NICE National Institute for Health and Care Excellence

NICE guideline

Specialist neonatal respiratory care for babies born preterm

NICE guideline

Published: 3 April 2019
www.nice.org.uk/guidance/ng124

Your responsibility

The recommendations in this guideline represent the view of NICE, arrived at after careful consideration of the evidence available. When exercising their judgement, professionals and practitioners are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or the people using their service. It is not mandatory to apply the recommendations, and the guideline does not override the responsibility to make decisions appropriate to the circumstances of the individual, in consultation with them and their families and carers or guardian.

Local commissioners and providers of healthcare have a responsibility to enable the guideline to be applied when individual professionals and people using services wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with complying with those duties.

Commissioners and providers have a responsibility to promote an environmentally sustainable health and care system and should assess and reduce the environmental impact of implementing NICE recommendations wherever possible.

Contents

This guideline is the basis of QS193.

Overview

This guideline covers specific aspects of respiratory support (for example, oxygen supplementation, assisted ventilation, treatment of some respiratory disorders, and aspects of monitoring) for preterm babies in hospital.

Who is it for?

- Healthcare professionals
- Commissioners and providers of specialist neonatal care services
- Parents and carers of preterm babies who need respiratory support

Recommendations

Parents and carers have the right to be involved in planning and making decisions about their baby's health and care, and to be given information and support to enable them to do this, as set out in the NHS constitution and summarised in NICE's information on making decisions about your care.

Making decisions using NICE guidelines explains how we use words to show the strength (or certainty) of our recommendations, and has information about prescribing medicines (including off-label use), professional guidelines, standards and laws (including on consent and mental capacity), and safeguarding.

1.1 Risk factors for bronchopulmonary dysplasia

1.1.1 Be aware that the risk factors for bronchopulmonary dysplasia (BPD) include those in table 1. Note that the risk factors 'treated with surfactant' and 'treated for a patent ductus arteriosus (PDA)' are likely to reflect the severity of the baby's condition. Surfactant should be used, and a PDA should be treated, where clinically appropriate.

The risk factors in table 1 (below) have been identified in large prospective cohort studies, but other gestational ages and other risk factors not listed here might also be associated with an increased risk of bronchopulmonary dysplasia.

Table 1 Identified risk factors for BPD

In babies born before 32 weeks	• Lower gestational age • Lower birthweight • Small for gestational age • Male sex • Core body temperature of less than 35°C on admission to neonatal unit • Invasive ventilation begun within 24 hours of birth • Clinical sepsis with or without positive blood cultures • Feeding with formula milk (exclusively or in addition to breast milk) • Treated with surfactant • Treated for a patent ductus arteriosus (PDA) The risk factors of being treated with surfactant and treated for a PDA are likely to reflect the severity of the baby's condition. Surfactant should be used, and a PDA should be treated, where clinically appropriate.
In babies born before 30 weeks	• Cardiopulmonary resuscitation performed at birth

For a short explanation of why the committee made this recommendation and how it might affect services, see the rationale and impact section on risk factors for BPD.

1.2 Respiratory support for preterm babies

Respiratory support before admission to the neonatal unit

1.2.1 When stabilising preterm babies who need respiratory support soon after birth and before admission to the neonatal unit, use continuous positive airways pressure (CPAP) where clinically appropriate, rather than invasive ventilation.

For a short explanation of why the committee made this recommendation and how it might affect services, see the rationale and impact section on respiratory support before admission to the neonatal unit.

Surfactant

1.2.2 Give surfactant to preterm babies who need invasive ventilation for stabilisation in the early postnatal period.

1.2.3 When giving surfactant to a preterm baby who does not need invasive ventilation, use a minimally invasive administration technique. If this is not possible, for example, in units without the facilities or trained staff to carry out these techniques, use endotracheal intubation to give surfactant, with early extubation afterwards.

In April 2019, this was an off-label use for some brands of surfactant. See NICE's information on prescribing medicines.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on giving surfactant.

Oxygen

1.2.4 Use nasal cannula or incubator oxygen for preterm babies who need supplemental oxygen.

1.2.5 Humidify oxygen when giving oxygen at higher flow rates, such as 2 litres per minute or more.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on oxygen.

Non-invasive ventilation techniques in the neonatal unit

1.2.6 For preterm babies who need non-invasive ventilation, consider nasal CPAP or nasal high-flow therapy as the primary mode of respiratory support.

Invasive ventilation techniques in the neonatal unit

1.2.7 For preterm babies who need invasive ventilation, use volume-targeted ventilation (VTV) in combination with synchronised ventilation as the primary mode of respiratory support. If this is not effective, consider high-frequency oscillatory ventilation (HFOV).

1.2.8 For preterm babies who need invasive ventilation but VTV and HFOV are not available or not suitable, consider synchronised intermittent mandatory ventilation (SIMV).

1.2.9 Do not use synchronised pressure-limited ventilation such as assist control (AC), synchronised intermittent positive pressure ventilation (SIPPV), patient-triggered ventilation (PTV), pressure support ventilation (PSV) or synchronised time-cycled pressure-limited ventilation (STCPLV).

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on ventilation techniques.

Nitric oxide

1.2.10 Do not routinely use inhaled nitric oxide for preterm babies who need respiratory support for respiratory distress syndrome (RDS), unless there are other indications such as pulmonary hypoplasia or pulmonary hypertension.

In April 2019, the following uses were off-label: inhaled nitric oxide for pulmonary hypoplasia and inhaled nitric oxide for pulmonary hypertension in babies less than 34 weeks' gestation. See NICE's information on prescribing medicines.

For a short explanation of why the committee made this recommendation and how it might affect services, see the rationale and impact section on nitric oxide.

1.3 Managing respiratory disorders

Corticosteroids

1.3.1 Consider dexamethasone to reduce the risk of BPD for preterm babies who are 8 days or older and still need invasive ventilation for respiratory disease. When considering whether to use dexamethasone in these babies:

- take into account the risk factors for BPD in table 1 **and**
- discuss the possible benefits and harms with the parents or carers. Topics to discuss include those in table 2.

  In April 2019, this was an off-label use of dexamethasone. See NICE's information on prescribing medicines.

1.3.2 For preterm babies who are younger than 8 days old, be aware that dexamethasone increases the risk of gastrointestinal perforation.

1.3.3 Do not use dexamethasone with non-steroidal anti-inflammatory drugs (NSAIDs).

1.3.4 Monitor the blood pressure of babies who receive dexamethasone, because of the risk of hypertension.

Table 2 Benefits and harms of dexamethasone in preterm babies 8 days or older

Outcome	Benefit or harm for preterm babies 8 days or older	Notes
Mortality before discharge	There is no difference in mortality before discharge in babies who receive dexamethasone compared with babies who do not receive dexamethasone.	There was evidence demonstrating this lack of difference.

Outcome	Benefit or harm for preterm babies 8 days or older	Notes
BPD at 36 weeks' postmenstrual age	• Babies who receive dexamethasone are less likely to develop BPD compared with babies who do not receive dexamethasone. On average: • without dexamethasone treatment, 63 babies per 100 would develop BPD (and 37 would not) • with dexamethasone treatment, 47 babies per 100 would develop BPD (and 53 would not).	There was evidence demonstrating this difference.
Cerebral palsy	There is no difference in the incidence of cerebral palsy in babies who receive dexamethasone compared with babies who do not receive dexamethasone.	Although there was evidence demonstrating this lack of difference, there is uncertainty about the risk, so the possibility of cerebral palsy occurring cannot be excluded.

Outcome	Benefit or harm for preterm babies 8 days or older	Notes
Other neurodevelopmental outcomes (neurodevelopmental delay and neurosensory impairment)	There is no difference in neurodevelopmental outcomes in babies who receive dexamethasone compared with babies who do not receive dexamethasone.	Although there was evidence demonstrating this lack of difference, there is uncertainty about the risk of neurodevelopmental delay and neurosensory impairment because the studies reported neurodevelopmental assessments at different timepoints.
Days on invasive ventilation	Babies who receive dexamethasone have fewer days on invasive ventilation compared with babies who do not receive dexamethasone.	Although there was evidence demonstrating this difference, there is uncertainty about the difference in the number of days on invasive ventilation because of the different ways the studies reported it.
Gastrointestinal perforation	There is no difference in gastrointestinal perforation in babies who receive dexamethasone compared with babies who do not receive dexamethasone.	Although there was evidence demonstrating this lack of difference, there is uncertainty about the risk, so the possibility of gastrointestinal perforation occurring cannot be excluded.

Outcome	Benefit or harm for preterm babies 8 days or older	Notes
Hypertension	Babies who receive dexamethasone are more likely to develop hypertension compared with babies who do not receive dexamethasone. On average: • without dexamethasone treatment, 3 preterm babies per 100 would develop hypertension (and 97 would not) • with dexamethasone treatment, 11 babies per 100 would develop hypertension (and 89 would not).	There was evidence demonstrating this difference.

Full details of the evidence for the benefits and harms of dexamethasone for preterm babies 8 days or older are in evidence review C: managing respiratory disorders.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on dexamethasone.

Diuretics

For a short explanation of why the committee did not make a recommendation, see the rationale on diuretics.

Caffeine citrate

1.3.5 Use caffeine citrate routinely in preterm babies born at or before 30 weeks, starting it as early as possible and ideally before 3 days of age.

1.3.6 Consider stopping caffeine citrate at 33 to 35 weeks' corrected gestational age if the baby is clinically stable.

1.3.7 Consider caffeine citrate for any preterm baby with apnoea.

Give a loading dose of 20 mg/kg of caffeine citrate, followed 24 hours later by a maintenance dosage of 5 mg/kg once daily, increasing up to 20 mg/kg daily if episodes of apnoea persist.

In April 2019, this dosage was an off-label use of caffeine citrate. See NICE's information on prescribing medicines.

1.3.8 Consider a maintenance dosage higher than 20 mg/kg daily if therapeutic efficacy is not achieved, while ensuring that a safe plasma level is maintained.

In April 2019, this dosage was an off-label use of caffeine citrate. See NICE's information on prescribing medicines.

When measuring plasma levels, prescribers should use the local laboratory's reference ranges. See the British National Formulary for Children for further information about caffeine citrate.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on caffeine citrate.

Patent ductus arteriosus

1.3.9 Do not treat a PDA in a preterm baby unless the PDA causes a significant clinical problem, for example, difficulty weaning the baby from a ventilator.

For a short explanation of why the committee made this recommendation and how it might affect services, see the rationale and impact section on PDA.

1.4 Monitoring

Oxygen

1.4.1 Use continuous pulse oximetry to measure oxygen saturation in preterm babies, supplemented by arterial sampling if clinically indicated.

1.4.2 After initial stabilisation, aim for an oxygen saturation of 91% to 95% in preterm babies.

1.4.3 For preterm babies on invasive ventilation who are clinically unstable, consider transcutaneous oxygen monitoring.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on oxygen monitoring.

Carbon dioxide

1.4.4 For preterm babies on invasive ventilation, aim for a carbon dioxide partial pressure (PCO_2) of:

- 4.5 kPa to 8.5 kPa on days 1 to 3 **and**
- 4.5 kPa to 10 kPa from day 4 onwards.

1.4.5 Reduce minute ventilation without delay in preterm babies with a low PCO_2, and check the PCO_2 within an hour of the low measurement being identified.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on carbon dioxide monitoring.

Blood pressure

1.4.6 Do not treat preterm babies for hypotension based solely on specific blood pressure thresholds, but take into account other factors, such as evidence of poor tissue perfusion. The aim of treatment should be to improve perfusion.

For a short explanation of why the committee made this recommendation and how it might affect services, see the rationale and impact section on blood pressure.

1.5 Sedation and analgesia

Morphine

1.5.1 Do not routinely use morphine for preterm babies on respiratory support.

1.5.2 Consider morphine if the baby is in pain. Assess the baby's pain using locally agreed protocols or guidelines.

In April 2019, the following uses were off-label: intravenous morphine for children under 12 years and oral morphine for children under 1 year. See NICE's information on prescribing medicines.

1.5.3 Regularly reassess babies on morphine to ensure that it is stopped as soon as possible.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on morphine.

Premedication before intubation

1.5.4 Consider premedication before elective non-urgent intubation in preterm babies.

1.5.5 If giving premedication, consider either:

- an opioid analgesic (for example, morphine or fentanyl), combined with a neuromuscular blocking agent (for example, suxamethonium) **or**
- propofol alone.

  In April 2019, the following uses were off-label: intravenous morphine for children under 12 years, oral morphine for children under 1 year, fentanyl for children under 2 years, and propofol for children under 1 month. See NICE's information on prescribing medicines.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on premedication for intubation.

1.6 Involving, supporting and informing parents and carers

Involving parents and carers while their preterm baby is on respiratory support

1.6.1 Explain to the parents and carers of preterm babies on respiratory support that non-nutritive sucking (using a dummy) during periods when the baby is awake is beneficial because:

- it can help soothe the baby between feeds **and**
- in babies fed by a nasogastric tube, dummy use can reduce the length of the baby's hospital stay.

1.6.2 Tell parents and carers about the benefits of using touch, for example, through skin-to-skin contact, to communicate with their baby.

1.6.3 Consider providing the Newborn individualized developmental care and assessment program (NIDCAP®) to improve cognitive development in babies born at less than 27 weeks.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on involving parents and carers.

Supporting parents and carers while their preterm baby is on respiratory support

1.6.4 Recognise parents and carers as partners in their baby's care, and support them in this role.

1.6.5 Encourage and support parents and carers to:

- be involved in planning and providing their baby's day-to-day care, for example, feeding and nappy changing
- participate in discussions and decisions about their baby during ward rounds, providing input into planning and providing care.

1.6.6 Provide regular opportunities and time for parents and carers to discuss their baby's care, ask questions about the information they have been given, and discuss concerns.

1.6.7 Give parents and carers the time, support and encouragement they need to become confident in caring effectively for their baby.

1.6.8 Offer parents and carers psychological support from a professional who is trained to deliver this type of help and advice.

Providing information to parents and carers while their preterm baby is on respiratory support

1.6.9 Ask parents and carers about how and when they would like to receive information about their baby's treatment and progress, and how they would prefer to be contacted when they are away from the neonatal unit.

1.6.10 Support discussions with parents and carers using written information. Ensure that information is up to date, relevant, appropriate to the parents' and carers' needs and preferences, and consistent between healthcare professionals. For more guidance on communication (including different formats and languages), providing information, and shared decision making, see the NICE guideline on patient experience in adult NHS services.

1.6.11 Ensure that information for parents and carers is delivered by an appropriate

healthcare professional, and information for hospitalised mothers who cannot visit their baby is delivered by a senior healthcare professional, for example, a neonatologist or specialist registrar, face-to-face whenever possible.

1.6.12 Be sensitive about the timing of discussions with parents and carers. In particular, discuss significant perinatal events without delay, providing the mother has sufficiently recovered from the birth.

1.6.13 Provide information for parents and carers that includes:

- explanations and regular updates about their baby's condition and treatment, especially if there are any changes
- what happens in the neonatal unit, and the equipment being used to support their baby
- what respiratory support is being provided for their baby
- how to get involved in their baby's day-to-day care, interact with their baby and interpret the baby's neurobehavioural cues
- the roles and responsibilities of different members of their baby's healthcare team, and key contacts
- information about caring for a premature baby to share with family and friends, and practical suggestions about how to get help and support from family and friends
- opportunities for peer support from neonatal unit graduate parents or parent buddies
- details of local support groups, online forums and national charities, and how to get in touch with them.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on supporting and providing information to parents and carers.

Neonatal services for preterm babies on respiratory support

1.6.14 Those responsible for planning and delivering neonatal services should ensure that neonatal units:

- are welcoming and friendly
- foster positive and supportive relationships by providing parents and carers with 24-hour access to their baby
- provide privacy for skin-to-skin contact and feeding
- have private areas for difficult conversations
- have comfortable furniture and provide a relaxing environment for families.

1.6.15 Ensure that healthcare professionals in neonatal units can support parents and carers by being competent in:

- communicating complex and sensitive information clearly
- tailoring information and support to the person's individual needs and circumstances.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on neonatal services.

1.7 Discharge planning

Planning safe discharge from the neonatal unit for preterm babies on respiratory support

1.7.1 Neonatal units should consider appointing a member of staff as a designated neonatal discharge coordinator to discuss the following with parents and carers:

- ongoing support and follow-up after discharge (also see the NICE guideline on developmental follow-up of children and young people born preterm)
- how to care for their baby at home
- how to use specialist equipment safely
- how to travel with their baby and specialist equipment.

1.7.2 When planning to discharge a preterm baby on respiratory support from the neonatal unit:

- follow the principles in the NICE guideline on postnatal care
- consider early referral to, and regular contact with, community and continuing healthcare teams
- consider an interim discharge placement to, for example, a hospice, alternative family member's home, step-down unit, transitional care unit, or alternative suitable accommodation, where appropriate.

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on planning safe discharge.

Supporting and providing information to parents and carers of preterm babies on respiratory support – preparing for discharge

1.7.3 Recognise parents and carers as partners in the discharge planning process. Answer their questions and concerns as they arise, and support them in making joint decisions with the discharge team.

1.7.4 Throughout the baby's neonatal admission, provide support and guidance for parents and carers with constructive and supportive feedback about how to care for their baby and how to use specialist equipment. Use a formal competency-based assessment tool to evaluate the safe use of specialist equipment.

1.7.5 Discuss any modifications that parents and carers might need to make to their home as soon as possible.

1.7.6 Educate parents and carers about possible emergencies that may arise, how to deal with them and who to contact for help and advice. This should include how to carry out cardiopulmonary resuscitation, and what to do if there are problems with any specialist equipment.

1.7.7 Provide parents and carers with opportunities to care for their baby overnight.

1.7.8 Provide information for parents and carers to help them care for their baby safely and confidently after discharge. Follow the principles in the section on communication and information-giving in this guideline, and also see the NICE

guideline on postnatal care. Information should include:

- how to recognise signs of illness in their baby, and what to do
- how to adapt routines such as feeding and sleeping after discharge, and information about safe sleep guidance
- how to make follow-up appointments and timing of immunisations
- who to contact after discharge, as well as a list of useful medical contacts.

1.7.9 Tell parents and carers about sources of support after discharge, for example:

- opportunities for peer support
- help and support for their own needs, for example, postnatal depression (also see the NICE guideline on antenatal and postnatal mental health).

For a short explanation of why the committee made these recommendations and how they might affect services, see the rationale and impact section on supporting and providing information to parents as part of discharge planning.

Terms used in this guideline

Automated oxygen titration

A control system that measures the oxygen saturation and automatically adjusts the oxygen flow to maintain oxygen saturation within a predefined target range.

Invasive ventilation

Administration of respiratory support via an endotracheal tube or tracheostomy, using a mechanical ventilator. The definitions of invasive ventilation modes are summarised in table 3.

Table 3 Definitions and groupings for analysis of invasive ventilation modes

Volume-targeted ventilation (VTV)	Volume guarantee ventilation (VGV) Target tidal volume (TTV) Pressure regulated volume control (PRVC) ventilation (PRVCV) Volume-limited ventilation (VLV) Volume assured pressure support (VAPS) Any synchronised pressure-limited ventilation (SPLV) plus VTV Synchronised intermittent mandatory ventilation (SIMV) plus VTV
Synchronised pressure-limited ventilation (SPLV)	Assist control ventilation (AC) Synchronised intermittent positive pressure ventilation (SIPPV) Patient-triggered ventilation (PTV) Pressure support ventilation (PSV) Synchronised time-cycled pressure-limited ventilation (STCPL)
Synchronised Intermittent Mandatory Ventilation (SIMV)	–
Non-synchronised pressure-limited ventilation (NSPLV)	Conventional mandatory ventilation (CMV) Non-triggered/unsynchronised time-cycled pressure-limited ventilation (TCPL) Intermittent mandatory ventilation (IMV)
High-frequency ventilation (HFV)	High-frequency oscillatory ventilation (HFOV) High-frequency flow interruption (HFFI)

Minimally invasive administration technique

Administration of surfactant through a thin endotracheal catheter without insertion of an endotracheal tube or invasive ventilation.

Minute ventilation

The tidal volume of each breath in millilitres (ml) multiplied by the number of breaths per minute gives the minute ventilation in ml/minute (usually expressed as ml/kg/minute, which is achieved by dividing by the baby's weight in kg).

Neurobehavioural cues

Sounds, characteristics of movements including facial expressions and physiological parameters such as heart rate, breathing patterns and skin tone that reflect the baby's current level of sensitivity or wellbeing, and reveal their current developmental stage.

Neurodevelopmental outcomes

In this guideline, neurodevelopmental outcomes at 18 months or older have been defined as:

- cerebral palsy (reported as presence or absence of condition, not severity)
- neurodevelopmental delay (reported as dichotomous outcomes, not continuous outcomes such as mean change in score):
  - severe (score of more than 2 standard deviations [SD] below normal on validated assessment scales, or a score of less than 70 on the Bayley II scale of infant development mental developmental index [MDI] or psychomotor developmental index [PDI], or complete inability to assign score because of cerebral palsy or severe cognitive delay)
  - moderate (score of 1 to 2 SD below normal on validated assessment scales, or a score of 70 to 84 on the Bayley II scale of infant development MDI or PDI)
- neurosensory impairment (reported as presence or absence of condition, not severity):
  - severe hearing impairment (for example, deaf)
  - severe visual impairment (for example, blind).

Non-invasive ventilation

Administration of respiratory support using a ventilator or flow driver, but not via an endotracheal tube or tracheostomy.

Perinatal

In this guideline, the perinatal period is defined as the period of time from 48 hours before birth up until 7 completed days after birth.

Preterm

A baby born before 37 weeks. This can be subdivided further:

- extremely preterm: babies born at less than 28 weeks
- very preterm: babies born at between 28 and 31+6 weeks
- moderate to late preterm: babies born at between 32 and 36+6 weeks.

Skin-to-skin contact

Holding a naked baby, or a baby wearing only a nappy, on the skin of a parent or carer, usually on the chest.

Stabilisation

Facilitating and supporting a smooth transition from fetal to neonatal life. The process involves careful assessment of heart rate, colour (oxygenation) and breathing, with provision of appropriate interventions where indicated.

Recommendations for research

Key recommendations for research

1 Non-invasive ventilation techniques

What is the effectiveness of high-pressure non-invasive positive pressure ventilation (NIPPV) compared with continuous positive airways pressure (CPAP) flow driver as the primary mode of ventilation?

For a short explanation of why the committee made the recommendation for research, see the rationale on non-invasive ventilation techniques.

Full details of the evidence and the committee's discussion are in evidence review B: respiratory support.

2 Surfactant

What is the best technique for delivering surfactant in a minimally invasive manner?

For a short explanation of why the committee made the recommendation for research, see the rationale on surfactant.

Full details of the evidence and the committee's discussion are in evidence review B: respiratory support.

3 Diuretics

What is the effectiveness of diuretics compared with placebo in preventing bronchopulmonary dysplasia (BPD) in preterm babies on respiratory support?

For a short explanation of why the committee made the recommendation for research, see the rationale on diuretics.

Full details of the evidence and the committee's discussion are in evidence review C: managing respiratory disorders.

4 Oxygen monitoring

Does targeting higher oxygen saturations of 92% to 97% in preterm babies lead to improved survival without significant complications?

For a short explanation of why the committee made the recommendation for research, see the rationale on oxygen monitoring.

Full details of the evidence and the committee's discussion are in evidence review D: monitoring.

5 Premedication before intubation

What is the most effective combination of an analgesic with a neuromuscular blocker, or an analgesic with an anaesthetic agent, for premedication in preterm babies requiring elective or semi-elective intubation?

For a short explanation of why the committee made the recommendation for research, see the rationale on premedication before intubation.

Full details of the evidence and the committee's discussion are in evidence review E: sedation and analgesia.

Other recommendations for research

Respiratory support before admission to the neonatal unit

Does CPAP plus prophylactic surfactant, administered by a non-invasive technique in the delivery room, improve outcomes compared with CPAP alone in preterm babies?

Surfactant

What is the optimal dosing regimen of surfactant when delivered in a minimally invasive manner?

Oxygen administration

What is the effectiveness of humidified and non-humidified supplemental low-flow oxygen in preterm babies?

What should be the target oxygen saturation range for preterm babies when using an automated oxygen titration system that creates a normal frequency-saturation curve?

Invasive ventilation techniques

Are there differences in the long-term neurodevelopmental outcomes for preterm babies receiving volume-targeted ventilation (VTV) compared with high-frequency oscillatory ventilation (HFOV) as their primary mode of ventilation?

Corticosteroids

What is the comparative efficacy of hydrocortisone compared with dexamethasone for preventing BPD in preterm babies requiring respiratory support?

Is nebulised budesonide effective compared with placebo in preventing BPD in preterm babies requiring respiratory support?

Diuretics

What is the effectiveness of diuretics compared with placebo in the treatment of BPD in preterm babies on respiratory support?

Caffeine citrate

What is the optimal maintenance dose of caffeine citrate in order to optimise neurodevelopmental outcomes in preterm babies?

Oxygen monitoring

What is the accuracy of pulse oximetry and transcutaneous measurement of partial pressure of

oxygen compared with arterial oxygen levels for detecting hyperoxia and hypoxia in preterm babies?

Carbon dioxide monitoring

What is the optimal carbon dioxide target range in preterm babies on non-invasive ventilation at different gestational ages?

Blood pressure

What is the optimal method and frequency of measuring blood pressure for preterm babies requiring respiratory support?

What is the optimal target blood pressure range for preterm babies requiring respiratory support?

Morphine

What is the effectiveness of morphine compared with containment holding for preterm babies receiving respiratory support?

Involving parents and carers

What is the impact of parental involvement as part of Family integrated care (FIC) or the Newborn individualised developmental care and assessment programme (NIDCAP®) on the incidence of BPD and length of hospital stay in preterm babies?

Discharge planning

What is best practice around discharge planning for preterm babies on respiratory support?

Rationale and impact

These sections briefly explain why the committee made the recommendations and how they might affect services. They link to details of the evidence and a full description of the committee's discussion.

Risk factors for bronchopulmonary dysplasia

Recommendation 1.1.1

Why the committee made the recommendation

There was evidence that lower gestational age, lower birth weight, being small for gestational age, male sex, lower body temperature, sepsis, any formula feeding, surfactant use, treatment for a patent ductus arteriosus (PDA), cardiopulmonary resuscitation and mechanical ventilation, are all independent risk factors for bronchopulmonary dysplasia (BPD) in preterm babies.

No evidence was found to link antenatal steroids, chorioamnionitis, intrauterine growth restriction, ethnicity or race, or postnatal steroid use, and BPD. However, the committee did not prioritise these areas for further research.

The committee was concerned that including surfactant use and treatment for PDA as risk factors for BPD could lead to a reduction in surfactant use and PDA treatment. They agreed that there was unlikely to be a causal link – rather, the increased risk of BPD associated with these factors is more likely to reflect the severity of the baby's condition, and that surfactant should be used, and a PDA should be treated, where clinically appropriate.

The committee noted that there was an absence of evidence for certain risk factors for BPD; some evidence was for specific gestational ages at birth from which the committee was unable to extrapolate to other gestational ages, and for some risk factors, the evidence was underpowered to detect an effect. The committee therefore concluded that other gestational ages and other risk factors not listed here might also be associated with increased risk of BPD.

No evidence was found for some of the potential risk factors that had been suggested by the committee (such as necrotising enterocolitis and supplementary oxygen), but these were not prioritised by the committee for further research.

How the recommendation might affect services

Knowledge of BPD risk factors means healthcare professionals can identify preterm babies who are more likely to develop BPD, and prioritise treatment regimens accordingly. This may reduce the incidence of BPD, which will lead to long-term savings for the NHS.

Full details of the evidence and the committee's discussion are in evidence review A: diagnosing respiratory disorders.

Return to recommendations

Respiratory support before admission to the neonatal unit

Recommendation 1.2.1

Why the committee made the recommendation

The evidence did not show a clear difference between continuous positive airways pressure (CPAP) alone and invasive ventilation with surfactant when used in preterm babies in the delivery room, for any of the outcomes that the committee had prioritised (mortality, BPD and neurodevelopmental outcomes). However, the evidence showed a possible reduction in mortality before discharge, and a possible reduction in the incidence of BPD at 36 weeks' postmenstrual age with CPAP.

One large study found that just over half of the babies who received CPAP instead of intubation did need to be intubated at some point during their hospitalisation. However, the committee agreed that this was a very positive result, because around half of babies avoided all the risks of invasive intervention.

The committee agreed that it is preferable to avoid invasive ventilation wherever possible and agreed that when stabilising a preterm baby in the delivery room, the non-invasive ventilation technique of CPAP should be used rather than invasive ventilation. The committee agreed that this approach may not be suitable for some babies, for example, if the baby is not breathing and needs invasive ventilation. In addition, the committee agreed that this approach would probably not be suitable for preterm babies born very early, for example at less than 25 weeks, because these babies may not have the necessary respiratory drive, and because the failure rate of non-invasive ventilation is high in babies of this age. The committee agreed that for these very preterm babies, it

may be more practical to use invasive ventilation with surfactant in the delivery room, but because this would be a clinical decision, it was not appropriate to set a particular age cut-off.

Because there was not enough evidence to make recommendations on the use of CPAP with surfactant compared with CPAP without surfactant in the delivery room, the committee recommended that further research be done in this area.

How the recommendation might affect services

Current practice in most units is to routinely intubate preterm babies (below a certain gestation, often 27 to 28 weeks, but specific cut-offs will vary) and give surfactant, so this will be a change in practice for these units. Because CPAP is associated with lower costs than invasive ventilation, this change is likely to lead to cost savings.

Full details of the evidence and the committee's discussion are in evidence review B: respiratory support.

Return to recommendations

Surfactant

Recommendations 1.2.2 and 1.2.3

Why the committee made the recommendations

It is established clinical practice in the UK to give surfactant to preterm babies needing invasive ventilation in the early postnatal period, based on good evidence and extensive clinical experience, so the committee agreed to make a recommendation that reinforces this.

In preterm babies who do not require invasive ventilation, there was evidence that minimally invasive surfactant administration techniques reduce the incidence of BPD, the number of days on invasive ventilation, and the incidence of pneumothorax, compared with endotracheal administration.

However, not all neonatal units have the facilities to carry out minimally invasive surfactant administration techniques, and not all healthcare professionals have been trained to use them. The committee agreed that in these circumstances, endotracheal surfactant administration followed by early extubation should be used, because there was evidence that it reduces the incidence of BPD compared with conventional administration of surfactant with continued ventilation.

Because there was not enough good evidence to make recommendations on which minimally invasive administration technique leads to the best outcomes, or on different surfactant dosing regimens, the committee recommended that further research be done in these areas.

How the recommendations might affect services

Current practice for giving surfactant to preterm babies varies among neonatal units because of differences in available facilities and training. The recommendations may increase the trend towards using less invasive techniques of surfactant administration. Neonatal units that currently use conventional endotracheal administration of surfactant may therefore change practice to use minimally invasive techniques or to extubate earlier.

Full details of the evidence and the committee's discussion are in evidence review B: respiratory support.

Return to recommendations

Oxygen

Recommendations 1.2.4 and 1.2.5

Why the committee made the recommendations

There was a small amount of evidence suggesting there is no difference in the effectiveness or safety of oxygen delivered by nasal cannula compared with oxygen delivered in the incubator. However, because the evidence was limited, the committee made a recommendation based on consensus that nasal cannula or incubator oxygen could be used. They noted that incubator oxygen may be preferred for short-term use and assessment, whereas nasal cannula oxygen is preferable for longer-term use because it allows the baby to be touched and cuddled, and provides a stable concentration of oxygen.

There was evidence that automated oxygen titration reduces the number of days on oxygen, reduces the number of manual adjustments for titration, and increases the time that preterm babies spend in the optimal target oxygen saturation range. However, the committee were concerned, based on their clinical knowledge, that the cumulative frequency oxygen curves for oxygen saturation achieved by automated titration may lead to the mean saturation level achieved by babies being reduced (because of the normal distribution of the frequency-saturation curve) compared with manual adjustments (where the frequency-saturation curve is skewed to the higher end of the target saturation range). The committee therefore made a research recommendation to

determine the optimal target oxygen saturation range for use in conjunction with an automated oxygen titration system.

There was no evidence comparing humidified to non-humidified oxygen, but the committee agreed that this is standard clinical practice at higher flow rates and made a consensus recommendation for the use of humidified oxygen. The committee also made a research recommendation to assess the effectiveness of humidified and non-humidified supplemental low-flow oxygen.

How the recommendations might affect services

The recommendations reflect current clinical practice.

Full details of the evidence and the committee's discussion are in evidence review B: respiratory support.

Return to recommendations

Ventilation techniques

Recommendations 1.2.6 to 1.2.9

Why the committee made the recommendations

Non-invasive ventilation techniques

The available evidence made it difficult to differentiate between the various non-invasive ventilation techniques. The evidence showed that nasal high-flow therapy had the highest probability of being the best technique for reducing mortality before discharge, compared with other non-invasive ventilation techniques. However, the committee agreed that babies born extremely preterm are less likely to manage successfully on nasal high-flow therapy as the primary mode of ventilation when compared with babies born less preterm.

The evidence showed a reduction in the failure of non-invasive ventilation with CPAP compared with nasal high-flow therapy. Using their clinical experience, the committee agreed that CPAP would be a more suitable option for use in babies born more preterm.

Because of the lack of good evidence, the committee agreed that CPAP or nasal high-flow therapy should be used as a primary mode of ventilation in preterm babies who need non-invasive ventilation, with the decision on which option to use being made for individual babies.

There was evidence that nasal intermittent positive pressure ventilation (NIPPV) had lower rates of failed non-invasive ventilation and fewer days on invasive ventilation than CPAP, but the delivery of NIPPV in the studies was significantly different to routine clinical practice in the UK, so the committee recommended that further research should be carried out comparing NIPPV and CPAP.

Invasive ventilation techniques

There was evidence from the network meta-analysis that volume-targeted ventilation (VTV) has the highest probability of being the best technique as the primary mode of ventilation, both for mortality before discharge and BPD at 36 weeks.

The committee agreed that VTV may not be appropriate for all preterm babies, for example, if there is an air leak. There was evidence that if VTV is not effective, high-frequency oscillatory ventilation (HFOV) should be considered as an alternative. The committee acknowledged that the flow sensors required for VTV are expensive, but the committee agreed that most units already have flow sensors for triggered ventilation and the same sensor could be used for VTV. In units or situations where neither VTV nor HFOV are available or suitable, the evidence showed that synchronised intermittent mandatory ventilation (SIMV) was the next most effective mode of ventilation.

The committee agreed that synchronised pressure-limited ventilation should be avoided because the evidence showed an increase in the incidence of mortality before discharge, compared with non-synchronised pressure-limited ventilation, HFOV and VTV. The evidence also showed an increase in days on invasive ventilation and pneumothorax, compared with VTV.

The evidence from the pair-wise analysis showed no significant difference between HFOV and VTV, and there was no evidence on neurodevelopmental outcomes at 18 months or older, so the committee recommended that further research should be carried out.

How the recommendations might affect services

The recommendations should reinforce current clinical practice and lead to greater consistency.

Full details of the evidence and the committee's discussion are in evidence review B: respiratory support.

Return to recommendations

Nitric oxide

Recommendation 1.2.10

Why the committee made the recommendation

There was no evidence of benefit for inhaled nitric oxide in preterm babies who need respiratory support for respiratory distress syndrome (RDS). There was some evidence of adverse effects, and the treatment is unlikely to be cost effective. The committee agreed that there may be exceptions for preterm babies who have other conditions such as pulmonary hypoplasia and pulmonary hypertension, for whom there may be some survival benefits.

How the recommendation might affect services

The recommendation will reduce the use of inhaled nitric oxide for preterm babies who need respiratory support, which may lead to cost savings to the NHS given the high acquisition cost of inhaled nitric oxide.

Full details of the evidence and the committee's discussion are in evidence review B: respiratory support.

Return to recommendations

Corticosteroids

Recommendations 1.3.1 to 1.3.4

Why the committee made the recommendations on dexamethasone

There was evidence that in babies 8 days or older, dexamethasone reduces the incidence of BPD, but dexamethasone is associated with an increased risk of hypertension. There were no clinically important differences in mortality before discharge between babies who received dexamethasone and those who did not.

There was some evidence suggesting that dexamethasone reduces the number of days on invasive ventilation, but this was difficult to interpret because of the different ways the studies reported the time on ventilation.

In babies 8 days or older, there was evidence that dexamethasone is not associated with an increased risk of cerebral palsy, neurodevelopmental delay, neurosensory impairment or gastrointestinal perforation. However, the committee emphasised that there was some uncertainty about the evidence for these outcomes.

In babies younger than 8 days, there was evidence that dexamethasone reduces the incidence of BPD but is associated with an increased risk of gastrointestinal perforation.

The committee therefore recommended that dexamethasone be considered for babies 8 days or older who still need ventilation for respiratory disease, after taking into account risk factors for BPD. This is in line with current practice, which is to use corticosteroids to assist weaning from ventilatory support when a baby is 8 days or older, rather than using corticosteroids as 'prophylaxis' for babies younger than 8 days old.

The committee agreed the importance of discussing the risks of gastrointestinal perforation, hypertension and cerebral palsy with parents and carers before starting dexamethasone therapy, because there may be lifelong implications for the baby and their family.

Although the combination of dexamethasone and non-steroidal anti-inflammatory drugs (NSAIDs) was not reviewed, the committee confirmed that they should not be used together because this increases the risk of gastrointestinal bleeding and perforation. The committee agreed that although this risk is widely recognised, it should be reinforced in the guideline to ensure that dexamethasone and NSAIDs are not used together in clinical practice.

Because of the increased risk of hypertension with dexamethasone, the committee recommended that babies' blood pressure should be monitored. There was no evidence about when or for how long to monitor blood pressure, so the committee agreed that this should be decided by the neonatologist responsible for the baby's care.

The evidence did not show any differences between different dosing strategies, and so the committee did not make any specific dosing recommendations.

Why the committee didn't make any recommendations on hydrocortisone and nebulised budesonide

Evidence comparing hydrocortisone and placebo was inconclusive, so the committee did not make any recommendations. The committee was aware that there is an ongoing, large multicentre randomised controlled trial investigating hydrocortisone compared with placebo in preterm babies

who need respiratory support, so did not make a research recommendation that would replicate this study. However, they agreed that a comparison of dexamethasone and hydrocortisone could provide useful guidance and so made a research recommendation for this comparison.

There was very little evidence for the use of nebulised budesonide and therefore the committee made a research recommendation.

How the recommendations might affect services

Current practice is to use corticosteroids in preterm babies to assist weaning or removal from ventilatory support, but they are not routinely used to prevent BPD in all preterm babies. The choice of dexamethasone or hydrocortisone varies among neonatal units. These recommendations are unlikely to affect how often corticosteroids are used, but they might prompt units who currently use hydrocortisone to consider dexamethasone as an alternative.

Full details of the evidence and the committee's discussion are in evidence review C: managing respiratory disorders.

Return to recommendations

Diuretics

Why the committee did not make any recommendations

The evidence on the use of diuretics in preterm babies on respiratory support was very limited. None of the studies identified assessed critical outcomes such as mortality before discharge, BPD or neurodevelopmental outcomes. Although the studies looked at short-term adverse effects associated with diuretics, it was not clear whether there was an increased risk of adverse effects because of the small sample size of the studies.

Because of the limited evidence and lack of clinical consensus, the committee could not make any recommendations for or against diuretic use in preterm babies on respiratory support. Instead, the committee recommended that further research be done in this area.

How the recommendations might affect services

Although they did not make any recommendations, some of the committee members thought that the lack of evidence identified may lead to healthcare professionals reviewing their use of diuretics. This may lead to a reduction in the use of diuretics in preterm babies on respiratory support, at

least until further evidence is available.

Full details of the evidence and the committee's discussion are in evidence review C: managing respiratory disorders.

Return to recommendations

Caffeine citrate

Recommendations 1.3.5 to 1.3.9

Why the committee made the recommendations

There was evidence that in preterm babies born before 31 weeks, caffeine citrate reduces the incidence of BPD, cerebral palsy (at 18 to 21 months' follow-up) and blindness (at 11-year follow-up) compared with placebo. However, from their clinical experience, and based on the inclusion criteria of the CAP study, the committee agreed that it was appropriate to start babies, born at or before 30 weeks (equivalent to babies born at or below 1.25 kg), on caffeine citrate on admission to the neonatal unit, so they recommended earlier initiation. Based on their clinical experience, the committee agreed that administering caffeine citrate would also reduce apnoea in older preterm babies.

There was evidence that, compared with lower doses, higher doses of caffeine citrate reduce the incidence of BPD, continued apnoea and extubation failure.

Evidence showed that the treatment with caffeine citrate before 3 days of age may lead to a reduction in BPD. There was also evidence that treatment with caffeine citrate for 15 to 30 days reduces the incidence of BPD compared with a shorter duration, and that treatment for longer than 30 days reduces the incidence of necrotising enterocolitis compared with treatment for less than 15 days.

To determine when caffeine citrate should be stopped, the committee referred back to the studies and identified the age at which caffeine citrate was started, the duration of caffeine citrate, and hence the age at which it had been stopped. The committee noted that caffeine citrate had been stopped in the studies at between 33 and 35 weeks. This reflected the clinical experience of the committee as the age at which preterm babies were no longer expected to have apnoea, and so this figure was used by the committee to develop their recommendations.

The committee made their dosing recommendations based on evidence that a higher dose is more effective than a lower dose, and on currently recommended doses used in clinical practice. However, the variation in loading and maintenance doses used across different clinical trials made selecting an optimal dose difficult, and although higher doses appeared to improve early outcomes, there were few data on long-term outcomes. For this reason, the committee recommended further research to identify the maintenance dose of caffeine citrate needed to optimise neurodevelopmental outcomes.

The committee also discussed whether monitoring caffeine citrate levels was necessary and noted that the Evelina London Paediatric Formulary advises that babies can receive 10 mg/kg of caffeine citrate twice daily without monitoring blood plasma levels (Evelina London 2015). The committee noted that there are units that do not currently monitor blood levels, and increasing doses to higher than 20 mg/kg daily may be a concern if units did not test blood levels at these higher doses. Therefore, the committee made an additional recommendation that if apnoea persists and a baby receives more than 20 mg/kg daily, caffeine citrate levels should be tested.

How the recommendations might affect services

The recommendations will have a minimal impact on current practice. The committee noted that there is some variation in dosage regimens across the NHS, so these recommendations should lead to greater consistency in the choice of dosage regimens. The committee agreed that oral caffeine citrate is used in most cases, and has a low acquisition cost. The committee acknowledged that intravenous caffeine citrate has a substantially higher acquisition cost. However, because of the single-use vial sizes available, irrespective of dose, a single vial will be required for administration of each dose, so increasing the dose would not increase the costs. In addition, only a small number of babies would need the intravenous solution. Furthermore, there may be a small increase in the number of blood tests performed to assess caffeine citrate levels if higher doses are used, but again the number of babies who will require high doses is small. Overall, the recommendations may result in a slight increase in drug and monitoring costs, but this is not anticipated to be substantial.

Full details of the evidence and the committee's discussion are in evidence review C: managing respiratory disorders.

Return to recommendations

Patent ductus arteriosus

Recommendation 1.3.10

Why the committee made the recommendation

There was no evidence of benefit from treating a PDA, and there was evidence for potential harms from treating it, with either medicines or surgery. However, the committee agreed that for some babies, treatment might be appropriate, for example, if there is difficulty weaning the baby from a ventilator.

How the recommendation might affect services

The recommendation will reduce the unnecessary treatment of PDA and the number of babies exposed to potential harms from its treatment. The recommendations may result in cost savings because fewer procedures will be carried out.

Full details of the evidence and the committee's discussion are in evidence review C: managing respiratory disorders.

Return to recommendations

Oxygen monitoring

Recommendations 1.4.1 to 1.4.3

Why the committee made the recommendations

The evidence on the best method for measuring oxygen levels in diagnosing hyperoxia or hypoxia in preterm babies was very limited. There were no studies assessing the diagnostic accuracy of SpO_2 (peripheral capillary oxygen saturation) compared with the standard PaO_2 (partial pressure of arterial oxygen) that met the review's inclusion criteria. The committee agreed, based on clinical consensus and their experience of clinical practice, that SpO_2 should remain the first-line method for continuous monitoring of oxygen saturation levels in preterm babies because of its widespread availability and non-invasive nature. The committee agreed that arterial sampling of partial pressure of oxygen remained the 'gold standard', but is not always possible and can never be continuous.

The only evidence on $tcPO_2$ (transcutaneous oxygen) was 1 study from the 1970s, and the way this procedure is performed has changed substantially since then. However, $tcPO_2$ is currently used in clinical practice, and in the committee's experience it can provide useful information. This is particularly the case for preterm babies on invasive ventilation who are clinically unstable and need continuous monitoring to guide management, and in whom SpO_2 may not be accurate.

Because of the lack of good evidence, the committee agreed that further research needs to be conducted looking at the diagnostic accuracy of $tcPO_2$ and SpO_2 against the gold standard arterial oxygen saturation in diagnosing hyperoxia and hypoxia in a preterm baby population.

There was evidence that higher target oxygen saturation levels reduce mortality. Although a higher target is associated with an increase in retinopathy of prematurity and an increased risk of BPD, the evidence suggested no increase in severe visual impairment at 18 months, and the reduction in mortality was considered to offset the increased risk of BPD. The committee were aware that target oxygen levels (up to 97%) may be more beneficial but there was no evidence to support this, so they made a research recommendation.

How the recommendation might affect services

The recommendations reflect current practice, where SpO_2 is generally used as routine continuous oxygen monitoring in preterm babies, and $tcPO_2$ is reserved for the more clinically unstable preterm babies as a continuous monitoring tool.

Many units already use 91% to 95% as their target saturation level for preterm babies, but for those that do not, this will be a change in practice. This will reduce the variation in clinical practice.

Full details of the evidence and the committee's discussion are in evidence review D: monitoring.

Return to recommendations

Carbon dioxide monitoring

Recommendations 1.4.4 and 1.4.5

Why the committee made the recommendations

The evidence showed no differences in the outcomes measured between higher and lower target ranges for the partial pressure of carbon dioxide in preterm babies on invasive ventilation. The committee recognised that the higher target ranges specified in the studies were in line with the definition of permissive hypercapnia and would probably not have any detrimental effects on clinical outcomes and long-term neurodevelopmental outcomes. In view of this, the committee agreed that when healthcare professionals are monitoring carbon dioxide levels in preterm babies on invasive ventilation, a higher target range would be acceptable. This avoids the need for frequent adjustment of the ventilators to reach an extremely tight target range.

There was variation in the target ranges of carbon dioxide used by different studies, and the range of days at which at different permissive hypercapnia levels were tolerated. The committee agreed to make a recommendation in line with the largest and most recent study that looked at clinical and long-term neurodevelopmental outcomes, but simplified the 3-stage ranges (days 1 to 3, days 4 to 6 and day 7 onwards) used in this study, to a 2-stage range based on their clinical experience that the difference in upper limits tolerated would be negligible and would have minimal detrimental effects on a preterm baby on invasive ventilation.

There was no evidence on the action to be taken when a low carbon dioxide level was detected, but the committee were aware that this was a dangerous situation, so agreed the action to be taken based on their clinical knowledge and experience.

All the evidence for the optimal target range of carbon dioxide was in preterm babies on invasive ventilation. The committee recognised the lack of evidence in preterm babies on non-invasive ventilation, so they recommended further research in this area.

How the recommendations might affect services

The recommendations reflect current practice, both where permissive hypercapnia is accepted in the monitoring of carbon dioxide levels in preterm babies on invasive ventilation, and for the action to be taken if hypocapnia is detected.

Full details of the evidence and the committee's discussion are in evidence review D: monitoring.

Return to recommendations

Blood pressure

Recommendation 1.4.6

Why the committee made the recommendation

There was no good evidence to define the normal range of blood pressure in preterm babies, or how blood pressure should be measured. The committee wanted to make healthcare professionals aware of this lack of evidence to prevent unnecessary treatment based on the level of blood pressure only. The committee advised, based on their clinical experience, that inadequate perfusion should be treated with the aim of increasing perfusion, and not to aim for a particular blood pressure target.

Because there was no good evidence, the committee made research recommendations to determine both the optimal blood pressure target and method of measuring blood pressure in preterm babies.

How the recommendation might affect services

For units that routinely monitor blood pressure in preterm babies and treat when blood pressure falls outside certain limits, this will be a change in practice. The recommendation will lead to less unnecessary monitoring and treatment of blood pressure.

Full details of the evidence and the committee's discussion are in evidence review D: monitoring.

Return to recommendations

Morphine

Recommendations 1.5.1 to 1.5.3

Why the committee made the recommendations

The evidence showed that there was no difference in mortality before discharge in babies who received morphine compared with placebo. Babies receiving morphine took longer to achieve full enteral feeding, and babies born at 27 to 29 weeks' gestation had an increased risk of severe intraventricular haemorrhage (IVH). There was some evidence that, when compared with placebo, morphine improves sedation and pain scores in preterm babies who need invasive respiratory support during infusion. However, moderate quality evidence from a larger study showed no difference in pain scores during endotracheal suctioning between babies who received morphine compared with placebo.

The only evidence available comparing morphine with fentanyl showed no clinically significant difference in rates of severe IVH.

There was some evidence that, when compared with midazolam, babies receiving morphine may have decreased rates of severe IVH.

Babies receiving morphine experienced less pain during infusion, but less sedation after infusion.

Because of the mixed evidence regarding the effectiveness of morphine and taking into account the risks, the committee agreed that morphine should not be used routinely, but may be considered

when it is clear the baby is in pain, and that neonatal units would have their own guidelines or preferred scales to determine pain in preterm babies.

The committee discussed other concerns about using morphine, such as suppressed respiratory drive and opioid dependency. They agreed that regular reassessments are important to ensure that morphine is stopped as soon as appropriate.

The committee did not make any recommendations for paracetamol or non-pharmacological interventions because there was no evidence available. Instead, the committee recommended that further research be done to compare morphine with containment holding during respiratory support, because the committee agreed that containment holding may improve outcomes in preterm babies, with a reduced risk of adverse events compared with pharmacological therapy.

How the recommendations might affect services

Use of sedation and analgesia currently varies among units. The recommendations will have little impact in units that do not routinely use morphine, but other units may need to change practice and this may lead to a reduction in the use of morphine. The recommendations will make practice more consistent across the NHS.

Full details of the evidence and the committee's discussion are in evidence review E: sedation and analgesia.

Return to recommendations

Premedication before intubation

Recommendations 1.5.4 and 1.5.5

Why the committee made the recommendations

There was some evidence from small, single studies that using an analgesic with a neuromuscular blocker, or an anaesthetic such as propofol used alone, is an effective regimen to achieve successful intubation in preterm babies, while avoiding adverse effects.

However, there was a lack of evidence to show exactly which medicines or classes of medicines form the best combination, so the committee recommended that healthcare professionals should consider premedication before elective intubation and recommended that further research be done in this area.

How the recommendations might affect services

Current practice of using premedication for elective intubation in preterm babies varies among units. Units that currently use single medicines (such as morphine or fentanyl) may need to change practice to follow the recommendation. The recommendation will make practice more consistent across the NHS.

Full details of the evidence and the committee's discussion are in evidence review E: sedation and analgesia.

Return to recommendations

Involving parents and carers while their preterm baby is on respiratory support

Recommendations 1.6.1 to 1.6.3

Why the committee made the recommendations

There was good evidence that using a dummy (non-nutritive sucking) during nasogastric feeds reduces the length of the baby's hospital stay. In addition, there was some evidence that the Newborn individualized developmental care and assessment program (NIDCAP®) improved neurodevelopmental outcomes relating to cognitive development and was a cost-effective intervention in babies born at less than 27 weeks. Although the evidence for skin-to-skin contact did not show any benefit, there was no evidence of harm. There was no evidence that Family integrated care (FIC) provided any additional benefits compared with standard care.

Based on their experience and the clinical evidence, the committee recommended explaining to parents and carers about the potential benefits of interacting with their baby because early social development and relationship-forming are key to successful emotional and behavioural development.

Because of the limited evidence available on FIC and NIDCAP®, the committee made it a priority to recommend that further research be done to investigate the potential impact of NIDCAP® and FIC on length of stay and BPD.

How the recommendations might affect services

The committee agreed that the recommendations on non-nutritive sucking and using positive touch (such as skin-to-skin contact) would not result in a major change in practice, but will help improve consistency in best practice.

Although there are cost implications for units to train professionals in NIDCAP®, the recommendation to consider NIDCAP® would lead to a more consistent approach across neonatal care networks to practice linked with neurodevelopmental care. It would also improve babies' access to this type of neurodevelopmental care and allow greater involvement of parents and carers in the care of their baby.

Full details of the evidence and the committee's discussion are in evidence review F: involving and supporting parents and carers.

Return to recommendations

Supporting and informing parents and carers while their preterm baby is on respiratory support

Recommendations 1.6.4 to 1.6.13

Why the committee made the recommendations

Support

There was good evidence that parents value emotional, psychological and practical support from staff, friends and family, peers (such as other parents of preterm babies) and employers when caring for a preterm baby receiving respiratory support. Parents also value professional support and counselling.

There was also evidence that parents value being partners in their baby's care, want to be supported by staff in caring for their baby, and need to be able to develop good communication and relationships with the staff caring for their baby.

There was evidence that parents value a comfortable, homely environment on the neonatal unit that is conducive to being involved in planning and providing care for their baby. Parents also value having 24-hour access to the neonatal unit, with private areas and privacy when needed.

Information

There was good evidence that parents and carers value high-quality, relevant, consistent information about their baby's health and care, including regular updates on their baby's progress. Parents and carers value information that is appropriate for their needs and explained clearly to them, and value the opportunity to ask questions. There was evidence that the appropriate timing of information is important to parents. The evidence also showed that parents and carers prefer information to be provided by an appropriate healthcare professional, and for it to be backed up by written information.

Parents value information on a range of topics, including how to interpret their baby's neurobehavioural cues, breastfeeding, skin-to-skin contact, the medical equipment used, who to contact, and other sources of information they could access themselves.

How the recommendations might affect services

The committee agreed that the recommendations would not result in a major change in practice, but will help improve consistency in best practice.

Full details of the evidence and the committee's discussion are in evidence review F: involving and supporting parents and carers.

Return to recommendations

Neonatal unit services

Recommendations 1.6.14 and 1.6.15

Why the committee made the recommendations

There was evidence that parents and carers value having 24-hour access to the neonatal unit, which should be a homely environment with comfortable furniture and private areas. In a number of the support and information themes, parents and carers agreed that healthcare professionals who provide information and support should be trained and competent in this, so the committee made an overarching recommendation.

How the recommendations might affect services

The committee agreed that the recommendations would not result in a major change in practice,

but will help improve consistency in best practice.

Full details of the evidence and the committee's discussion are in evidence review F: involving and supporting parents and carers.

Return to recommendations

Discharge planning – planning safe discharge

Recommendations 1.7.1 and 1.7.2

Why the committee made the recommendations

There was evidence about the importance of good communication with parents about their baby's discharge. The committee agreed that a designated neonatal discharge coordinator, as a single point-of-contact, would facilitate the communication of key information with parents and carers. The committee also agreed that early referral to community and continuing healthcare teams would also help parents prepare for their baby's discharge. Having the option to discharge to an alternative location, such as to another relative's home or a hospice, would enable parents and carers whose homes are not suitable for their preterm baby to be able to care for their baby outside the hospital.

The committee also recognised that some of the advice in the NICE guideline on postnatal care was also relevant to babies born preterm and so made a cross reference to this guideline.

However, because there were only 2 studies, and no evidence for a number of themes identified by the committee, the committee agreed that more research could better define best practice, and so made a research recommendation.

How the recommendations might affect services

The committee agreed that the recommendations would not result in a major change in practice, but will help improve consistency in delivering best practice.

Full details of the evidence and the committee's discussion are in evidence review G: discharge planning.

Return to recommendations

Discharge planning – preparing for discharge

Recommendations 1.7.3 to 1.7.9

Why the committee made the recommendations

There was evidence that parents and carers value having support and information about their baby's routine care, being involved in preparing for the baby's discharge, and having information on equipment, identifying illness in their baby, and dealing with emergencies. Parents and carers also value information about future care, such as contact details, follow-up appointments and immunisations, ongoing peer support and self-care for problems such as postnatal depression.

How the recommendations might affect services

The committee agreed that the recommendations would not result in a major change in practice, but will help improve consistency in delivering best practice.

Full details of the evidence and the committee's discussion are in evidence review G: discharge planning.

Return to recommendations

Context

In 2016, a national neonatal audit found that approximately 13% of babies in the UK need specialist neonatal care, either because they are born preterm (at less than 37 weeks) or because of an illness or condition.

A comparison of the EPICure studies published in 2012 found that, between 1995 and 2006, the number of babies born at less than 26 weeks and admitted to neonatal units increased by 30% in England. Over the same period, survival rates for babies born at 22 to 25 weeks and admitted for intensive care increased by 13%. In addition, a higher proportion of these babies survived without disability (particularly babies born at 24 to 25 weeks). International comparisons show that the neonatal mortality rate varies significantly by country.

Preterm babies are at risk of respiratory disorders, including respiratory distress syndrome and bronchopulmonary dysplasia (BPD). High-quality respiratory care can reduce the length of hospital stay and risk of long-term disability. BPD is particularly common in preterm babies who require assisted ventilation. Babies with BPD need prolonged specialist care and respiratory support.

Respiratory support is used in different ways in different units, and it is unclear what the best method is for providing ventilation and preventing BPD. There are many other areas of uncertainty and variation in how respiratory support is provided. There is also variation in other areas of respiratory management, including how corticosteroids are used to prevent and manage BPD.

Since 2013, neonatal critical care services have been managed within Operational Delivery Networks. For healthy babies and babies with minor problems, most care is provided by the hospital they are born in. Neonatal intensive care units are responsible for babies who have more complex problems. Neonatal intensive care, and the service specifications for Neonatal Critical Care and Neonatal Intensive Care Transport, are within the scope of the neonatal critical care Clinical Reference Group.

This guideline is for:

- healthcare professionals in primary, secondary and tertiary care
- parents and carers of babies born preterm who need respiratory support
- commissioners and providers of specialist neonatal care services.

Groups that are covered

- Babies born preterm who need respiratory support (for example, oxygen supplementation or assisted ventilation) in hospital, beginning in the neonatal period.

Groups that are not covered

- Babies born at term.
- Babies who need respiratory support because of congenital disorders, for example, congenital diaphragmatic hernia.

Finding more information and resources

You can see everything NICE says on this topic in the NICE Pathway on specialist neonatal respiratory care in preterm babies.

To find out what NICE has said on topics related to this guideline, see our NICE web page on postnatal care.

For full details of the evidence and the guideline committee's discussions, see the evidence reviews. You can also find information about how the guideline was developed, including details of the committee.

NICE has produced tools and resources to help you put this guideline into practice. For general help and advice on putting NICE guidelines into practice, see resources to help you put guidance into practice.

ISBN: 978-1-4731-3339-6

Accreditation