East of England Neonatal ODN
(Hosted by Cambridge University Hospitals)

Clinical Guideline: Strategies to reduce incidence of IVH and promote neuroprotection in the infant <31 weeks gestation

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For use in: EoE Neonatal Units
Guidance specific to the care of neonatal patients.

Used by: Neonatal units, Transport teams

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Date of meeting	

Audit Standards:

Audit points
85% **of babies born at 30 weeks or less follow an optimisation pathway, or there is evidence of a formal review of learning, if optimisation pathway was not followed.**
85% **of eligible babies are nursed on a mattress that is elevated to 15 - 30 degrees**
85% **of eligible babies are nursed with the head neck and body in the midline position.**
85% **of eligible babies have been assessed using the Reducing IVH checklist**

Contents

Summary

This guideline outlines current accepted practices to reduce the risk of IVH in preterm babies at increased risk of intraventricular haemorrhage. It provides recommendations for all Midwifery, neonatal nursing, medical staff and parents/carers in the support of preterm babies. It sets out the expectations for the standard of care required to reduce harm.
This guideline is intended for use alongside other East of England Guidelines currently used for the management and care of our preterm population, hyperlinks to the relevant documents will be included for further reading.

Its intended use is for all babies 30 weeks gestation or below during their first 72 hours of life.

Introduction

Preterm babies born less than 30 weeks gestation have a greater incidence of Intraventricular haemorrhage (IVH). This risk increases as gestational age decreases. Current neonatal practice for the resuscitation of babies has lowered to include babies born as early as 22 weeks gestation. Active resuscitation is expected if the clinical risk picture is favourable towards survival[1]. Although survival rates have improved in the preterm population[2], IVH is still a significant cause of mortality and morbidity[3,4]. The grade of IVH can be categorised as mild (grade 1 and 2) or severe (grade 3 and Periventricular haemorrhagic infarction)[5].

Grade	Papile (1978) based on CT	Volpe (2008) based on cUS	Percentage of GM-IVH	Mortality rate	Incidence of definite neurological sequelae
I	Subependymal hemorrhage	GMH with no or minimal IVH (<10% on parasagittal view)	40%	0–12%	15%
II	IVH without ventricle dilatation	IVH (10–50% on parasagittal view)	25%	2–24%	25%
III	IVH with ventricle dilatation	IVH (>50% on parasagittal view; usually distends lateral ventricle)	20%	8–32%	50%
IV	IVH with parenchymal hemorrhage	Periventricular echodensity (called PVHI)	15%	22–45%	75%

GM-IVH : germinal matrix and intraventricular hemorrhage, CT : computed tomography, cUS : cranial ultrasound, GMH : germinal matrix hemorrhage, IVH : intraventricular hemorrhage, PVHI : periventricular hemorrhagic infarction

You, S.K. (2023)[5]

Adverse neurodevelopmental outcomes later in life are closely associated with the occurrence and severity of IVH in preterm or LBW infants[6]. There are few therapeutic options once a severe IVH has been identified, therefore prevention is vitally important in the management of these babies. A recent meta-analysis by Rees *et al* (2022) concluded that all grades of IVH had a potential to have a poor neurological outcome, contradicting previous beliefs that the milder grades of IVH resolved with no adverse effect[7].

There are already many initiatives in place to facilitate the baby being born in optimal condition and providing neuroprotective benefits, such as the Saving babies lives Care bundle, version 3 and the PeriPrem pathway currently being followed within the East of England. The current evidence on individual postnatal components to reduce IVH is not as conclusive. When used together in the form of a care bundle, such as: an elevated head position; head, neck and torso in midline; minimal handling during stabilisation and general cares; standard use of caffeine and vitamin K; and cautious use of medications that directly affect cerebral blood flow, a reduction in IVH has been demonstrated [8,9], even when the initial IVH incidence was low[10] Thus supporting the benefits of a care bundle that

can be implemented on all levels of unit. Each delivery is unique with multiple factors that can impact on the health professional's ability to meet certain aspects of the care bundle. In these cases where optimisation has not been achieved, it is recommended these babies are reviewed within a formal setting to identify any areas of learning.

1. In-utero transfer

Evidence looking at outcomes in relation to place of birth, strongly favours extreme preterm babies being born at tertiary level hospital with a NICU[11,12,13]. The stress of an ex-utero transfer increases the likelihood of an IVH occurring[14]. To improve the outcomes for this preterm population, Recommendation 5 in the GIRFT report[15], includes the following core key attainments.

- To born in a hospital with a NICU
- To receive antenatal steroids and MgSO4
- Maternal antibiotics if there is evidence of infection
- Achieve optimal cord management
- To maintain normothermia and
- To receive colostrum in the first 24hours.

For babies who meet the criteria to be born at a hospital with a NICU, every effort should be made to recognise signs of preterm labour and facilitate an in-utero transfer[13,14,15]. Whenever possible, parents should be involved in this decision process when planning for an extremely preterm birth. Where there is a potential chance of survival in peri-viable babies, born at the earliest stage of foetal maturity, a risk assessment should be undertaken. This will include a discussion with the parents regarding the likelihood of survival, taking into account parental wishes when deciding to transfer or actively resuscitate[16], see figures 1a and 1b. This discussion should include senior clinical staff from the obstetric, midwifery and neonatal teams who will be caring for the mother and her baby. Parents should be counselled on the potential outcomes and inherent uncertainty surrounding the birth of a preterm baby, and reviewed regularly if the pregnancy continues. For further information please follow link to the EoE inutero transfer and BAPM Perinatal management of Extreme preterm birth before 27weeks of gestation guidelines.

2. Antenatal steroids

Antenatal steroids, given within seven days of birth have an anti-inflammatory effect, protecting the preterm brain, reducing the likelihood of IVH, respiratory distress syndrome, perinatal or neonatal death[17,18]. Giving Steroids to the mother should be considered when preterm delivery is anticipated, explaining the risks and benefits associated with corticosteroids for both mother and baby. No more than two courses of steroids should be given due to the risks of reduced fetal growth and postnatal hypoglycaemia[18]. Corticosteroids are most effective if the timing of the full course is completed between 24hours and seven days prior to the birth[18].

3. MgSO4

Administration of Magnesium Sulphate to women in established preterm labour reduces incidence of cerebral palsy and motor dysfunction in the baby. The benefits have been demonstrated to be greater for babies <30weeks gestation[17,19].

4. Antenatal antibiotics

Antenatal infection may play an important role in predisposing preterm babies to IVH[20]. The short term benefits of giving antibiotics to a mother with confirmed preterm prolonged rupture of membranes (PPROM) is robust, but, if there is no evidence of PPROM or sign of chorioamnionitis, the potential benefits are not as clear[19]. Administering antibiotics to the mother any time before birth is effective, although ideally at least 4hours before birth is the optimum if infection is suspected.

5. Optimal cord management / delayed cord clamping (DCC)

If clinical condition allows, delaying cord clamping for at least 60 seconds or longer[21] is recommended, to improve the circulatory blood volume preventing a sudden drop in blood pressure when the baby takes their first breath. There are many other benefits associated with DCC including reducing death by nearly a third[22]. However, the practice of Umbilical Cord Milking has been associated with an increased risk of severe IVH in the preterm population (<28weeks) and should not be encouraged[23]. Further guidance can be found in the regional delayed cord clamping guideline.

6. Thermoregulation

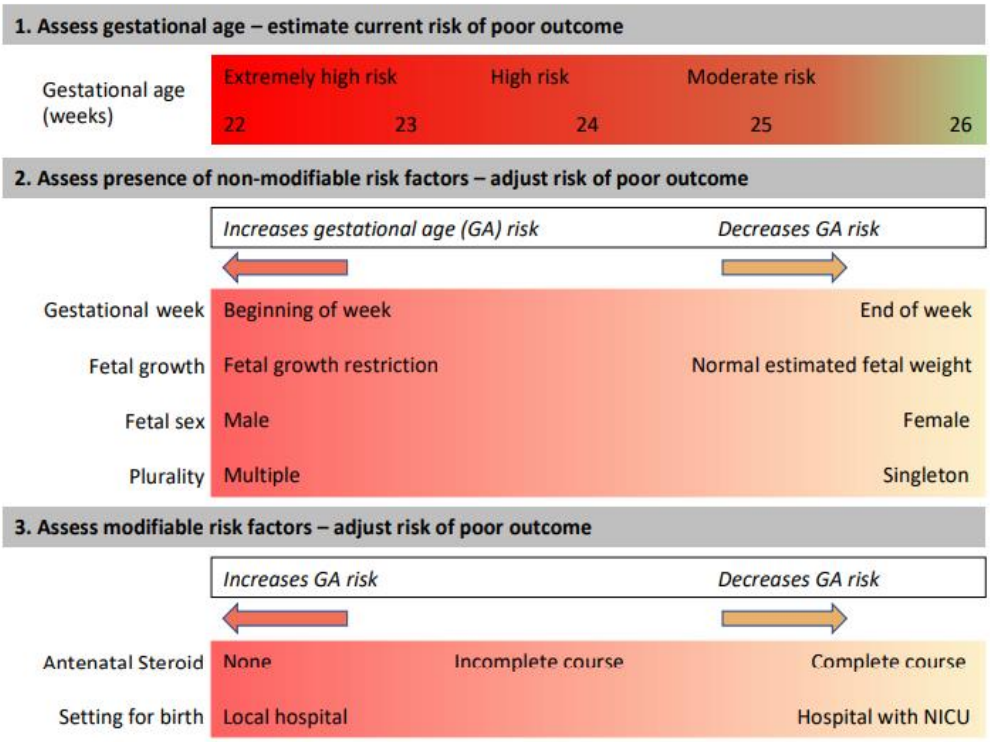
Preterm babies are extremely susceptible to temperature changes from the surrounding environment. Maintaining normothermia is essential to reduce harm as both hypothermia and hyperthermia can have adverse effects on the baby[24,25]. Prolonged cold stress has been associated with an increased risk of IVH, NEC, RDS, BPD etc. The World health Organisation (WHO) defines hypothermia as less than 36.5ºc. For every 1ºc drop below the normal temperature range, there is an associated 28% increase in the incidence of mortality[26]. They should be placed directly into a Neohelp™ bag (or equivalent) without drying, their head should be covered by both the plastic and a woollen hat. See Appendix 1. Once the cord is clamped and cut from the placenta, move the baby over to the resuscitaire and place under a radiant heater. An additional heat source from a chemical warming mattress can be used under the baby if the baby's temperature remains low. **Use with extreme caution as temperature rises can be rapid causing hyperthermia and risk of burns if used with another heat source**[24]. Frequent monitoring of the babies temperature should be undertaken whilst the mattress is in use. Once settled on the neonatal unit, use of humidity with a closed wall incubator will facilitate temperature stability, reducing transepidermal water loss in preference to the Neohelp™ bag[24]. For further strategies to monitor thermoregulation, use the EoE thermoregulation guidelines.

7. Stabilisation and Resuscitation.

There are many variants that impact on the outcome of preterm babies, with risks increasing as gestational age and weight decrease. The incidence of a poor outcome increases with the intensity level of delivery room resuscitation[27]. With the highest level of resuscitation being an independent risk factor for Intraventricular haemorrhage (IVH), Periventricular Leukomalacia (PVL) and Bronchopulmonary dysplasia (BPD)[24,28,29].

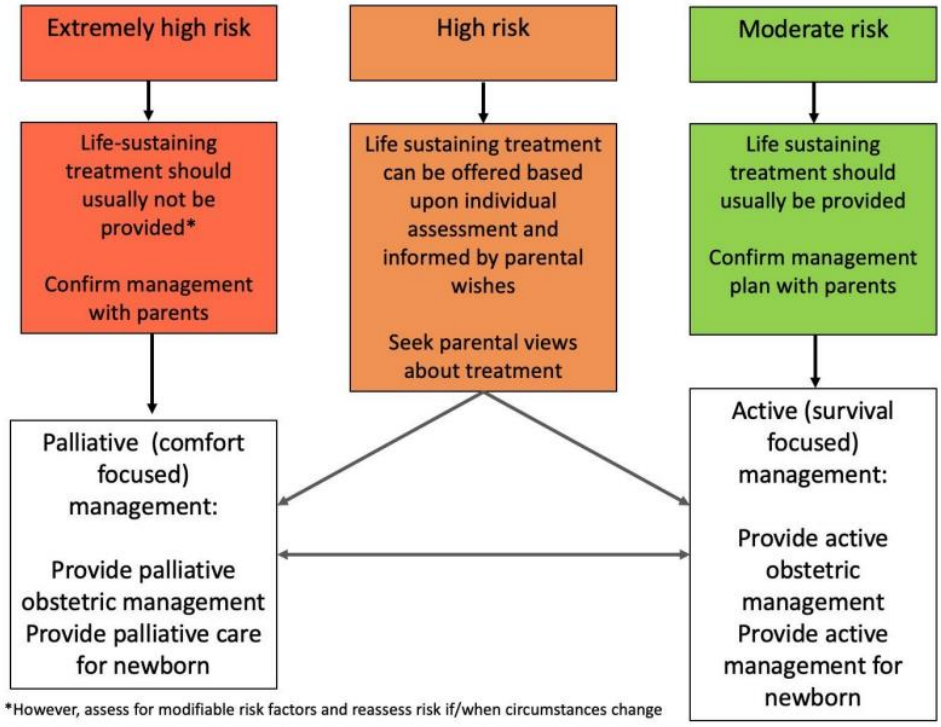
Although intubation may be unavoidable in the more extreme preterm babies, it is associated with a poorer outcome. Therefore careful management of stabilisation or resuscitation is essential to avoid unnecessary risks[24]. Ideally, the attending team should be experienced in resuscitation of the extreme preterm baby, led by a consultant neonatologist. It is recommended that the Clinician intubating at delivery, meets the standards of Intermediate capability for intubation as per the BAPM Neonatal airway safety Standard 2024[30] (See Appendix 2). In emergency situations, where this is not achievable, the most experienced member of the team should lead and determine the level of resuscitation required to stabilise the baby. During stabilisation in the delivery room, the saturation probe should be placed pre-ductally - on the right hand or arm, to obtain the most accurate oxygen saturation and heart rate[31]. For further information see first hour of care guideline

Figure 1a



BAPM Visual tool for refinement of risk. (2019)

Figure 1b



BAPM Decision-making around management of delivery, following risk assessment and after consultation with parents.

8. Oxygen saturation

Preterm babies are deficient in anti-oxidative protection making them highly susceptible to oxygen toxicity[24]. Therefore, there may be some benefit to tolerate slightly lower saturations of 85-92% during the initial resuscitation, avoiding hypoxia and hyperoxia. Although there are only a few trials looking at titrated oxygen compared to 100% oxygen, those that are available favour titrated oxygen relating to delivery room oxygen saturations[24]. The UK resuscitation council recommends aiming for a saturation of >80% at 5mins of age[31]. Saturations of <80% at 5mins is strongly associated with IVH[32]. During stabilisation the UK resuscitation council's minimum recommendations for pre-ductal saturations should be followed[31]. Once stabilised, NICE recommends oxygen saturation targets for preterm babies should be within the range of 91-95%. This range reduces the risk of Retinopathy of prematurity related to hyperoxia or increased mortality and IVH related to hypoxia[33]. Regular rotation of probe site will reduce risk of skin damage. For further information see EoE saturation targeting guideline.

9. **Surfactant administration**

With reference to the East of England Surfactant Replacement Therapy for Neonates with Respiratory Distress and current evidence.

Prophylactic Surfactant administration is no longer endorsed, in favour of early rescue therapy. The method of administration should depend on the mode of ventilation, clinical stability of the baby and locally agreed methods e.g INSURE; LISA [34].

It is recommended in: babies who need intubation as part of their stabilisation process; in a very preterm baby who is not steroid mature; preterm babies with RDS on CPAP with FiO_2 >0.3 and/or increasing work of breathing with respiratory and/or mixed acidosis and/or radiographic evidence of neonatal RDS should receive early surfactant[34].

10. Delivery room cuddles.

Early post birth contact between parent and baby is recognised as crucial for supporting the bonding process. Often, due to the acuity of the preterm baby, it may be several days or weeks before they are well enough to be held. This separation can prevent that initial physical and psychological bond. The benefits of close contact for both parents and preterm babies have also been well documented. Providing a delivery room cuddle soon after birth helps to facilitate a family-centred care approach, and potentially improve long-term family attachment. If there are no contraindications, see appendix 2, delivery room cuddles irrespective of birth gestation should be encouraged and is appreciated by parents[35]. When placing the baby into the parent's arms, try to maintain the midline position of the head and body.

11. Volume guarantee ventilation

For preterm babies requiring invasive ventilation within the first 72 hours of life, volume-targeted or volume-guarantee (VG) ventilation should be the primary mode of respiratory support when used in combination with synchronised ventilation. VG ventilation automatically adjusts in real time to maintain a relatively stable tidal volume, reducing peak inspiratory pressure as the lungs improve. Studies have shown that Infants ventilated using volume-targeted ventilation had reduced death/BPD, duration of ventilation, pneumothoraces, hypocarbia and periventricular leukomalacia/severe intraventricular haemorrhage[36,37]. There will be times when, clinically, it is not possible to use VG, in this situation there should be clear documentation in the notes of the decision.

Monitoring of PCO_2 levels via blood gases, transcutaneous monitoring or end-tidal CO2 is recommended. CO_2 levels should be maintained at 4.5-8.5kPa[33].

Closed suction can be used in preference to open suction to avoid significant changes to oxygenation and carbon dioxide levels within the bloodstream and maintain physiological stability[38].

Due to the closed nature of the circuit, it may help to reduce the risk of introducing infection. It should take no longer that 10 seconds to complete suctioning of the ET tube to ovoid iatrogenic deterioration.

(NB: Early use of rescue ventilation via high-frequency oscillatory ventilation HFOV may increase the risk of IVH)[33].

12. Vitamin K

Prophylactic administration of IM vitamin K is standard practice on all neonatal units to prevent vitamin K deficient bleeding otherwise known as haemorrhagic disease of the newborn (HDN). HDN can cause bleeding in almost all organs and can be fatal, therefore babies who are at high risk of bleeding are given vitamin K as a treatment and is considered in the best interests of the baby[39]. If the intravenous route is used in preterm neonates, it may not provide the same protection as the intramuscular injection, due to the depot effect of intramuscular route being lost; further doses of Vitamin K may be required. The amount and frequency of further doses should be based on coagulation status, and also the route of administration of these doses. If the intramuscular route is used for the subsequent dose then only one further dose may be needed, if the oral route is used, then an oral dose will be required at day 7 and day 28 of age.[40,41]

13. Caffeine

Early routine administration of caffeine has been associated with an improvement in systemic blood flow, blood pressure and improved left ventricular stroke volume[42]. Along with its anti-inflammatory action and oxidative stress modulation, provides a neuroprotective effect[43,44]. In addition, it reduces the need for mechanical ventilation, improves likelihood of a successful extubation and reduces incidence of IVH, BPD and PDA[45]. Caffeine should be given as part of the first hour of care pathway in line with the East of England first hour of care guidance.

14. Sodium bicarbonate

Sodium bicarbonate as a treatment for metabolic acidosis, continues to be controversial in relation to its benefits, as there are many pathological pathways that influence metabolic acidosis. Studies show use of Sodium bicarbonate is associated with an increased risk of IVH and death in the preterm population[46]. Even taking into account the severity of illness incidence of IVH and Death remained higher[47].

Bolus doses of sodium bicarbonate should not be used routinely for the treatment of metabolic acidosis in this population. If senior clinical review considers the administration of sodium bicarbonate as beneficial, it should be given slowly[46]. There is some empiric evidence that low dose Sodium bicarbonate, in extremely preterm infants, given continuously through the UAC helps to avoid metabolic acidosis and the need to correct[48]. See The East of England Pharmaceutical monograph (sodium bicarbonate and heparin neonatal IV monograph) for more information.

15. Inotropes

Instability of the cardiovascular system has been associated with increased risk of IVH. With both low and high blood pressure increasing likelihood of adverse outcomes. The relationship between Blood Pressure (BP) and Cerebral Blood Flow (CBF) is complex and not fully understood. Evidence is limited on whether treating hypotension improves outcomes, and sudden increases in BP can be harmful. For infants who require ventilator support, invasive blood pressure monitoring should ideally be used in preference to cuff BP, which should be interpreted with caution in preterm babies[49,50]. For more stable preterm babies, a minimal handling approach may be a more effective way to reduce changes to CBF.

Treatment with inotrope support should not be started only on a low blood pressure, other systemic symptoms should be present, e.g. low pH, high lactate, low urine output, Tachycardia or hypoxaemia[44]. Use of volume expanders can be considered if there is evidence of hypovolaemia increased capillary leak or blood loss[49,50]. For further information see EoE Hypotension guideline.

16. Treatment of Patent Ductus Arteriosus

A patent ductus Arteriosus (PDA) is common complication for preterm babies, a symptomatic PDA increases the risk of a preterm baby developing an IVH[51]. There has been some research looking into the use of prophylactic or early pharmacological treatment to prevent PDA[52,53], Although treatments for PDA closures were effective, the evidence did not show any benefit to prophylactic or early treatment. Consideration of risks of treating compared to not treating should be assessed when determining treatment. NICE[34] recommends treating a PDA only if causing clinically significant problem.

17. Positioning

Maintaining the baby in an elevated position of 15^0 to 30^0, with the head supported in the midline enables optimal cerebral drainage, preventing occlusion of the jugular venous system, thus reducing cerebral venous congestion associated with periventricular haemorrhagic infarction[54]. Although 2 fairly recent systematic reviews in 2018[57] and 2020[56] could not find conclusive evidence that positioning alone reduced IVH, they and other studies found elevated midline positioning did not increase the incident of IVH but did prevent further progression towards the more severe grades of IVH[58,59]. When combined with other measures to prevent IVH in the form of care bundles, studies were able to show a significant improvement in reducing IVH[59].

18. Handling

The benefits of minimal handling by healthcare professionals have been well documented for the preterm population. Many of the contact episodes on a NICU tend to have a painful element to them, e.g. blood tests, cannulation, cuff BP etc[60]. Clustering cares and performing procedures should be assessed on need and the baby's tolerance to handling. Aim for two person handling (4 handed care) for medical interventions, cares, position changes, weighing and sheet changes. Initial approach should be slow to allow the baby time to expect the touch and paced to avoid stress. Sudden position changes should be avoided unless an emergency event has occurred, it should be performed slowly and with care, with a maximum turn of 90^0 in one single movement. In line with the elevated head position, the lower limbs or body should not be raised above the head, potentially increasing the cerebral venous pressure, see appendix 4. Further guidance on positioning and handling can be found in the East of England Developmental care guideline.

19. Skin to skin

A recent study looking the risk of IVH and sepsis for babies exposed to early Skin to skin, which included extremely preterm babies did not show an increase in either IVH or sepsis[61,62].
Skin to skin in the first 72 hours should be agreed in conjunction with the medical and nursing team to determine clinical stability and suitability before undertaking, The traditional position of placing the baby chest to chest with the head to one side should be avoided in favour of placing the baby on their side, allowing the head to remain in the midline, avoiding increased pressure on the blood flow to the brain via the jugular arteries[63]. See appendix 5. Extra care should be taken to ensure the baby remains warm due to the reduced skin contact[64]. To minimise stress of the infant, the person having skin to skin does the transfer of the baby if medically fit and confident enough to. This will aid the development of vestibular, proprioceptive and tactile sensory systems[65]. If local guidance is available on parent led transfer for skin to skin, these should be followed. The benefits of skin to skin

for the parents and baby have been comprehensively documented and should be encouraged for all families in NICU.

20. Pain and Stress and comfort

Studies have identified how the effects of pain and stress can adversely impact on the maturation of the preterm brain and subsequent neurodevelopment of the preterm baby. To mitigate the adverse effects, regular assessment of pain and comfort should be undertaken, using a recognised neonatal pain tool, with a step wise approach to pain management depending on the level of optimal pain relief needed[66]. Every effort should be made to monitor and mitigate the adverse effects of pain. This includes encouraging parent/carer presence during painful procedures where possible, following the ethos of Ficare. The use of a recognised positioning assessment tool, such as The FINE positioning comfort score will assist in the assessment of the baby's comfort and is recommended to help reduce stress caused by poor positioning. See appendix 6. Non-pharmacological methods for reducing pain for minor procedures should be employed consistently, avoiding long periods of distress or crying. For more painful procedures, Pharmacological interventions can be used but they have shown a mixed response to neuroprotection, therefore it is advised to avoid long-term use[60]. The effectiveness of any interventions should be evaluated, acted upon and documented. For further information see EoE Pain guideline.

21. Cranial Ultrasound.

Ultrasound monitors are available on most neonatal units, providing readily accessible scanning opportunities of the preterm brain. A cranial ultrasound assists in the identification germinal matrix haemorrhages, large bleeds or large cysts, including potential areas of concern seen as echogenic areas within the white matter. Literature available identifies 2 different options regarding timing of scanning: To perform initial scan on day 1 or after the 72-hour window[67,68]. As there is no evidence directly relating to the adverse effects of performing an ultrasound within the 72-hour window, we are following the expert opinion of the neurocritical care community. The D1 scan should be performed as soon as possible after birth to detect any lesions that may be antenatal in origin. However, this should be deferred if there is any concern that a CrUSS could destabilise the patient. If clinical need requires an ex-utero transfer within the first 72 hours after birth, it is advisable to perform a baseline head ultrasound prior to transfer, if this has not already been performed.

22. Infection

Although there is now a stronger emphasis on treating suspected or confirmed infection in the intrapartum stage of pregnancy. There is still a need to consider and treat infection in the baby postnatally. Preterm birth (<37 weeks gestation) is considered a risk factor in its own right and if there is evidence of maternal infection (another risk factor) this would trigger the need to screen and treat the baby with antibiotics[69]. The risk of death for preterm babies due to infection is significantly higher than in term babies. Although antibiotics do not directly reduce IVH, the preterm brain is more susceptible to damage from inflammation, cytokines, free radicals and glutamate adversely impacting on the neuronal cells leading to brain injury. Episodes of postnatal infection resulting in a sick and unstable baby, affecting changes to cerebral blood flow, can increase the likelihood of IVH even outside of the 72 hour window. The baby should be carefully monitored and reviewed alongside all other systems to identify any change or deterioration in their condition that may indicate infection[70]. For further information on Risk factors for infection and Antibiotic treatment, refer to the East of England Neonatal antibiotic policy.

23. Nutrition

The nutritional requirements for preterm brain development and growth has been extensively studied resulting in changes to recommendations as greater understanding of their needs has become clearer[71,72]. The acuity of the baby can prevent toleration of enteral feeds and the babies' ability to absorb all the nutrients necessary for growth. Although Breast milk is considered gold standard for all babies regardless of gestational age for optimal growth and development[73]. In general, a number of nutritional strategies may be required to ensure that every effort is made to promote healthy growth[74]. Guidance on the management and nutritional needs of preterm babies is covered extensively on the East of England website. Please refer to PN guideline, Enteral feeding guideline, Neonatal feeding policy, Donor Milk guideline, oral feeding guideline, Probiotic guideline.

24. References

1. Mactier, H. *et al.* (2020) *Perinatal Management of extreme preterm birth before 27weeks of gestation: a framework for practice.* Arch Dis Child Fetal Neoantal Ed. May Vol 105, No.3, F232- F239

2. MBRRACE-UK (2021) *MBRRACE-UK Perinatal Mortality Surveillance report. UK Perinatal deaths for births from January to December 2019.* Available at: https://www.npeu.ox.ac.uk/assets/downloads/mbrrace-uk/reports/perinatal-surveillance-report-2019/MBRRACE-UK_Perinatal_Surveillance_Report_2019_-_Final_v2.pdf

3. NNAP (2022) *National Neonatal Audit Programme (NNAP) Summary report on 2022 data.* Available at: https://nnap.rcpch.ac.uk/annual-reports.aspx

4. Picollo, B. *et al.* (2022) *Intraventricular Haemorrhage in Preterm newborn: Predictors of mortality.* Acta Biomed Vol.93,N.2.

5. You, S.K. (2023) Neuroimaging of Germinal Matrix and Intraventricular Hemorrhage in Preterm Infants. J Korean Neurosrug Soc 66(3) p239-246 Available at: https://pubmed.ncbi.nlm.nih.gov/37170495/

6. Zhous, M. *et al.* (2023) *Neurodevelopmental outcomes in preterm or low birth weight infants with germinal matrix-intraventricular hemorrhage: a meta-analysis.* Pediatr Res **95**, 625–633 (2024). https://doi.org/10.1038/s41390-023-02877-8

7. Rees, *et al.* (2022) *Preterm brain Injury and Neurodevelopmental Outcomes: A Meta-analysis.* Pediatrics. vol150. 6. Available at: https://publications.aap.org/pediatrics/article/150/6/e2022057442/189905/Preterm-Brain-Injury-and-Neurodevelopmental

8. Christ, L. *et al* (2015) *Reducing intraventricular haemorrhage in a level III neonatal intensive care unit*. BMJ qual saf 24(11). 718-719

9. Tatawy, S. *et al.* (2022) *Care bundle Application Decreases the frequency and severity of Intraventicualr Hemorrhage in Preterm Neonates: Single Center Study.* PSJ 2(2), 112-119

10. Xuanru, M. *et al.* (2021) *Validity of an IVH and PVL prevention bundle interventions in a centre with very low incidence of severe IVH: a case control study.* BMJ paediatrics Open. 5(suppl 1): A1-A132

11. Marlow, N. *et al.* (2014) *Perinatal outcomes for extremely preterm babies in relation to Place of birth in England: The EPICure 2 study.* Arch Dis Child fetal Neonatal ed. 99, F181-188

12. Yao, S. *et al.* (2023) *The effectiveness of interventions to prevent intraventricular haemorrhage in premature babys: a systematic review and network meta-analysis.* Journal of Neonatal-Perinatal medicine. 16. P5-20.

13. Shipley, L. Hylger, G. and Sharkey, D. (2022) *Temporal trends of inutero and early postnatal transfer of extremely preterm babies between 2011 and 2016: a UK population study.* Ardh DIS child Fetal Neonatal Ed. 107. F201-205

14. Blaxter, L. *et al.* (2017). *Neonatal head and torso vibration exposure during inter-hospital transfer.* Journal of Engineering in Medicine. Vol 231(2) p99-113.

15. GIRFT (2022) *Neonatology GIRFT national report*. Available at: Neonatology GIRFT national report - Getting It Right First Time - FutureNHS Collaboration Platform

16. BAPM (2019). Perinatal Management of Extreme Preterm Birth before 27weeks of gestation. A BAPM framework for practice. Available at: https://www.bapm.org/resources/80-perinatal-management-of-extreme-preterm-birth-before-27-weeks-of-gestation-2019

17. Razak, A. *et al.* (2023) *Interventions to reduce severe brain injury in preterm neonates. A systematic review and meta-analysis.* JAMA network Open. 6(4). e237473

18. RCOG (2022) *Green-top guideline No.74. Antenatal corticosteroids to reduce neonatal morbidity and mortality.* Available at: Antenatal corticosteroids to reduce neonatal morbidity and mortality (wiley.com)

19. RCOG (2019) *Green-top guideline No.73. Care of women presenting with suspected Preterm prelabour rupture of membranes from 24+0 weeks of gestation.* Available at: Care of Women Presenting with Suspected Preterm Prelabour Rupture of Membranes from 24+0 Weeks of Gestation - Thomson - 2019 - BJOG: An International Journal of Obstetrics & Gynaecology - Wiley Online Library

20. Huang, *et al.* (2019) *Antenatal infection and intraventricular hemorrhage in preterm infants. A meta-analysis.* Medicine. 98:31 Available at: https://journals.lww.com/md-journal/fulltext/2019/08020/Antenatal_infection_and_intraventricular.38.aspx

21. Ryan, M. *et al.* (2019) *Neuroprotection from acute brain injury in preterm babys.* Paediatrics & child health, 276-282. Available at: https://doi.org/10.1093/pch/pxz056

22. NHS England (2023) Saving Babies Lives through optimal cord management. NHS England website. Available at: https://www.england.nhs.uk/long-read/saving-pre-term-babies-lives-through-optimal-cord-management/#:~:text=Optimal%20cord%20management%20is%20the,they%20take%20their%20first%20breaths

23. NICE (2022) NG25: Preterm Labour and birth. Available at: https://www.NICE.org.uk/guidance/ng25

24. Patel, P. Banerjee, J. and Gadambe, S. (2016) *Resuscitation of extremely preterm Infants-controversies and current evidence.* World Journal clinical paediatrics. 8;5(2) p151-158.

25. Croop, S. *et al.* (2020) *The golden Hour: a quality improvement initiative for extremely premature babies in the neonatal intensive care unit.* Journal of Perinatology. Available at: https://doi.org/10.1038/s41372-019-0545-0

26. Chiu, W. *et al.* (2022) *Reducing intraventricular haemorrhage following the implementation of a prevention bundle for neonatal hypothermia.* PLoS ONE 17(9): e0273946

27. Yoon, S. *et al.* (2021) *Impact of neonatal resuscitation changes on outcomes of very-low-birth-weight babies.* Scientific reports. 11:9003

28. Viaroli, F. *et al.* (2018) *Reducing Brain Injury of Preterm Baby's in the delivery room.* Frontiers in Pediatrics. 6. 290.

29. Tamai, K. *et al.* (2023) *Delivery room intubation and severe intraventricular haemorrhage in extremely preterm babies without low Apgar scores: A Japanese retrospective cohort study.* Scientific Reports. 13:14990

30. BAPM (2024) BAPM Neonatal Airway Safety Standard. A BAPM framework for practice. Online. Available at: https://www.bapm.org/resources/BAPM-Neonatal-Airway-Safety-Standard Accessed 13/01/25

31. UK resuscitation council (2021) Newborn resuscitation and support of transition of infants at birth Guidelines. Available at: https://www.resus.org.uk/library/2021-resuscitation-guidelines/newborn-resuscitation-and-support-transition-infants-birth

32. Jiang, S. *et al.* (2024) *Association between 5-minute oxygen saturation and neonatal death and intraventricular haemorrhage among extremely preterm infants.* Journal of Perinatology. Available at: https://www.nature.com/articles/s41372-024-02194-w

33. NICE (2019) NG 124: Specialist Neonatal respiratory care for babies born preterm. Available at: https://www.nice.org.uk/guidance/ng124

34. Ng, E and Shah, V. (2021) *Guidelines for surfactant replacement therapy in neonates.* Paediatrics and Child Health. P35-41.

35. Clarke, P. *et al.* (2021) *Delivery room cuddles for extremely preterm babies and parents: concept, practice, safety, parental feedback.* Acta Paediatrica. 110. P1439-1449. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8246903/pdf/APA-110-1439.pdf

36. Guaman, M.C. *et al.* (2022) *Volume guarantee vs. pressure-limited ventilation in evolving bronchopulmonary dysplasia.* Frontiers in Pediatrics. Available at: Volume-guarantee vs. pressure-limited ventilation in evolving bronchopulmonary dysplasia (nih.gov)

37. Wheeler, K. *et al.* (2011) *Volume-Targeted versus Pressure-Limited Ventilation for Preterm Infants: A Systematic Review and Meta-Analysis*. Neonatology.100. p219-227

38. Taylor, J.E. *et al.* (2011) *Tracheal suctioning without disconnection in intubated ventilated neonates.* Cochrane database of systematic reviews. Issue 12.

39. NHSGGC (2024) Vitamin K prophylaxis for neonates. NHSGGC Paediatrics for health professionals. Online. Available at: https://www.clinicalguidelines.scot.nhs.uk/nhsggc-guidelines/nhsggc-guidelines/neonatology/vitamin-k-prophylaxis-for-neonates/

40. British National Formulary for children. (2025) Online. Available at: https://bnfc.nice.org.uk/drugs/phytomenadione/#indications-and-dose Accessed 13/01/25

41. EMC online (2024) Konakion MM Paediatric 2mg/0.2ml solution for injection. Available at: www.medicines.org.uk/emc Accessed: 13th February 2024

42. Moschino, L.*et al.* (2020) *Caffeine in preterm infants: where are we in 2020.* ERJ Open Research. 6. Available at: https://openres.ersjournals.com/content/erjor/6/1/00330-2019.full.pdf

43. Abdel-Hady, H. *et al.* (2015) *Caffeine therapy in preterm infants.* World J clinical paediatrics 8. 4(4). P81-93

44. Sammut, A. *et al* (2021) *IVH prevention bundle protecting preterm brains.* UCLH Guideline. Provided by and used with their permission.

45. Lea, C. Smith-Collins, A, Luyt, K. (2017) *Protecting the premature brain: current evidence-based strategies for minimising perinatal brain injury in preterm babys.* Arch Dis Child fetal neonatal ed. 102. F176-182

46. Massenzi, L. *et al.* (2021) *Use of intravenous sodium biacarbonate in neonatal intensive care units in Italy: a nationwide survey.* Italian Journal of Pediatrics 47:63

47. Berg, C. *et al.* (2010) *Sodium Bicarbonate administration and Outcome in Preterm Babys.* The Journal of Pediatrics. 157. P684-687

48. Neonatal Formulary (2020*) Drug use in pregnancy and the first year of life*. 8th Ed.

49. Stathopoulou, T. *et al.* (2023) *Strong association between inotrope administration and intraventricular haemorrhage, gestational age, and the use of fentanyl invery low gestational age baby's: A retrospective study.* Children. 10:1667.

50. Mullaly, R and El-Khuffash, A. (2023) *Haemodynamic assessment and management of hypotension in the preterm.* Arch dis child fetal neonatal ed. 109: F120-127

51. O'Reilly, P. *et al* (2021) *Indomethacin for* symptomatic patent ductus arteriosus in preterm infants. Cochrane Database of Systematic Reviews. Issue 1 Art. No.: CD013133.

52. Tsao, P. (2022) *Pathogenesis and prevention of intraventricular haemorrhage in Preterm Babys.* J Korean Neurosurg. Soc. 66(3) p228-238

53. Gupta, S. *et al* (2024) *Trial of Selective Early treatment of patent Ductus arteriosus with Ibuprofen.* The new England Journal of Medicine. Available at: https://www.nejm.org/doi/full/10.1056/NEJMoa2305582

54. Bilj-Marcus, K. *et al.* (2017) *The effect of head positioning and head tilting on the incidence if intraventricular haemorrhage in very preterm babys: A systematic review.* Neonatology. 111. P267-279

55. Gross, M. *et al.* (2021) *Evaluating the effect of a neonatal Care bundle for the prevention of Intracranial Hemorrhage in Preterm Babys.* Children, 8. 257.

56. Romantsik, O. Calevo, M>G> and Bruschettini, M. (2020) *Head in Midline position for preventing the occurrence or extension of germinal matrix- intraventricular haemorrhage in preterm infants (review).* Cochrane database of systematic reviews.

57. Bijl-Marcus, K. *et al.* (2018) *Neonatal care bundles are associated with a reduction in the incidence of intraventricular haemorrhage in preterm infants: a multicentre cohort study.* Arch Dis fetal Neonatal Medicine. 105. F419-424

58. Kochan, M. *et al.* (2019) *Elevated head positioning of extremely low birth weight intants: effects on cardiopulmonary function and the incidence of periventricular-intraventricular haemorrhage.* Journal of perinatology. 39. P54-62

59. El Amouri, S. *et al.* (2021) *Reducing Intraventricular Hemorrhage in preterm babies less than 30 weeks of gestation in neonatal Intensive care unit, level III: A bundle of care.* J Clinical Neonatal 10. P165-169.

60. Campbell-yeo, M. Erickson, M and Benoit, B (2022) *Assessment and Management of pain in preterm Infants: A practice update.* Children. 9.244

61. Bedetti, L. *et al.* (2023) *Early Skin to skin contact in preterm Babys: is it safe? An Italian experience.* Children 10, 570.

62. Johansson, M. *et al.* (2024) *Early skin to skin contact and the risk of intraventricular haemorrhage and sepsis in preterm babies.* Acta Pediatrica. 00. P1-7

63. Blackett, K. *et al.* (2022) *Side-lying Kangaroo care: All the benefits whilst still maintaining midline head Positioning.* Arch Dis Child 107,(2) A172

64. Collados-Gómez, L. *et al* (2022) *Lateral Kangaroo Care in Hemodynamic Stability of Extremely Preterm Infants: Protocol Study for a Non-Inferiority. Randomized Controlled Trial CANGULAT.* Int. J. Environ. Res. Public Health. 19, 293

65. Özgün Kaya, K *et al* (2020*) Neuromotor and sensory development in preterm infants: prospective study.* Turkish Pediatric Association. P46-53

66. McPherson, C. *et al* (2020) *The influence of Pain, agitation, and their management on the immature brain.* Pediatric research. 88. P168-175.

67. Guillot, M. Chau, V. Lemyre, B. (2020) *Routine Imaging of the preterm Neonatal brain.* Paediatrics& Child Health. 25 (4)P249-255.

68. Hand, L. *et al.* (2020) *Routine Neuroimaging of the preterm brain.* American Academy of Pediatrics. 146(5)

69. NICE (2021) NG195. *Neonatal Infection: antibiotics for prevention and treatment.* Available at: Overview | Neonatal infection: antibiotics for prevention and treatment | Guidance | NICE

70. Kim, F. *et al.* (2020) *Neonatal Sepsis.* BMJ. 371:m3672

71. Roggero, P. *et al.* (2020) *New Insights in preterm Nutrition.* Nutrients. 12. 1857. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7353182/pdf/nutrients-12-01857.pdf

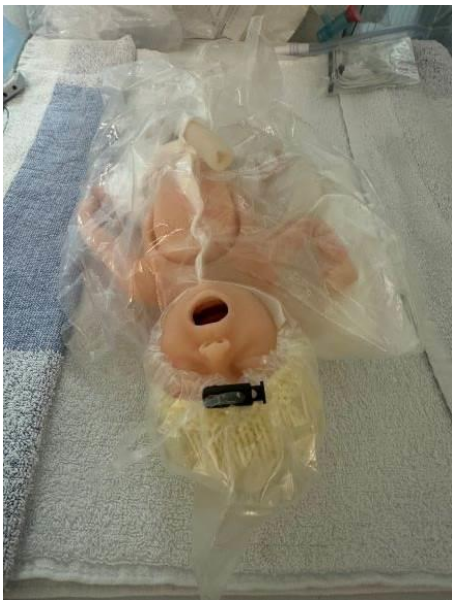
72. Cormack, B. *et al.* (2019) *The influence of early nutrition on brain growth and neurodevelopment in Extremely preterm babies: A narrative review.* Nutirents. 11. 2029. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6770288/pdf/nutrients-11-02029.pdf

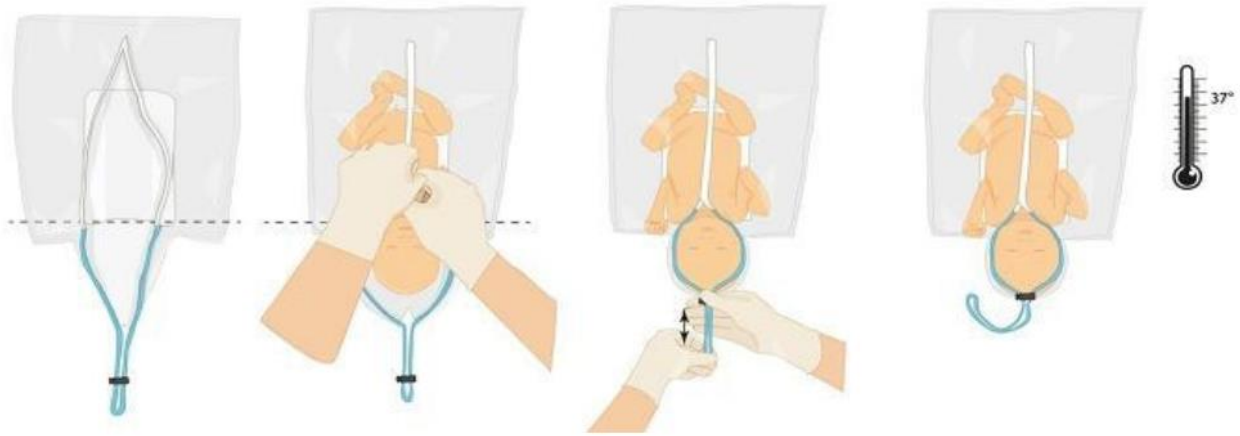
73. World Health Organization. (2020) Protecting, promoting and supporting breast feeding. *The baby friendly hospital initiative for small, sick and preterm newborns.* Available at: https://iris.who.int/bitstream/handle/10665/333686/9789240005648-eng.pdf?sequence=1

74. Nava, C *et al.* (2024) *Preterm nutrition and brain development.* BMJ Nutrition, prevention & health. 0:e000749

Appendix 1
Neohelp bag

Pictures from Sylvia Lemos Sampaio, Luton and Dunstable Hospital (2024)





Sammut, A. *et al.* (2021) IVH prevention bundle protecting preterm brains. UCLH guideline. Kindly shared with the East of England.

Appendix 2
Expected range of capability for maternity and neonatal staff groups.

Capability	Basic	Standard	Intermediate	Advanced	Specialist
Staff Type	Can provide effective airway support and ventilation via facemask or LM for babies ≥ 34 weeks with #normal anatomy.	Effective airway and ventilatory management for preterm and term infants using a wide range of airway adjuncts and non-invasive respiratory support. Has limited or no intubation experience.	As for standard capability and can intubate the trachea under optimal conditions but not able to consistently intubate in urgent/emergency settings and/or across all gestations.	As for standard capability and can consistently intubate most babies with normal anatomy including extreme preterm infants.	As for advanced capability and can intubate or manage the neonatal airway in most situations including those presenting with a difficult airway.
Midwifery Staff					
Neonatal Special Care nurses					
Neonatal ICU/HDU nursing staff					
Tier 1 medical staff e.g. ST1-3, FY1-3, GP Trainees, ENNPs					
Neonatal Transport nursing staff					
Tier 2 trainee ST3-4 (not neonatal SPIN or GRID)					
Tier 2 trainee ST5-7 (not neonatal or paediatric critical care SPIN or GRID)					
Junior ANNPs <3 years' NICU experience					
SCU Consultant					
ST 5-6 (neonatal SPIN or GRID) or equivalent					
LNU consultant					
Senior ANNPs >3years in NICU					
ST7 (neonatal SPIN or GRID) or equivalent/ Neonatal Transport Doctor/ANNP					
NICU Consultant					

Green= expected minimum capability level (for trainees, expected minimum by end of training level).
Grey shading: likely range of capabilities.

Appendix 3
Delivery room cuddle

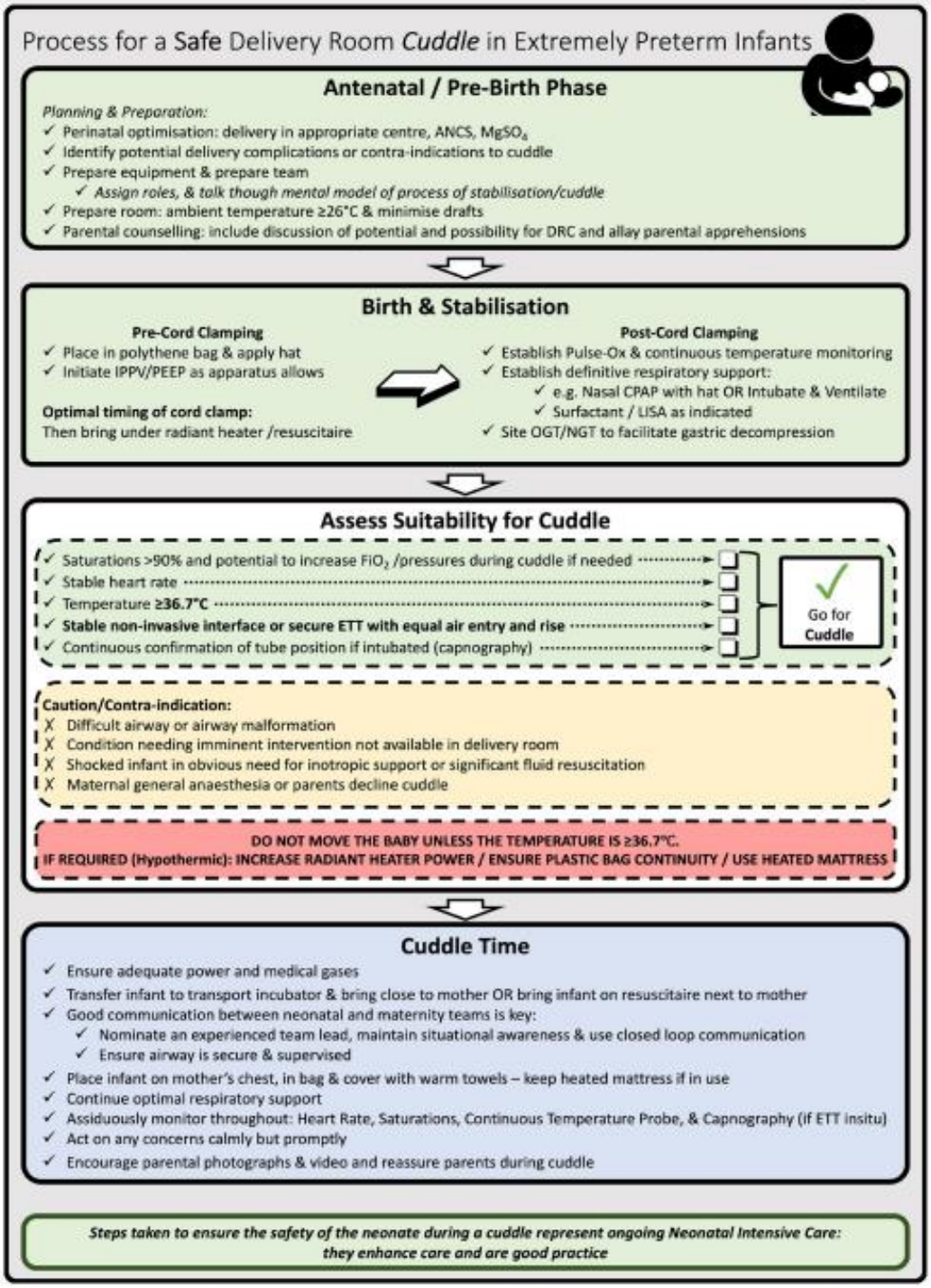
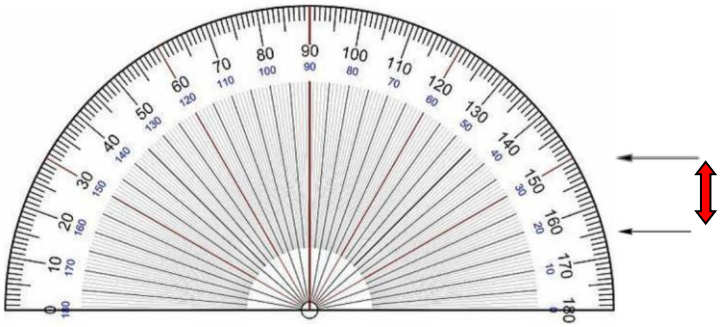


FIGURE 3 Process for a safe Delivery Room Cuddle in extremely preterm infants. ANCS, Antenatal Corticosteroids; CPAP, Continuous Positive Airway Pressure; ETT, Endotracheal Tube; FiO_2, Fraction of Inspired Oxygen; IPPV, Intermittent Positive Pressure Ventilation; LISA, Less Invasive Surfactant Administration; $MgSO_4$, Magnesium Sulphate; OGT/NGT, Oro-Naso-Gastric Tube; PEEP, Positive End-Expiratory Pressure; Pulse-Ox, Pulse-Oximeter Saturations & Heart Rate

Appendix 4
Positioning and Handling
Pictures from:
Yong, J *et al.* (2023) A clinical care bundle to reduce the risk of intraventricular haemorrhage (IVH) in all preterm babies ≤ 28weeks gestation on the neonatal unit. Shared Learning event. Available at: https://www.healthinnovationoxford.org/wp-content/uploads/2024/05/Jean-Yong-IVH-clinical-care-bundle-OxAHSN-shared-learning-event-1.pdf

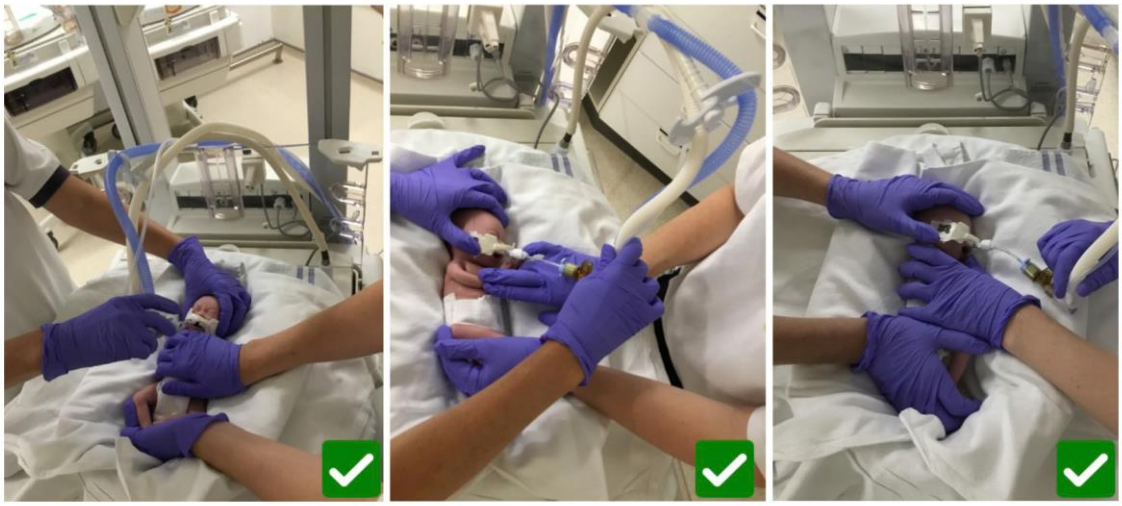
Keep Head of incubator elevated between 15^0 and 30^0, unless necessary for a procedure.



Nurse with head, neck and trunk in line with each other and shoulders in line with hips.

Head rotation to either side may lead to complete occlusion or obstruction of the jugular venous-drainage system of the same side[6] and this should be avoided

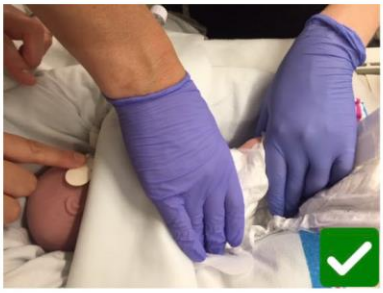
A parent + staff member is the optimum situation to change a baby's position, or 2 staff members if a parent is not present. Turn baby slowly and steadily. Turn a maximum of 90^0 at a time.



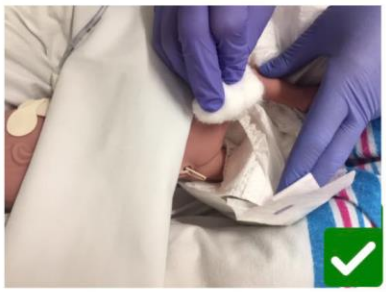
Avoid turning a baby 180 degrees in one movement. Only change sheets if really necessary- prioritise a safe head over a tidy bed.

Nappy Changes

Legs should not be lifted above their head. To carry out nappy changes, flex legs into chest and slide nappy under bottom. Consider side lying nappy changes.



Tuck clean nappy outside dirty nappy



Undo dirty nappy and clean baby

Remove dirty nappy.
Legs not elevated during whole process.

Legs should not be lifted above their heads

Appendix 5
Skin to Skin

Pictures from
Blackett, K. *et al.* (2022) *Side-lying Kangaroo care: All the benefits whilst still maintaining midline head Positioning.* Arch Dis Child 107,(2) A172

Appendix 6
Positioning comfort scale

		Least Comfortable				Most Comfortable
1.	Aah! Factor	Baby looks uncomfortable (include facial expression and colour) – you feel you want to do something about it!	0	1	2	Baby looks relaxed, comfortable, cosy, content
2.	Head and Trunk	Trunk arched/rotated or twisted **with** a. Head extended **or** b. Chin on chest **or** c. Head flat to side with twisted neck.	0	1	2	Head and trunk in line, with head in midline, or ¾ to side (no twisted neck)
3.	Arms	a. Flaccid or stiff, and stretched out **or** b. "W" position with shoulders retracted (pushed back) **or** c. Twisted, trapped under body or between body and bedding d. Immobilised	0	1	2	**ALL** of the following: a. Shoulders forward, (protracted) b. Arms flexed; relaxed (but not limp) c. Possibly to reach face/mouth with ease.
4.	Hands	a. Fingers splayed **or** b. Hand tightly fisted, **or** c. Immobilised, or restricted by clothing	0	1	2	**One or more** of the following a. Hands relaxed, open or fingers softly folded b. Hands together/clasped c. Touching head, face, mouth, own body d. Holding onto something
5.	Legs and feet	a. Flaccid, with straight or "frog leg" posture (abducted and externally rotated at hips) with feet pointing outward **or** b. Stiff straight legs with toes splayed or curled tight, and/or pushes hard on bedding c. External rotation with feet turned outwards	0	1	2	**In all** positions a. Flexed legs with feet touching each other or resting against other leg **and** b. Able to reach boundary for bracing feet. In prone knees should be tucked under body, feet angled towards each other (not turning out) NOTE: Prone positioning should not be used within the first 72hours
6.	Arousal	a. Agitated/jerky/jittery movements **and/or** b. Fussing or crying; or unable to respond	0	1	2	a. Sleeping restfully or quietly awake b. Minimal or smooth movement.
	Total					(max score =12)

East of England Neonatal ODN
(Hosted by Cambridge University Hospitals)

Exceptional Circumstances Form

Form to be completed in the **exceptional** circumstances that the Trust is not able to follow ODN approved guidelines.

Details of person completing the form:	
Title:	Organisation:
First name:	Email contact address:
Surname:	Telephone contact number:
Title of document to be excepted from:	
Rationale why Trust is unable to adhere to the document:	
Signature of speciality Clinical Lead: Date:	Signature of Trust Nursing / Medical Director: Date:
Hard Copy Received by ODN (date and sign):	Date acknowledgement receipt sent out:

Please email form to: kelly.hart5@nhs.net requesting receipt.

Send hard signed copy to:

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