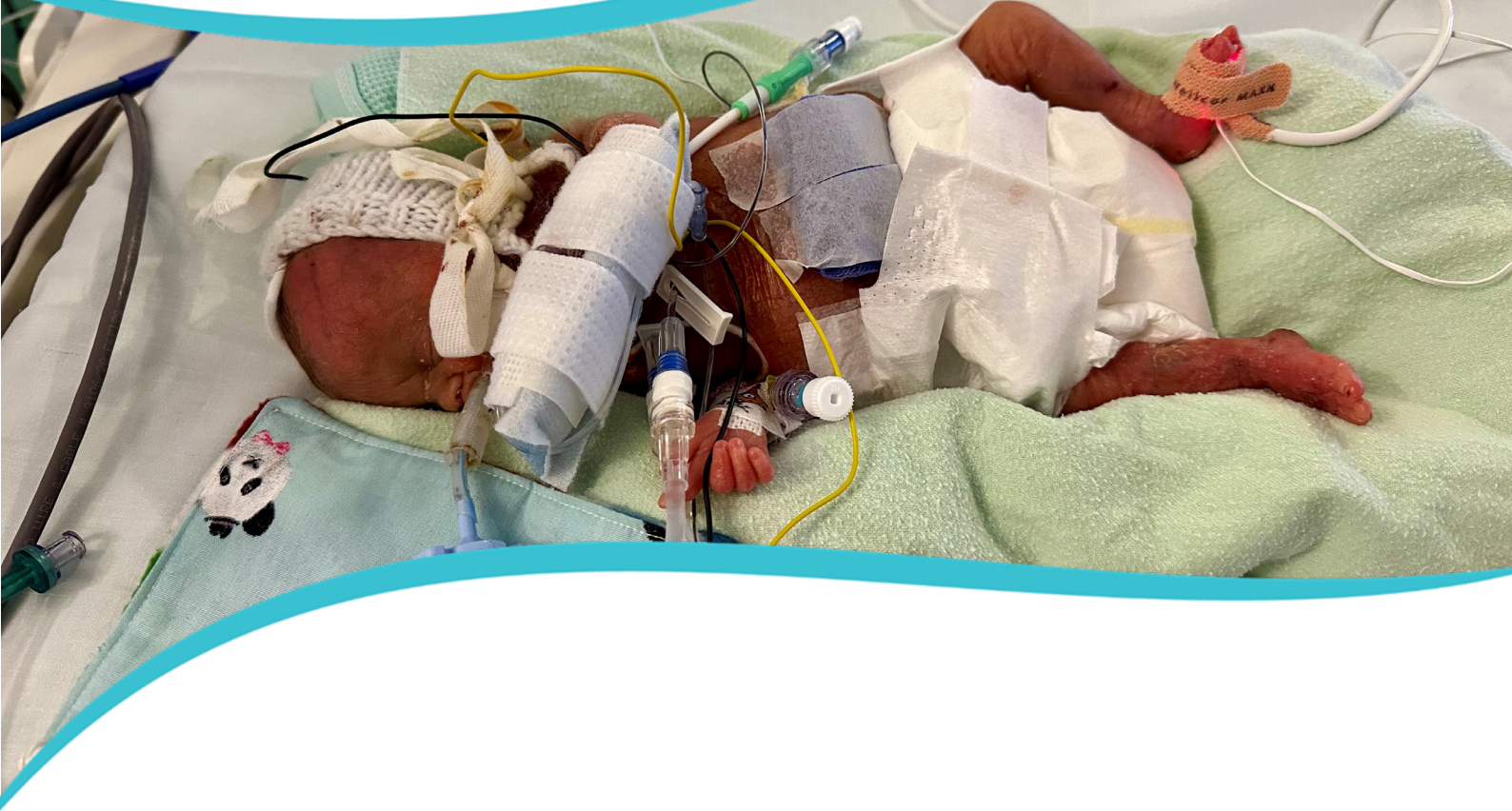




British Association of
Perinatal Medicine



Perioperative Care of Extremely Premature Babies at <28 Weeks Gestation

A BAPM Framework for Practice

October 2024

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Acknowledgements

This framework is the result of a huge combined effort by a dedicated, experienced and passionate team that represents the breadth of skills in BAPM. The babies we care for will benefit from our effort. Laura in our BAPM office was a tremendous help in formatting and creating this framework in the usual style.

About this Framework

Introduction

This framework offers a high-level approach to perioperative care of an extremely premature newborn baby for all neonatal staff groups.

Target users

Health care professionals on neonatal intensive care units that care for babies at <28 weeks gestation.

Scope

This is intended as a framework to assist care providers who deliver care to babies at <28 weeks gestation around the time of an operation. The framework starts once the decision that an operation is needed has been made by the clinical team and parents. It is beyond the remit of this framework to address whether that operation is in the best needs of the baby. We leave the specific implementation of the recommendations to the care provider to adopt and deliver. We recognise that these principals could be reasonably applied to any newborn infant that requires an operation during admission to NICU.

Background

Neonatal intensive care is delivered more frequently and to more extremely premature babies than previously. There are frameworks for the general care of babies, however, there is little guidance about the perioperative care of an extremely premature baby. This might result in variation in practice on a neonatal intensive care unit and the risk that outcomes may be affected. This has been highlighted in the Paediatric Surgery GIRFT report from 2021. This framework offers a high level approach to perioperative care of extremely premature babies for all neonatal staff groups. In addition, the document covers how we might best support families during their baby's operation. The location where a necessary operation takes place or who delivers the anaesthetic are outside the scope of this framework. Trusts are invited to develop local guidelines to implement these recommendations .

Evidence

In an extremely premature baby there is often a lack of sufficient evidence to make recommendations (e.g. for specific analgesic preparations or dosing strategies). On this basis this Framework has used a combination of neonatal studies in more mature babies or consensus after discussion within the working group to make relevant recommendations. We will review these recommendations as new evidence emerges. References are provided for further reading.

Definitions

- Extremely premature newborn baby: Baby <28 weeks gestation.
- Baby: An Extremely premature newborn baby of <28 weeks gestation.
- Parent to mean all parents, carers and legal guardians.

Language

The British Association of Perinatal Medicine is committed to continuously fostering an inclusive environment and we acknowledge the effect language can have on individuals and populations. The framework / toolkit uses the terms 'woman / mother or birthing parent' throughout to include people who do not identify as women but who are pregnant, in labour and in the postnatal period. The term breastfeeding is also used but should be taken to include those who term this method of feeding as chest or body feeding. Please always take time to make sure you are using the preferred pronouns and terminology of the patient and their support network.

The guide is a work in progress and comes from work developed by our communications team and equality, diversity and inclusion steering group. The language guide is specific to the UK context and to aid the creation and review of documents designed for the healthcare professional audience. therefore, it may not be relevant in other settings. We also acknowledge that we may not get the language right every time, and welcome feedback on our work.

Abbreviations

BAPM	British Association of Perinatal Medicine.
NICU	Neonatal Intensive Care Unit.
GIRFT	Getting It Right First Time
ASA	American Society of Anesthesiologists
NICE	National Institute of Healthcare and Excellence.
ESPGHAN	European Society for Paediatric Gastroenterology, Hepatology and Nutrition
MOM	Mothers own Milk
PN	Parenteral Nutrition

Summary of recommendations

1. Parental communication should be timely, open and ideally delivered jointly from the surgeon, neonatologist and paediatric anaesthetist.
2. All babies requiring an operation should be managed jointly by a neonatologist, a paediatric surgeon and a paediatric anaesthetist
3. During transfer:
 - Use the most appropriate team available at the time. This may be theatre or neonatal staff, or specialist teams.
 - Ensure that all transport equipment is easily and safely accessible.
 - Prevent hypothermia with pre-planned perioperative warming strategies and bundles.
4. Pre warm theatre to minimise risk of hypothermia in baby
5. Monitor babies' vital signs (blood pressure, heart rate, fluid balances) regularly.
6. At the earliest opportunity commence:
 - Standardised parenteral nutrition.
 - Early enteral feeding in post-surgical babies.
 - Early positive oral feeding experiences.
7. Maternal breast milk (MBM) is the preferred choice of milk where available.
8. Neonatal units should have a guideline for pain management in the perioperative period.
9. Validated pain scoring tools should be used regularly and used to adjust given analgesia.
10. Plan analgesia dosing regimen to avoid gaps in the post-operative period.
11. Use opioids and paracetamol as the main analgesics in the post-operative period.
12. Use non-pharmacological pain management strategies as early as possible.
13. Document and handover pain management plans in the perioperative period.

Parent communication

General principles of communication should be aligned with those in the GMC's [Good Medical Practice](#)¹ and Royal College of Surgeons' [Good Surgical Practice](#)². Four key points are explored below.

Timely and senior communication

The potential need for surgical intervention at any time can be daunting to a parent and the prospect of a baby undergoing surgery in the neonatal period may provoke significant stress and anxiety. Parent communication under these circumstances needs to be senior led, timely, honest, sensitive and balanced.

Joint face to face communication is the ideal

Communication should ideally be in person, in a quiet location close to the baby. Wherever possible, in neonatal centres that are co-located with paediatric surgical services, parental communication should be delivered jointly by the surgeon undertaking the procedure, the neonatologist and the anaesthetist. Uncertainties and potential risks or harms should be discussed as well as written consent obtained. There should be time allowed for parental questions.

It is not always possible for joint counselling to be undertaken due to acuity of the clinical situation or service constraints. Where this is not possible, separate conversations must be documented in the medical records and clear communication between teams regarding the information communicated, as well as the medical and surgical plan for the baby to ensure seamless patient care.

Babies who require transfer to another hospital for specialist surgical services and ongoing management

Some surgery cannot be performed at a baby's current location and there is a need for transfer to another hospital. Parents should be made aware that their baby is being transferred for *consideration* of surgical intervention rather than a guaranteed surgical procedure(s). Whilst most babies that are transferred for surgery do undergo the procedure, the clinical condition of the baby can deteriorate, or new information may become available that means surgery is no longer appropriate. Therefore, it is important to manage parental expectations in this regard, especially if the baby is unstable or may require a major surgical procedure.

Written record in medical notes and for parents

There should be a written record in the medical notes detailing the parental communication episode.

It would be reasonable to provide a copy of the communication record to parents so they have a written summary of the discussion and include NICU contact details. It is well recognised that parental recall of information can be limited, especially at times of stress and worry and a written record can mitigate against this. If written information is given, it should be written in a simple and compassionate style that avoids jargon and would be acceptable and understandable to parents.

Table 1: Minimum information to be discussed with all parents whose baby is planned to undergo an operation

Information to be discussed with all parents
The type of operation needed*
Reason for the operation*
Risks and benefits*
Where the operation will take place (hospital and location)
Post-operative plans (i.e., location of care after the operation)
When they can see their baby again after the operation
The next meeting for a further update
*This information should be covered in the consent process

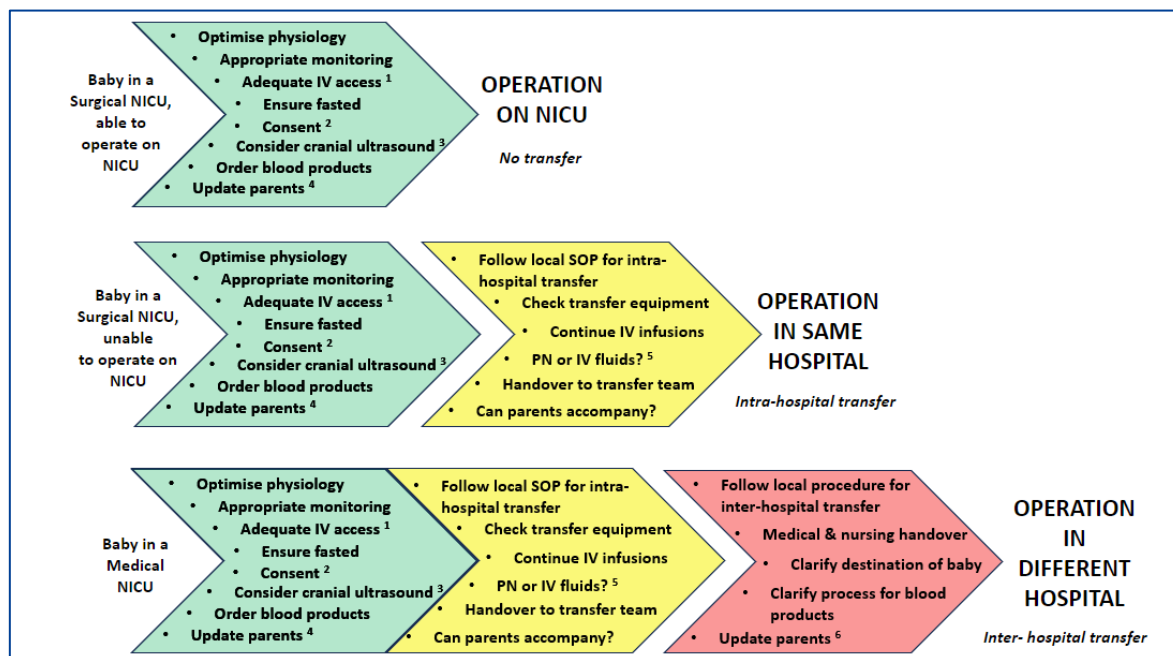
Table 2: Additional information to be discussed if a baby requires intra-hospital or inter-hospital transfer for an operation

If a transfer is involved
Who will transfer the baby (internal team, specialist transport team)
Whether parents accompany on the transfer
Arrangements for parental travel if transfer is to another hospital
Exact location (ward details) and contact phone number of receiving location

Preparation for surgery

There are some key points that are applicable to all babies requiring surgery (see Figure 1). These are detailed below in the green arrow. Additional considerations when preparing a baby for surgery depend upon whether a transfer is required. The transfer may be within the same hospital (intra-hospital) and are detailed in the yellow arrow, or to a different hospital (inter-hospital) as outlined in the red arrow. The hospital may be in the same geographical region or further away from home. Some babies will not require a transfer as there is the option to perform surgery on the NICU.

Figure 1: Preparation of a baby for an operation depending on need for transfer



¹ In cases of surgical central line insertion, challenges with IV access may be the reason the baby is undergoing a surgical procedure, therefore this has to be approached with a degree of pragmatism.

² This is the responsibility of the person(s) performing the procedure, and should be done in line with guidance from Royal College of Surgeons.

³ It would be good practice to obtain a recent cranial ultrasound scan of any extremely preterm baby undergoing an operation to help inform the wider clinical context of the baby.

⁴ See communication section (Table 1) for specific points to cover.

⁵ Consider whether to continue PN or to convert to intravenous fluid. Follow local guidance, if applicable.

⁶ See Table 2 for additional points to cover when a baby is being transferred to a different hospital.

Operative environment

There is limited evidence about the ideal environment to perform surgery for babies. A risk versus benefit of transport and suitable resources available to undertake surgery in the Neonatal Unit needs to be undertaken for each case.

It is both feasible and safe to perform surgical procedures in NICU. No special area is needed but designing an operating room within NICU would be ideal if planning a new unit. It is especially useful to consider in very low birth weight and critically ill babies who have a high risk associated to transfer to the operating theatre. Having a criteria/proforma for procedures and patients is recommended. Appendix 1 lists matters to consider when providing an NICU operating space.

Equipment required for babies during perioperative care

The purpose of this section is to provide suggestions of the type of equipment and associated issues to consider when managing babies during their perioperative care. The consensus of the working group is not to suggest specific equipment as there are various makes and models available.

When transferring the patient between areas, this must be done by the most appropriate team at the time. This may be theatre or neonatal staff, or specialist teams. All equipment should be easily and safely accessible during transfer. The checklist below outlines what equipment is generally required for safe transfer.

An example checklist

(Adapted from the Embrace checklists)^{3, 4, 5}

Ensure all equipment is safely secured to the trolley or incubator.

- Transport incubator, trolley or pod with gel warming mattress.
- Age/weight appropriate restraint devices.
- Transport certified ventilator.
- Intubation drugs and equipment.
- Sufficient oxygen and air in portable cylinder.
- Suction unit and batteries fully charged.
- Transport monitor.
- Infusion devices rationalised and safely secured.
- Charged batteries for monitor and infusion pumps.
- 'Grab bag' – appropriate drugs and fluids with equipment should be immediately available and checked according to local policy.
- Resource file – drug chart, observation charts, guidelines etc.
- Completed Pre-departure checklist.

Monitoring and handover for babies that need an operation

Collaborative management between surgical, medical and nursing staff is vital to achieve a positive surgical outcome. Ineffective handover can result in under monitoring, medication errors or delay in response/follow up.

Key points

- Assess and document the baby's clinical condition in terms of an A, B, C etc approach during transfer to and from theatre.
- Assess the baby's pain responses and ensure adequate analgesia is administered.
- The baby's vital signs should be monitored closely
- Ensure that necessary blood tests are reported and acted upon before and after an operation
- A blood gas analysis is done within 30 minutes of return to the unit and acted upon if needed.
- A strict fluid balance should be maintained, ensuring fluid given in theatre is accounted for.
- Observe the wound site(s), dressings and any drains.
- Temperature probes and ECG leads should be used with caution in babies <28/40 and those with fragile skin at risk of pressure ulcers e.g., hydropic or cooled babies.
- Maintain NICU infection control measures throughout the perioperative period

Transfer to unit

- Babies that require an operation are managed jointly by the neonatologist, paediatric surgeons and paediatric anaesthetist.
- The day-to-day surgical management of the baby should be documented in the medical notes by the surgical team.
- Any significant deterioration should be reported to both the surgical and neonatology teams.
- Always read the operation note for post-operative instructions and duration of antibiotic course.

Observations and documentation

- Most babies have full and continuous physiological electronic monitoring of vital signs that include temperature, heart rate, respiratory rate, oxygen saturations, and blood pressure. This should be continued throughout the perioperative period.
- If such monitoring is not available, the frequency of observations should be guided by the nursing assessment, clinical presentation and alongside any medical team instructions or guidance. (Clinical judgement should always take precedent in a deteriorating or unstable baby, who should have observations recorded more frequently if their condition dictates this.)
- In addition to the vital sign parameters, a change in baby's behaviour, parent feedback, tissue viability score, neurological score, jaundice levels, blood glucose levels and blood gases should be used to make a clinical assessment and identify the potential deterioration of a baby.

Monitoring and handover

- Handover of clinical information in the perioperative period should occur between the most senior clinicians available.
- As a minimum, handover details would include but not be limited to, operation performed and findings, intraoperative fluid or blood products, intraoperative pain relief and other medication, continuous infusions, post operative instructions (period nil by mouth, duration of antibiotic course), who has updated the parents in regards to operative findings.
- Expected handover situations include:
 1. Handover from NICU team to transport team.
 2. Handover from transport staff to surgical and anaesthetic team before and after operation.
 3. Handover from transport team to NICU team on return to NICU.
- Notify the parents of the baby's arrival back from theatre as soon as is practical and ensure they are updated by the surgeon and, ideally, the neonatologist.
- Continue full cardiorespiratory monitoring for the perioperative period and then as per local guideline on NICU.
- If ventilated, consider end tidal CO₂ monitoring as this is considered best practice.
- If the baby was intubated in the operating theatre, obtain a chest X-ray on return to the unit to confirm the correct placement of the endotracheal tube and obtain a blood gas within 30 minutes of return to NICU.
- Use a validated pain tool to document a pain score with observations.
- Assess the baby's pain responses and ensure adequate analgesia is administered.
- All care should follow the surgical post-op orders on the operation record.
- Surgical drains should be managed as per surgeon's instructions. Do not attach to suction unless specifically requested to by the surgeon.

Monitoring

Continue full cardiorespiratory monitoring for the perioperative period and then as per local guideline on NICU (ECG, saturations, respirations, apnoea, blood pressure, temperature).

Management of temperature

Background

Thermoregulation is known to be one of the most important aspects of all neonatal care, with well published evidence of increased morbidity and mortality associated with poor temperature control. Thermoregulation is a vital body function that maintains a core body temperature between 36.5 °C and 37.5 °C, with the World Health Organisation defining hypothermia as a core body temperature <36.5 °C.

Inadvertent intraoperative hypothermia is a preventable complication with severe adverse consequences. Extended periods of cold stress can lead to harmful side effects which include hypoglycaemia, decrease lung surfactant synthesis leading to respiratory distress and apnoea leading to hypoxia and pulmonary hypertension requiring prolonged mechanical ventilation and poor neurological outcomes; intraventricular haemorrhage; arterial hypotension; metabolic acidosis; necrotizing enterocolitis, and failure to gain weight. For surgical babies further complications and increased risks include tissue hypoxia, necrosis and wound break down; coagulopathies; surgical-wound infection; nausea and vomiting; pain; increased blood loss; and prolonged recovery time and length of hospital stay and even death.

Thermoregulation in babies

Aspects that contribute to hypothermia include:

- Immature thermoregulatory capacity.
- Increased bodyweight to surface area ratio.
- Increased heat loss from the head.
- Limited subcutaneous fat and thin keratine layer.
- High transepidermal water loss.

Mechanisms for heat loss in babies

Radiant, Evaporative, Conductive and Convective heat losses contribute to the challenges of thermal care in the baby. It is essential that babies are nursed within their 'neutral thermal environment' (NTE). This is defined as "the environmental air temperature at which a baby with a normal body temperature has a minimal metabolic rate and therefore minimal oxygen consumption"⁹. The maintenance of the NTE is the aim of neonatal temperature control and management.

Literature

Several articles show that babies of younger gestational age, lower weight, those with longer surgery time, those that received more fluid, and no prewarming are at risk of hypothermia. Being a preterm baby, requiring emergency surgery and higher ASA grades also have a strong association with hypothermia.

Recommendations from ERASreg (2020)⁷ are continuous monitoring of intraoperative core temperature, and to take pre-emptive measures to prevent hypothermia (<36.5 C) and maintain normothermia. Other articles show that the key means of reducing perioperative hypothermia is to maintain normal body temperature before transport to the operating room and at other select time points throughout the perioperative period.

Theatre temperature

In the UK there are no documented recommendations on surgical operating theatre temperature to prevent hypothermia for babies. However, maintaining the overall theatre environment to be comfortable for the staff, reducing the risk of hypo and hyperthermia in the baby requires careful balance. The theatre should be pre warmed before the baby arrives. In addition, the theatre should have the capacity to reach a temperature of 28°C.

Operative theatres ambient air temperature is generally lower than neonatal units. The Department of Health recommended that when building a new neonatal unit it should be possible to independently vary room temperatures in the range 21°C to 30°C, with a daily range of 23–25°C.

Recommendations

A good effective pre-planned perioperative warming strategy and the use of hypothermia bundles should be incorporated into the maintenance of normothermia during perioperative care, transportation, active warming before induction of anaesthesia, active warming during anaesthesia and surgery, and accurate measurement of core temperature.

Location of surgery should be as per local guidelines but all locations should have facilities to keep babies warm perioperatively on NICU, during transport if applicable and during surgical procedure.

[Appendix 2](#) lists strategies to consider in order to prevent hypothermia.

Fluid management in the perioperative period

Fluid management in babies undergoing surgery is complex and dependent on factors such as gestational age, postnatal age, physiological maturation of organ systems, type of surgery, concomitant illness and blood loss. This is further complicated with prematurity due to organ immaturity and high trans-epidermal losses, especially in the first week of life.

Fluid management is divided into 3 main aspects:

1. Replacement of fluid deficits.
2. Administration of maintenance fluids.
3. Replacement of any losses.

Replacement of fluid deficits

It is uncommon for babies to undergo elective surgery. Prior to the operation, a thorough assessment of the baby's hydration status might include fluid balance, blood pressure and lactate. Should a baby be deemed to be underfilled prior to surgery, there should be careful consideration around the fluid replacement duration and the time to surgery. This would be dependent on the type and urgency of procedure.

In more acute situations, such as isolated perforation there may be a more urgent need for surgery and babies should be on intravenous fluids.

Determining the deficit would include a thorough assessment including history, examination, laboratory results, point-of-care testing results, daily weights and fluid balance.

Administration of maintenance fluids

NICE recommends the use of standardised parenteral nutrition as maintenance fluids for preterm babies, which could be used in the perioperative period. Many centres restrict the use of parenteral nutrition intraoperatively. It would be important to consider maintenance fluids in these cases.

It is recommended to ensure normoglycaemia. Risk factors for hypoglycaemia include prematurity, perinatal stress or asphyxia, being small of gestational age, maternal diabetes and any conditions which make the baby prone to hypoglycaemia (including interruption of iv fluid or PN maintenance). There is also a risk of hyperglycaemia that should be managed appropriately.

Replacement of additional fluid losses

Monitoring is very important postoperatively, particularly of vital signs such as blood pressure, heart rate, and a regular assessment of fluid balances. In cases of circulatory instability due to blood loss or third space losses, the goal is to restore and normalise circulating intravascular volume in a timely fashion with crystalloids, colloids or blood products as applicable. Gastric and stoma losses should be reviewed as per unit guidelines. Sometimes babies will require packed red blood cells, platelets and FFP during the procedure if they have anaemia, thrombocytopaenia or abnormal clotting respectively. These blood products would be administered in line with the British Committee for Standards in Haematology guideline.

Management of nutrition

Babies are at increased risk of developing significant nutritional deficits due to negligible stores and delays in establishing nutrition. Recommended nutritional requirements are difficult to meet especially in those whose journey may be complicated by surgery, particularly those involving the gastro-intestinal (GI) tract or with associated infections. Improved nutritional status contributes to increased survival rates and improved outcomes. A neonatal dietitian is an integral part of the MDT providing consistent nutritional care to each baby.

Parenteral Nutrition (PN)

NICE recommends that PN should commence within 8 hours of life until the transition to full enteral feeds^{9, 19}. In babies who are unwell requiring multiple other infusions, it is important to maximise nutrition and review the concentration of drug infusions in discussion with the neonatal pharmacist. Babies undergoing surgery may require prolonged PN, which increases the risk of morbidities such as central line-associated sepsis and PN-induced cholestasis.

Enteral feeds

Following surgery, the aim is to establish enteral feeds and wean a baby off PN. This should be a multidisciplinary team (MDT) decision. Local or network standard enteral feeding guidelines should be used. Early trophic feeds may improve recovery time by increasing gut blood flow and motility, limiting the impact of starvation on the structure of the gut and resultant atrophy. A period of bowel rest is often standard practice for example in necrotising enterocolitis (NEC) or with associated intra-abdominal sepsis due to inflammation. We recommend early enteral feeding in post-surgical babies as evidence suggest this leads to a shorter length of stay and decreased surgical site infections with no increase in anastomotic leaks²⁰.

Initiation of feeds and subsequent increases may be assessed by quantity and type of gastric aspirate; vomiting; consistency, volume and frequency of stool or stoma loss; and growth. Multiple factors affect the bowel's overall condition, its motility and subsequent ability to tolerate enteral feeds and it may be necessary to progress more slowly for example post gastroschisis repair.

Where a stoma has been formed due to congenital abnormalities such as small bowel atresia or as treatment for NEC, caution should be taken as enteral feeds advance and PN is reduced to ensure stoma losses are within limits and the baby is growing appropriately.

For post GI surgery for conditions that may require a trans anastomotic tube (TAT), continuous feeds might be the preferred method of feeding if post pyloric. Where a gastrostomy is formed, feeds should be started as bolus feeds as per local policy..

Surgical babies can develop an aversion to oral feeding if oral feeding is delayed or if painful symptoms are associated with feeding. Early positive oral feeding experiences can negate this with early support from a speech and language therapist.

Choice of milk

Early buccal colostrum should be given ideally within 6 hours of birth or as soon as available providing babies with a positive oral experience and this should be continued.

Maternal breast milk (MBM) is the preferred choice of milk. If MBM is unavailable or insufficient to meet requirements, donor human milk (DHM) should be considered. Human milk (HM) stimulates peristalsis and gut motility and along with growth factors, immunoglobulins, oligosaccharides and glutamine lowers the extent of microbial dysbiosis resulting in enhanced mucosal healing, intestinal stem cell proliferation, decreased enterocyte apoptosis and improved intestinal adaptation²¹. HM reduces the incidence of NEC in high-risk populations such as preterm babies or gastroschisis. HM has been reported to shorten length of stay, PN duration and time to full enteral feeds in congenital GI malformations requiring surgery²².

ESPGHAN recommends the introduction of human milk fortifier to ensure that nutritional requirements for babies are adequately met²³. A joint discussion with neonatologists, dietitians and surgeons should decide on appropriate timing of introduction with additional consideration for those babies post GI surgery/and with a stoma.

Babies who are on DHM may be transitioned to preterm formula or if indicated, specialised formula such as an extensively hydrolysed preterm formula as per local unit policy.

Longer term nutrition

The nutritional management of babies following surgery can range from normal feeding to complex nutritional care over many months and sometimes years. Long-term outcomes have improved but challenges remain. Therefore, the family and baby should be supported by a full multi-disciplinary team including weekly nutrition ward rounds to manage and support the nutritional needs and growth of these babies.

Management of pain

Background

Effective pain management is an essential standard of care for all babies in NICU. Increased painful stimuli during the neonatal period and inadequate analgesia have an adverse effect of neurodevelopmental outcomes, growth and emotional temperament²⁴.

Assessment of pain

Well established pain assessment methods have been used extensively in neonatal units and studies have not shown one method to be superior to others²⁵. Some commonly used pain scales were designed for procedural pain/acute pain only and not validated on post-operative pain. Examples of pain scales that are validated in babies in the post-operative period include Neonatal Pain, Agitation and Sedation Scale (N-PASS), Premature Baby Pain Profile (PIPP), and Neonatal Pain Assessment Tool (NPAT). Babies should be assessed at regular intervals.

Engagement of parents in pain assessment and management has been shown to have a positive impact on their satisfaction with neonatal services and care of their baby²⁶. It is recommended that staff should ensure parents are shown how they can assist with the assessment and management of their baby's pain. To help make sure that parents understand the information given, it may be helpful to provide them with written information to support this. For example, Bliss has resources which cover being involved in a baby's care and procedures.²⁷

- Use of a validated scoring system of pain assessment should be consistent within each neonatal unit in the pre, peri and post-operative period.
- Adjust analgesia as the pain score changes.
- Plan analgesia dosing to avoid gaps in pain relief in the post-operative period
- Explaining, supporting and showing parents how they can be actively involved in the assessment and management of their baby's pain.

Pharmacological management

Systemic Analgesia

The main agents that are used in neonatal units are paracetamol and opioids (e.g. morphine and fentanyl are most frequently used in Europe)²⁸. Comparative studies of opioid agents and dosing strategies in the neonatal population have not found a significant difference between continuous infusion versus bolus regime or with one opioid compared with another. The consensus of the working group is that opioid drugs and paracetamol should be the main analgesics in the post-operative period.

Morphine

Suggested morphine infusions for the postsurgical baby are 10-20 microgram/kg/hr but may need adjustment in view of past medical history. Morphine can be given enterally or intravenously, although doses vary based on route of administration and enteral administration may not be possible in the immediate post-operative period. Opioid analgesia should be reduced in a stepwise manner post-operatively at the earliest opportunity based on pain assessment using a validated tool. Babies who have received opioid analgesics for an extended period are at risk of withdrawal and dose weaning should be carried out more slowly, monitoring the baby for signs of withdrawal.

Paracetamol

Paracetamol is an effective analgesic in babies and has been shown in small studies to reduce the requirement for opioids in the newborn period²⁹. Dosing and monitoring in this age group for analgesic purposes has not been extensively studied³¹. There is no national recommended dosing for IV paracetamol in BNFc in preterm infants of corrected gestation less than 32 weeks. The following is a possible dosing regimen based on consensus from the working group and studies reviewed.

Table 3: Suggested regimen for paracetamol for analgesia in <28 week corrected gestation

<i>Doses are based on Guy's & St Thomas' formulary³⁰.</i>		
Route	Dose	Notes
Intravenous	7.5mg/kg 12 hourly (bd)	
Oral/enteral	20mg/kg loading dose, then 15mg/kg 12 hourly (bd)	Oral route may be contraindicated until enteral feeding is re-established.
Rectal	20mg/kg loading dose, then 15mg/kg 12 hourly (bd)	Only whole suppositories should be administered to ensure accurate dosing. No licensed paracetamol suppositories are available <60mg but various strengths are available as unlicensed 'specials'. NB rectal route may be contraindicated in some instances

Local Analgesia

It is not uncommon to use local anaesthetics agents like levobupivacaine for local skin infiltration to supplement intra and postop analgesia in clinical practice (e.g. for line insertions) as a multimodal analgesic approach provides optimum pain relief and reduces/avoids requirements for opiates. In addition, topical local anaesthetics are potentially useful.

Non-pharmacological management

Use of skin-to-skin contact, containment, non-nutritive sucking and sweet tasting solutions have all be shown to reduce the response to procedural pain²⁸. It is the consensus of the working group that these strategies should continue to be utilised as early as is practical in the perioperative period. In addition, staff should ensure that parents are shown how they can assist with the assessment and management of their baby's pain utilising parental resources such as those available from Bliss²⁷.

Documentation of medication

Accurate documentation of medication delivery is a vital part of safe neonatal care and the post-operative handover from the surgical and anaesthetic teams to the ward team has been shown in studies to create the potential for medication error when analgesia is not routinely mentioned³².

Analgesics administered intraoperatively should be well documented and made part of the routine handover on transfer of care from theatre to ward. This will minimise the risk of under- or overdosing.

Medication related considerations

Many premature babies are prescribed multiple medicines. If a baby needs an operation there are a number of things to consider to avoid errors:

- The handover of complex patients before and after the operation must include all medications.
- The effect of the surgery and the anaesthetic medications on physiology, metabolism and excretion.
- Managing periods of nil-enteral including IV equivalents and PR medication.
- Fluid volumes.
- Compatibility in IV access lines.
- Interactions between current and additional medications.

A plan for medications should be made before the operation involving the nursing staff, pharmacist, neonatologist, surgeon and anaesthetist, as required. The conclusions should be clearly documented as part of the pre-operative assessment.

The neonatal team speaking to the anaesthetist should be familiar with the patient's current medications so they can agree which medicines are essential to continue in the perioperative period (e.g. inotropes) and which can be withheld.

Drugs with a narrow therapeutic range, such as aminoglycosides and vancomycin, should be highlighted so that timed doses are given.

Medications that alter the bleeding or thromboembolic risk such as low molecular weight heparin or tranexamic acid, whilst rarely used in preterm babies, must be used with caution both pre- and post-operatively. Heparin for patency of arterial lines can and should be continued. Full dose or therapeutic heparin infusions, for example used in a renal vein thrombosis, should be stopped 12 hours before surgery and care taken if deciding to re-start. Advice from a haematologist should be sought.

Fasting prior to operation

Because patients will be fasted before an operation then any medicines being administered via the enteral route should be reviewed. (See [Table 4](#).) These might be switched to parenteral administration or temporarily withheld, considering the availability of parenteral equivalents and the risks of temporary omission. Medicines which can be safely withheld include those with long half-lives (such as caffeine citrate or levothyroxine) or only longer-term benefits e.g. routine vitamin supplementation. PR administration is also an option for a small number of medicines if the GI tract is not affected by the surgical intervention.

If there is no other option it is sometimes appropriate to give medicines enterally despite a patient being designated 'nil by mouth'. In this case the medicine should be given in as small a volume as possible, this may need to be discussed with the anaesthetist if it is in the immediate pre-operative period.

Table 4: Considerations regarding medications in perioperative period

Essential to continue perioperatively	Administer pre / post-operatively (oral formulations may need to be switched to IV equivalents whilst NBM)	Withhold until feeds re-established
<ul style="list-style-type: none"> • Inotropes • Dinoprostone/alprostadiol • Esmolol • Steroids for adrenal insufficiency • Dose monitored e.g. gentamicin and vancomycin • Treatments for metabolic disorders e.g. levocarnitine • Treatments for congenital hyperinsulinism e.g. octreotide, glucagon • Heparin for arterial line patency 	<ul style="list-style-type: none"> • Electrolytes and minerals • Antibiotics • Antivirals e.g. ganciclovir, zidovudine, aciclovir • Diuretics • Steroids for chronic lung disease • Thyroid supplements (IV only necessary if prolonged NBM) • PDA treatment • Anticonvulsants e.g. phenobarbital, levetiracetam • Antiarrhythmics e.g. digoxin • Antihypertensives e.g. propranolol • Octreotide for chylothorax • Caffeine citrate • Anticoagulation (restart when safe to do so) 	<ul style="list-style-type: none"> • Vitamins and iron • Antireflux treatment

Perioperative medication handover

Accurate documentation of medication delivery is a vital part of safe neonatal care. Studies have shown the potential for medication error when analgesia is not routinely mentioned at the post-operative handover from the surgical and anaesthetic teams to the ward team^{32, 33}.

Analgesics administered intraoperatively should be well documented and made part of the routine handover on transfer of care from theatre to ward. This will minimise the risk of under- or overdosing”.

The pre-operative handover should list all medications and clarify whether they are being continued or stopped. Consider drugs with a narrow therapeutic window such as aminoglycosides and vancomycin. The post-operative handover should include all medications continued / given during the operation, and additional medications given or started.

Care should be taken regarding the concentration of a drug infusion and the diluent used, as routine practice may differ between departments and hospitals. Drug infusion concentrations designed for older children can result in significant volume overload for smaller premature infants.

Post-operative medication management

The post-operative plan should include any medications the neonatal team are being asked to start e.g. analgesia, sedation, muscle relaxants, and antibiotics. There should also be a documented plan for post-operative analgesia which may be decided by the neonatal team (See [analgesia section](#)).

Drug metabolism and excretion can be affected by fluid restriction, renal impairment, and the impact of surgery. Consider closer monitoring of drugs with a narrow therapeutic range or dosed based on serum levels such as aminoglycosides and vancomycin.

Medications should be reviewed daily. It may be reasonable to consider re-starting enteral medications when a baby is tolerating and absorbing half their total enteral feed volume. It may be appropriate to re-start medications in a stepwise manner to avoid a large volume and/or high osmolarity changes to feeds^{34, 35}.

Special considerations

Compatibility and Interactions

The number of parenteral medications, and the challenge of intravenous access in babies means that multiple continuous and intermittent IV infusions might be delivered through a single IV line. On this basis there is a risk of incompatibility between infusions. Examples include precipitation (e.g. liposomal amphotericin) and crystallisation (e.g. calcium with ceftriaxone). Compatibility should not be assumed. In addition, there is an increased risk of drug-drug interactions and cumulative toxic effects. Line patency should be considered and where medications are being withheld for surgery these volumes may need to be replaced with intravenous fluids to maintain patency of the lumen. Consider these compatibility and interactions issues with your neonatal pharmacist.

Feeding Tubes

Feeding tubes are at risk of becoming blocked by medications³⁶. Unlike standard nasogastric tubes, trans-anastomotic tubes (TATs) cannot be replaced. If they become blocked, enteral feeds, as well as medications, cannot be given. To reduce the risk of blockage avoid administering thick suspensions or partially dispersed tablets down a TAT.

TATs may also be transpyloric, and patients with a stoma may have regions of bowel bypassed or removed. Consideration should be given to the site of absorption of medications administered through TATs and/or given enterally to patients with a stoma.

High osmolarity medications and supplements (such as sodium chloride 30% oral solution or sodium feredetate (sytron®) can also reduce absorption, and if given to patients with a stoma stoma-output should be monitored.

Governance

These are auditable standards that would be useful for a unit to underpin implementing the recommendations of this document.

1. Consent discussion with parent, surgeon and neonatologist.
2. Prewarming theatre
3. Baby's temperature on arrival to theatre, pre return from theatre and readmission to NICU.
4. Use of PN for maintenance fluid for all babies.
5. Use of MOM for post operative feeding.
6. Use of validated pain score.
7. Incident reports for perioperative period and review of emerging theme.
8. Documented Handover for perioperative period (including but not limited to operation performed and findings, intraoperative fluid or blood products, intraoperative pain relief, post operative instructions (period nil by mouth, duration of antibiotic course), who has updated the parents in regards to operative findings.

Key horizons and research

During our review for this framework, the group felt that the care of these babies would benefit from further research in these areas.

1. There is a lack of published data regarding the optimal intraoperative temperature of the baby and of the environment.
2. There is data regarding the increased risk of intraventricular haemorrhage when moving these babies in the first 48 hours after their delivery. On this basis the recommendation is that babies are delivered in a tertiary level NICU. In addition, there is a move towards operating on NICU. However, there is a lack of published data around the optimal place for an operation in these babies.
3. There is a recommendation to commence early enteral feeding but there is a lack of a definition for "early".
4. MOM is the best choice of feeding in the perioperative period. However, there is a lack of data regarding what additional measures in these babies would give the greatest benefit when combined with MOM.
5. There is a lack of research into many of the medications used on NICU in preterm babies that include but is not limited to paracetamol, morphine, clonidine and dexmedetomidine.

Appendix 1: Operating on the neonatal unit

This is a list of issues to consider if you want to provide an operating space on the neonatal unit.

Risks and benefits of operating on the unit verses transferring to the operating theatre.

- Disconnection, transfer (pre and post op), thermoregulation
- Logistics of surgical procedure on neonatal unit
- Provision of GA (hypnosis, analgesia, muscle relaxation)
- Administration and storage of medication

Staff

- People will take on different roles in different environments
- Who does what?
- Unfamiliar environment/ equipment for surgical team

Space

- Logistics and risk of transfer
- Location remote/relative to operating theatre
- NICU vs Theatre – very different
- Proximity to other babies

Systems

- MDT familiarity (WHO surgical checklist)
- Staff introductions, role allocations and clarity (airway, ventilation, blood, scribe, drugs, CPR)
- Positioning (patient and staff) surgical and medical access/visibility
- White board screens (drug calculations, pre planning aide memoire, resus, define surgical area)
- Utility of neonatal staff observing procedure

Equipment availability

- Monitoring
- Ventilation (Ventilators, HFOV, Nitric oxide)
- Air flow and ventilation – set numbers of air changes in a period of time for clean field
- Infusion pumps
- Surgical instruments
- Lighting/diathermy/suction
- Temperature control (theatre room temperature vs nicu temperature)
- Sinks for handwashing

Obstacles and risk to cover

- Different approaches from different teams
- Unfamiliar environment re Lighting and Equipment
- Infection control
- Safety of transport vs location of operation

Sound

- Loud, ongoing noise is known to cause long term developmental issues.

Lighting

- NICUs have poor lighting. Need for additional lighting

Parental stress

- Baby undergoing operation
- Other babies on unit

Appendix 2: Prevention of hypothermia

Continuous central and skin temperature monitor should be applied and used	
On NICU Pre transfer	
Minimal exposure	
Pre procedure thermoregulation	
Mechanism	Measure
Convective	Hat on head
	Blankets/covers
	Plastic wraps or bags
Conductive	Warming mattress or warming pad
Radiant	Warmed incubator
	Humidity in incubator (if appropriate)
Evaporative	Warmed incubator
	Humidity in incubator (if appropriate)
	Humidified ventilation gases
Warming during transport in addition to above	
Mechanism	Measure
Radiant	Pre warmed incubator
Evaporative	Pre warmed incubator
Pre warming of induction of anaesthesia area and theatre	
Mechanism	Measure
Convective	Draft free room
	- Closed windows and doors
	- Limit people entering and exiting room
Conductive	Pre warmed theatre trolley
	Forced air mattress
Radiant	Pre heated anaesthetic room and theatre
Evaporative	Humidified ventilation gases
During procedure (In theatre or on NICU)	
Mechanism	Measure
Convective	Pre Warm room (Intraoperative comfort of the surgical team is important)
	Overhead radiant heater
Conductive	Warming mattress or warming pad
	Warm fluid infusions and blood products
	Prevent skin cleaning fluids pooling under baby
Radiant	Warm room
Evaporative	Humidified ventilation gases
Post Operative	
Minimal exposure/change in temperature of environment -	
Mechanism	Measure
Convective	Pre warmed incubator
Conductive	Pre warmed incubator
Radiant	Pre warmed incubator
	Humidity in incubator (if appropriate)
Evaporative	Humidity in incubator (if appropriate)
	Humidified ventilation gases

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is registered in England & Wales
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