loperamide should not be required and, therefore, it should be discontinued after stoma closure. However, if there are significant losses with feeding following stoma closure, reintroduction of loperamide may be considered by the Consultant Paediatric Surgeon and Attending Consultant Neonatologist.

3.2.7 Stoma Closure

All decisions on when to reverse a stoma will be made by the Consultant Paediatric Surgeon and Attending Consultant Neonatologist. Factors which are considered are whether there is a useful length of unused intestine and any existing problems related to the stoma, such as poor growth, electrolyte disturbances, prolapse, retraction, stenosis or skin excoriation.

If the infant is growing well and there are no problems, or there is very little extra intestinal length to be gained, a decision for late closure will usually be made.
3.3 Gastroschisis
In babies with gastroschisis, there is a risk of NEC as bowel motility returns. Many of these babies seem to tolerate standard formula milks poorly. [2]
Therefore, EBM is the milk of first choice and breast-feeding should be strongly encouraged antenatally and actively supported postnatally.
If EBM is unavailable, Aptamil Pepti 1 – a hydrolysed protein formula should be used and continued after discharge until the first paediatric surgical review. At this stage parents should be advised to change to a standard formula of their choice. Change of formula should be done over a few days replacing 30ml (1fl oz) Aptamil Pepti 1 per feed with appropriate formula replacing 30ml (1fl oz) per feed each day. A leaflet explaining how to change to a standard formula should be given to parents at discharge. (See Appendix 5 for formula and 5A if breastfeeding). A standard GP letter is available to request this product on prescription that should be faxed by the nursing team prior to discharge. (Appendix 6)

3.4 Oesophageal Atresia with distal TOF
Babies born with oesophageal atresia with distal TOF will usually feed enterally early via transanastomotic tube (TAT) and prolonged PN is seldom needed.
Gastro-oesophageal reflux is very common once these infants reach full feeds. Medical anti-reflux treatment, including Gaviscon Infant or Instant Carobel as a feed thickener should be considered.

3.5 Oesophageal Atresia without distal TOF
Babies born with oesophageal atresia without distal TOF will usually require a gastrostomy to be formed. As these infants have a very small stomach, feeds should be started as 2 hourly bolus feeds, even in term infants. Continuous feeds are only very rarely necessary. PN is rarely required for these infants born near term providing full enteral feeds can be reached in a timely fashion.

3.6 Duodenal, jejunal or ileal atresias
PN should be considered for babies with intestinal atresias. These are categorised as:-

Type 1: Membrane across the lumen – no loss of intestinal length
Type 2: Proximal and distal segments separated by a cord, with no defect in mesentry – normally no loss of intestinal length
Type 3a: Defect in the mesentery, as well as the intestine. This represents loss of intestine.
Type 3b: “Apple peel”. The superior mesenteric vessels are absent. Thus, most of the small intestine gets a precarious blood supply from the marginal vessels. The intestines wrap themselves around the vessels, hence the appearance and name.
Type 4: Multiple atresias.

Early trophic feeds (1ml/kg, 2hourly) can usually be introduced even if gastric aspirates are moderately high.
PN is usually needed, especially with high jejunal or duodenal atresias.
As babies with Type 3a, 3b & 4 atresias, may have lost intestinal length, they may take some weeks to adapt and grow on full enteral feeds. If less than 2/3 of small intestinal length is available for absorption and breast milk is not available, see Section 3.1 for the choice of milk.

3.7 Hirschsprung's disease
If stable, these babies are managed with rectal washouts and a single operation at several weeks of age.
If they are unwell, or not decompressing with washouts, then an early stoma is the safest option. Once the baby is stable, enteral feeds can be commenced.
Breast milk is preferred as, additionally, the washouts are made easier. Special feeds are not required. PN is rarely needed.
3.8 Meconium ileus

These babies require consultation with the CF team for consideration of pancreatic supplementation (Nottingham Neonatal Service Guideline F4).

4. Assessing Feed Tolerance

Feed tolerance is assessed using a number of factors including vomiting; quantity and type of aspirate; consistency, volume and frequency of stool or stoma loss; weight gain and growth. Detailed nursing and medical recording is essential for informed decision making. For many infants, standard recording is adequate for decisions on progressing feeds. Where feed tolerance is poor and variable such as found with high stomas, a summary flow chart of these parameters can be useful and should be completed as part of the daily medical review where this is requested by the medical and surgical team (Appendix 4).

4.1 Aspirates

High volume aspirates are common following gastrointestinal surgery and feeds will not be started until these have settled, though early trophic feeding is beneficial. Guidance will be given daily on proportion of aspirate to be replaced and this may differ from the advice in Guideline D3 due to the surgical condition and it’s potentially altered anatomy.

The volume of aspirate that is relevant will be dependent on the volume of feed given so instructions will be given to stop or reduce feeds or continue and ‘replace’ the aspirate itself according to the following guide:

- if aspirate < ½ feed volume since last aspirate – ‘replace’ the aspirate itself via nasogastric or orogastric tube and continue feeding
- if aspirate ≥ ½ feed volume but < whole feed volume - ‘replace’ half of the aspirate itself via nasogastric or orogastric tube and discard the rest
- if aspirate ≥ whole feed volume since previous aspirate – do not ‘replace’ the aspirate, stop feeding until senior medical and surgical review

This should only ever be a guide and decisions, particularly those on the borderline of this guidance, must be made according to the individual baby’s clinical condition. Advice should be sought from the Consultant Paediatric Surgeon and Attending Consultant Neonatologist.

Gastric acid hypersecretion is common in patients with short bowel syndrome. If present, the degree of hypersecretion is proportional to the degree of bowel resected and may contribute to malabsorption by inactivating pancreatic enzymes, thus, interfering with absorption. Treatment with an H₂ blocker (ranitidine) or a proton pump inhibitor (omeprazole) should be considered where stoma output is watery and losses high (>30% of intake) and if the gastric pH is <3. In such cases, a trial of ranitidine initially (followed by a two week trial of omeprazole if there is no improvement) should be considered. If no improvement during the trial of treatment, the medication should be stopped.

4.2 Stools

All stools must be recorded on daily nursing charts and details of consistency, colour and volume stated. These will be summarised in the daily medical review and used as a basis for decision making for the following days feed progression. If very loose stools are present a request can be made for estimation of reducing sugars. As this is a costly and labour intensive analysis it is only set up weekly on Monday afternoon/Tuesday morning and should be discussed with the IEM laboratory x55080.

4.2.1 Stomas

Where a stoma is present consideration should be given to use of the detailed flow chart (Appendix 4) if feed intolerance is likely, as with jejunal and high ileal stomas. See Section 3.2.1 for further details.

4.3 Weight gain and growth

Daily weight gain is only necessary for detailed fluid management and should not be continued and used as a basis for weight gain and growth. However, as for all infants on NICU, growth should be recorded and plotted weekly on a UK-WHO Neonatal & Infant Close Monitoring Chart. (Nottingham Neonatal Guideline D17)

Careful interpretation of weight gain is necessary, particularly where large fluctuations are more likely explained by fluid changes. Detailed recording of fluid input and losses alongside actual nutritional intake will help with meaningful interpretation. The Neonatal Dietitian will advise as necessary.
5. Guidance for discharge

Once established on enteral feeding and ready for discharge from hospital, the choice of feed will depend on clinical need. Where EBM is available and mother still intends to breastfeed, every effort should be made to establish breast feeding with or without supplements. The Neonatal Dietitian will advise as required. Fresh EBM should be used in preference to frozen once colostrum and early EBM (first 7 days) has been used.

Where infants are no longer receiving breast milk, those tolerating whole protein formulas should be changed to Nutriprem 2 or term formula as per existing guidelines on feeding post discharge (Nottingham Neonatal Service Guideline D9) unless specialised formulas are required.

Infants with birth weight <2kg
Breast-feeding
or Nutriprem 2 where breast milk is not available

Infants with birth weight ≥2kg
Breast-feeding
or Term formula where breast milk is not available

Infants who will not tolerate the appropriate formula above may need to be discharged on a specialised formula and must be referred to the Neonatal Dietitian for advice. SMA PRO Gold Prem 1 is not available in the community so a transition to SMA PRO Gold Prem 2 may be required.

Babies with gastroschisis who are not receiving maternal breast milk should be discharged on Aptamil Pepti 1 until surgical review in clinic. Written guidance should be given to the family (see appendix 5) and a copy of the standard letter faxed to the GP prior to discharge (see appendix 6) Where specialised formulas such as Aptamil Pepti 1, which have been designed to meet the needs of term infants, are required for preterm infants, the concentration may need increasing. This will require ongoing review from the Neonatal Dietitian.

Infants requiring loperamide at discharge should continue to receive the same preparation used in hospital providing 1mg/ml rather than the proprietary product routinely available in the community (Imodium – 0.2mg/ml) which requires 5x the volume to achieve the same dose and contains sorbitol which may result in osmotic diarrhoea. This should be made clear on the prescription at discharge.

BIBLIOGRAPHY

APPENDIX 1: Current Approach to At Risk Premature Non-Surgical Babies (Guideline D3)

- Starting feeds – 2 hourly bolus feeds are preferred regimen

<table>
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<th>First feed advice</th>
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<tbody>
<tr>
<td>&gt;30 weeks and well</td>
<td>Start 2 hourly bolus feeds from birth, at step 2 or 3. Some babies will tolerate</td>
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<td></td>
<td>full feeds immediately and this can be tried in those 32/40 and above.</td>
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<tr>
<td>23-30 weeks and well</td>
<td>Start feeds in first 24 hours and review at 24 hours</td>
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<tr>
<td>If on Inotropes (any gestation)</td>
<td>Delay starting feeds</td>
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<tr>
<td>&lt;33 weeks and AEDF</td>
<td>Review abdomen at 24 hours of age, then start step 1 feeds and review regularly</td>
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<tr>
<td>IUGR</td>
<td>Start and review abdomen at 24 hours and thereafter</td>
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AEDF - absent end-diastolic flow on antenatal scan
IUGR - intrauterine growth retardation (< 10th centile for weight)

- Advancing Feeds – low risk – ‘green regimen’

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<th>Volume 2 hourly</th>
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<td>At Attending Consultant Neonatologist’s discretion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Advancing feeds - high risk – ‘yellow regimen’

<table>
<thead>
<tr>
<th>Step</th>
<th>Volume 2 hourly</th>
<th>Increment</th>
<th>End of day rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 ml/kg</td>
<td>24 hours</td>
<td>12 ml/kg</td>
</tr>
<tr>
<td>2</td>
<td>2 ml/kg</td>
<td>12 hours</td>
<td>36 ml/kg</td>
</tr>
<tr>
<td></td>
<td>3 ml/kg</td>
<td>12 hours</td>
<td>(an increase of 24ml/kg /day)</td>
</tr>
<tr>
<td>3</td>
<td>4 ml/kg</td>
<td>12 hours</td>
<td>60 ml/kg</td>
</tr>
<tr>
<td></td>
<td>5 ml/kg</td>
<td>12 hours</td>
<td>(an increase of 24ml/kg /day)</td>
</tr>
<tr>
<td>4</td>
<td>6 ml/kg</td>
<td>12 hours</td>
<td>84 ml/kg</td>
</tr>
<tr>
<td></td>
<td>7 ml/kg</td>
<td>12 hours</td>
<td>(an increase of 24ml/kg /day)</td>
</tr>
<tr>
<td>5</td>
<td>8 ml/kg</td>
<td>12 hours</td>
<td>108 ml/kg</td>
</tr>
<tr>
<td></td>
<td>9 ml/kg</td>
<td>12 hours</td>
<td>(an increase of 24ml/kg /day)</td>
</tr>
<tr>
<td>6</td>
<td>10 ml/kg</td>
<td>12 hours</td>
<td>132 ml/kg</td>
</tr>
<tr>
<td></td>
<td>11 ml/kg</td>
<td>12 hours</td>
<td>(an increase of 24ml/kg /day)</td>
</tr>
<tr>
<td>7</td>
<td>12 ml/kg</td>
<td>12 hours</td>
<td>156 ml/kg</td>
</tr>
<tr>
<td></td>
<td>13 ml/kg</td>
<td>12 hours</td>
<td>(an increase of 24ml/kg /day)</td>
</tr>
<tr>
<td>8</td>
<td>At Attending Consultant Neonatologist’s discretion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Feed Intolerance

In at risk groups, reassess feed tolerance after the first 24 hours and decide whether continued ‘gut priming’ or advancing feeds should be undertaken according to whether infant is low or high risk. 1-2ml/kg of gastric residual volume is not important and should simply be replaced. Where the gastric residual at higher volumes is equivalent to 100% of the bolus, then stop advancing the feeds or stop the feeds and organise a clinical review. Bilious aspirates or significant abdominal distension requires cessation of feeds and a clinical review.
APPENDIX 2: Issues to consider when deciding on a feed

1. **Lactose**: Pepti-Junior is clinically lactose free, whereas EBM, Aptamil Pepti 1, term and preterm formulas all contain lactose. Breast milk confers significant advantages. Therefore, although transient lactose intolerance may occur following any gut trauma and EBM has all the CHO as lactose, breast milk would still be our first feed of choice. Lactase activity increases 5 fold throughout the last trimester, is increased by early feeding and is thought to be inducible by the presence of lactose. [12] The presence of lactose if tolerated, would also optimise the appropriate gut micro flora.[13] However, if breast milk is not tolerated, the presence of undigested CHO in the bowel could in theory predispose to necrotising enterocolitis. Although low lactose feeds appear to have been used automatically in short bowel syndrome (SBS) in published studies, whether this is intentional or just because semi-elemental/elemental feeds nearly always contain a reduction in lactose, is unknown.

2. **MCT (Medium Chain Triglycerides)**: EBM, Nutriprem 1 and term formulas are not sources of MCT. Pepti-Junior has 50% and SMA PRO Gold Prem 1® 33% of fat as MCT. Although MCT may be more readily absorbed without the need for bile salt emulsification, animal studies suggest that it is probably less beneficial than LCT, especially LCPs, in promoting mucosal adaptation. [3, 14]. A source of MCT may be beneficial in babies with conjugated jaundice, often seen in infants following gut surgery due to the prolonged use of PN. However, infants with raised conjugated bilirubin who are growing well on adequate volumes of breast milk or standard formulas should not be changed routinely.

3. **LCPs (long chain polyunsaturated fats)**: are thought to be essential for normal brain and retinal development in preterm infants who do not have the maturity of enzyme function to produce them from essential fatty acids, [15] and are known to be major trophic factors in short bowel. [14] They are naturally present in EBM and added to Nutriprem 1, SMA PRO Gold Prem 1®, Nutriprem 2, Pepti-Junior, Aptamil Pepti 1 and Neocate.

4. **Hydrolysed protein**: whole protein is present in EBM, Nutriprem 1 & 2. Hydrolysed protein as peptides is found in breast milk fortifier (BMF), SMA PRO Gold Prem® 1 & 2, Aptamil Pepti 1 and Pepti-Junior. Neocate LCP contains protein in its most hydrolysed form as amino acids.

   Although it may seem logical that the higher degree of protein hydrolysis, the more readily it will be absorbed, there is contradictory published evidence and it is likely that whole protein may be as well utilised [16, 17]. The further a protein is hydrolysed, the greater the osmotic effect, so lactose is usually replaced with glucose polymer to help reduce osmolality of the final product. Whilst it has been suggested that cow’s milk protein may have a role in the development of NEC and sepsis [18] and that dietary antigen sensitisation may have a role in promoting or sustaining inflammation in both [4], good evidence in support of this is awaited.

   There is a retrospective review in neonates with SBS which supports the use of EBM or fully elemental formulas (amino acids, rather than peptides) in reducing duration of parenteral nutrition (PN) [5]. However, semi-elemental formulas may also help in decreasing peak bilirubin concentration. There is also a suggestion that amino acids may be of benefit in SBS as they eliminated the need for PN in a small number of children with SBS in whom peptide formulas had been unsuccessful [19].

5. **Nutritional profile**: SMA PRO Gold Prem 1® is one of two hydrolysed protein formulas in the UK designed to meet the specific needs of the preterm infant. It has been selected over the alternative product – Hydrolysed Nutriprem – due to its greater degree of protein hydrolysis, lower lactose and higher MCT. It will therefore be used as suggested in section 3.1.1 unless the need for total avoidance of lactose or higher MCT is established.
APPENDIX 3:

Table of nutritional comparison of feeds that may be considered in surgical patients

<table>
<thead>
<tr>
<th>Per 100ml Feed</th>
<th>Unfortified EBM (term/mature preterm)</th>
<th>Fortified EBM (term/mature preterm)</th>
<th>Nutriprem 1</th>
<th>SMA PRO Gold Prem 1®</th>
<th>Aptamil Pepti 1 13.6% ~16%</th>
<th>Pepti-Junior 12.8% ~15%</th>
<th>Neocate LCP</th>
<th>Nutriprem 2</th>
<th>SMA PRO Gold Prem 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein g</td>
<td>1.3 (estimate)</td>
<td>2.5 (estimate)</td>
<td>2.6</td>
<td>2.9</td>
<td>1.6</td>
<td>1.9</td>
<td>1.8</td>
<td>2.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Degree of Hydrolysis</td>
<td>Whole protein</td>
<td>Whole protein + peptides$</td>
<td>Whole protein</td>
<td>*peptides</td>
<td>*peptides</td>
<td>*peptides</td>
<td>amino acids</td>
<td>Whole protein</td>
<td>*peptides</td>
</tr>
<tr>
<td>Fat g</td>
<td>4.2</td>
<td>4.2</td>
<td>3.9</td>
<td>4.0</td>
<td>3.5</td>
<td>4.1</td>
<td>3.5</td>
<td>4.1</td>
<td>3.4</td>
</tr>
<tr>
<td>Fat as MCT %</td>
<td>8%</td>
<td>8%</td>
<td>33%</td>
<td>3%</td>
<td>50%</td>
<td>5%</td>
<td>5%</td>
<td>9%</td>
<td>6%</td>
</tr>
<tr>
<td>LCP's</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CHO g</td>
<td>7.4</td>
<td>10.2</td>
<td>8.4</td>
<td>8.1</td>
<td>7.1</td>
<td>8.3</td>
<td>6.8</td>
<td>8.0</td>
<td>7.2</td>
</tr>
<tr>
<td>Lactose %</td>
<td>100%</td>
<td>72%</td>
<td>56%</td>
<td>46%</td>
<td>41%</td>
<td>&lt;2%</td>
<td>Nil</td>
<td>78%</td>
<td>69%</td>
</tr>
<tr>
<td>Energy kcal</td>
<td>70</td>
<td>86</td>
<td>80</td>
<td>80</td>
<td>67</td>
<td>79</td>
<td>66</td>
<td>77</td>
<td>67</td>
</tr>
<tr>
<td>Calcium mg</td>
<td>35</td>
<td>101</td>
<td>94</td>
<td>116</td>
<td>47</td>
<td>55</td>
<td>50</td>
<td>59</td>
<td>66</td>
</tr>
<tr>
<td>Phosphate mg</td>
<td>15</td>
<td>53</td>
<td>62</td>
<td>77</td>
<td>26</td>
<td>30</td>
<td>28</td>
<td>32</td>
<td>47</td>
</tr>
<tr>
<td>Iron mg</td>
<td>neg</td>
<td>neg</td>
<td>1.6</td>
<td>1.8</td>
<td>0.5</td>
<td>0.6</td>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Vit D microg</td>
<td>neg</td>
<td>5.0</td>
<td>3.0</td>
<td>3.7</td>
<td>1.3</td>
<td>1.4</td>
<td>1.3</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Osmolality mosm/kg #</td>
<td>~284</td>
<td>~450</td>
<td>~375</td>
<td>~293</td>
<td>~280</td>
<td>~320</td>
<td>210</td>
<td>~240</td>
<td>~340</td>
</tr>
</tbody>
</table>

Fortified EBM is 1 sachet of Nutriprem breast milk fortifier to 50ml EBM
Term/Mature Preterm EBM - Addition of BMF should be done just prior to feeding where possible to reduce time for amylase in EBM to breakdown lactose leading to increased osmolality.[20]

* Figures for osmolality are approximate as per company literature. Those for concentrated solutions are an estimate based on figures given for standard dilution.

\$ Peptides – from fortifier
* Peptides – degree of hydrolysis variable with longer chain peptides in BMF > Aptamil Pepti 1 > Pepti-Junior > SMA PRO Gold Prem 1/2®
## APPENDIX 4

### 14 Day Summary Chart for Feed Tolerance in Infants with Surgical Stomas

<table>
<thead>
<tr>
<th>Date</th>
<th>Weight – only if weighed that day (kg)</th>
<th>Total fluids (ml/kg/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PN</th>
<th>PN (ml/kg/d)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>ENTRAL</th>
<th>Type of milk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume &amp; Frequency</td>
</tr>
<tr>
<td></td>
<td>Amount (ml/kg/d)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTPUT</th>
<th>Stoma output (ml/kg/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of vomits</td>
</tr>
<tr>
<td></td>
<td>IV replacement* (ml/kg/d)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Na STATUS</th>
<th>Serum Na (mmol/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urine Na (mmol/l)</td>
</tr>
<tr>
<td></td>
<td>PN - Na intake (mmol/kg/d)</td>
</tr>
<tr>
<td></td>
<td>Na suppl (mmol/kg/d)</td>
</tr>
<tr>
<td></td>
<td>Total Na intake (mmol/kg/d)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NOTES</th>
<th>Loperamide (microg/kg qds)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>NOTES</th>
<th>IV replacement will generally be with 0.9% NaCl with 10mmol KCl in 500ml. Where infants are receiving PN an increase in nutrition could be achieved by replacing with the aqueous solution. This should be a consultant decision based on nutritional needs with neonatal dietitian advice if available.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Milk, preferably EBM should be increased according to individual tolerance using rates in the NICU Yellow Regimen (Appendix 1) as a maximum</td>
</tr>
<tr>
<td></td>
<td>2. Where feed intolerance is suspected or likely, decisions on fluid replacement, feed advancement, need for Na supplements, loperamide, etc should be made based on the previous day’s tolerance using summary above. Changes should not necessarily be made daily as the infant may need longer than this to adjust to a change. This should be completed daily by the doctor performing the daily review to allow decisions to be made on the Consultant Ward Round</td>
</tr>
</tbody>
</table>
Advice for Parents at Discharge from Neonatal Unit after Gastrochisis Repair

Babies born with gastrochisis are less likely to tolerate standard infant formulas in the early weeks of life. If you continue to breast feed then no formula is required.

If you need to use formula before your first outpatient review with the paediatric surgeon we would suggest using the specialised formula - Aptamil Pepti 1 - for the first few weeks after discharge until normal bowel activity returns. This is available from your GP on prescription.

If your baby has been having any of this formula prior to discharge, you will be given a small supply to take home and a letter for your GP requesting it be prescribed for the next few weeks. You will be advised to change to a standard infant formula at your first outpatient review with the paediatric surgeons. The options available are:

If your baby was born at or after 34 weeks gestation:-

Aptamil First, Cow & Gate First, Hipp Combiotic 1 or SMA Pro First

If your baby was born before 34 weeks gestation:-

4 x 900g tins per month of Nutriprem 2 will have been requested from your GP to replace the Aptamil Pepti 1 until your baby achieves the necessary catch up growth. This is likely to be in the first few weeks or months after going home and is only available on prescription to a maximum of 6 months corrected age. Your baby will no longer require iron and vitamin supplements when receiving Nutriprem 2.

Change of formula should be done over a few days replacing 30ml (1fl oz) Aptamil Pepti 1 per feed with appropriate formula, replacing 30ml (1fl oz) per feed each day.

For example:

Baby being offered approximately 90ml (3 fl oz) Aptamil Pepti 1 every 3-4 hours

Day 1 - 60ml (2 fl oz) Aptamil Pepti 1
30ml standard formula

Offer at all feeds for next 24 hours

Day 2 - 30ml (1 fl oz) Aptamil Pepti 1
60ml (2 fl oz) standard formula

Offer at all feeds for next 24 hours

Day 3 - 90ml (3 fl oz) standard formula

Continue this feed

If at any point you feel your baby isn’t tolerating the new feed or you need further advice please ring Chris Jarvis, Specialist Neonatal Dietitian, 0115 9249924 x 57622 or the neonatal unit. You can return to the feed previously tolerated until you obtain specific advice.
Dear Dr ........................................

This baby will soon be discharged from the Neonatal unit and due to the need for surgery for repair of gastroschisis, has been established onto either exclusive breast feeding or the hydrolysed protein formula – **Aptamil Pepti 1** – until normal gut motility is established. If Mum continues to breast feed there will be no reason to change this.

However, if any formula is required, parents have been advised to introduce Aptamil Pepti 1 as mentioned above so we would be very grateful if you would prescribe this ACBS approved product until paediatric surgical review when a transition to a standard formula is likely to be advised.

<table>
<thead>
<tr>
<th>Name of Product</th>
<th>Manufacturer</th>
<th>Amount per 28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aptamil Pepti 1</td>
<td>Nutricia</td>
<td>4 x 900g packs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or 9 x 400g tins</td>
</tr>
</tbody>
</table>

Parents have been given an advice sheet on transition to a standard formula of their choice when the paediatric surgeon advises them to do so.

**If the baby was born prior to 34 weeks gestation** the baby will require Sytron 1ml daily and 0.6ml Abidec daily while breast feeding but if on Aptamil Pepti 1 only 0.3ml Abidec daily and 1 ml Sytron as requested in the discharge summary. At transition to a whole protein formula the nutrient enriched post discharge formula is advised over a standard term formula – **Nutriprem 2** - for babies born prior to 34w gestation until the necessary catch up growth has been made or a maximum of 6 months corrected age. They will require 4 x 900g tins every 28 days. Iron and vitamins **are not** required with Nutriprem 2.

Please contact the continuing care team who will be visiting this family with any queries.

Yours sincerely
Please sign and print name

**Continuing Care Team, Nottingham Neonatal Service**