Early Respiratory Care for VON infants

This is guidance for infant <30 weeks or <1.5Kg delivered at RIE and SJH/Borders

Antenatal
Delivery room respiratory bundle
Early respiratory care from arrival to the NNU until 72 hours
The intubated infant
The infant who has not been intubated but is receiving CPAP
Intubation criteria (from one hour to 72 hours of life)
Thermal control
Early extubation/weaning guidance (GET THEM OFF)
Extubation criteria - infant must meet all of the following and be within first 72 hours of life
Re-intubation criteria following previous extubation
Infants born at 22-25 weeks PMA
Criteria to trial off CPAP/HFNC or step down to HFNC or nasal cannula oxygen (NC)
Criteria to restart CPAP/HFNC (first 72 hours)
Longer term ventilation strategies (>72hours)

Our aim is to:

1. Minimise lung damage and therefore reduce BPD in preterm infants.
2. Aim to avoid intubating infants ≥25 weeks gestation unless they fail a trial on CPAP (see exceptions below) as this appears to decrease the rate of death or bronchopulmonary dysplasia. Ref 10-11,29
3. Extubate early in all infants who were intubated.
4. **Use of a delivery room and respiratory guideline** has been shown to reduce length of ventilation and hospital stay [9]

Antenatal

1. **Organise for deliveries at less than 32 weeks' postmenstrual age (PMA) to take place at a level 3 neonatal unit if the referring team consider that *in utero* transfer is safe for the mother.** The Epicure 2 study showed that risk of death was reduced for infants delivered in centres with a level 3 neonatal unit (OR 0.73, 95% CI 0.59-0.90) and among level 3 services, those with high rates of activity had fewer deaths overall (OR 0.68, 95% CI 0.52-0.89)[1,31].
2. **Give antenatal steroids to women in threatened preterm labour between 24^{+0} and 34^{+6} weeks PMA[31] *.** A Cochrane review of 21 studies (3885 women and 4269 infants) showed that antenatal steroids reduced the risk of death by 31% (95% CI 19-42%), of IVH by 46% (95% CI 31- 67%) and of RDS by 44% (95% CI 31-57%) [2], and this is reflected in RCOG guidance[3]. There are likely to be survival benefits for the neonate born at 23 weeks' gestation who has been exposed to antenatal steroids, so if following discussion with obstetric colleagues and parents, a decision has been made to offer intensive care to a baby born at this gestation then our practice is to counsel in favour of

giving the mother corticosteroids prior to delivery.
*Antenatal steroids are indicated at later gestations for some groups of women for the purpose of reducing risk of neonatal RDS.

3. **Promotion of breast milk expression.** (discussion with parents and midwives). The feeding of maternal breast milk during hospital stay reduces the risk of short and long term morbidities in premature infants, including: enteral feed intolerance; nosocomial infection; necrotizing enterocolitis (NEC); chronic lung disease (CLD); retinopathy of prematurity (ROP); developmental and neuro-cognitive delay; and rehospitalization after NICU discharge [4-6, 46]. Use 'Ready, coming or not' special features form.

Delivery room respiratory bundle:

1. **Preparation**
   a. **Teamwork[15,27,44]** In 2004 the Joint Commission investigated cases of infant death or injury occurring during delivery and found that ineffective communication and teamwork were the most common underlying causes[18]. Neonatal resuscitation, particularly the resuscitation of the VLBW infant, requires careful surveillance, timely identification of complications, and timely and appropriate interventions. Improving team performance and providing consistent care giving practices have been identified as fundamental principles to improve neonatal outcomes through the reduction of errors and improvement in patient safety.[19-26,44] Team membership should include 2 doctors/ANNP (junior and middle grade) familiar with respiratory care pathway and a senior member of nursing staff to support. Consultant should be called for support in infants <29 weeks PMA. Undertake resus pause –use delivery management form, define team roles during resus.
   b. Thermal control
      i. Consider temperature of delivery room, transfer corridors and resuscitation room. Aim for an ambient temperature of 25^0C[9].
      ii. Resuscitaire warmer should be on and the bed preheated to maximal temperature.
   c. **Have surfactant available if newborn is <30 weeks PMA**.

2. **Thermal control** on infant arrival
      i. The newborn should be immediately placed in a plastic bag without drying. This has been shown to improve admission temperature which is predictive of oxygen dependency[7-8, 34].
      ii. On arrival to resuscitaire, replace the metal for a plastic cord clamp, apply a woollen hat and place a temperature probe under the infant [7-11,29,31]. The bag should be drawn up around the infant's neck to maintain a neutro-thermal environment.

iii. Monitor infant's temperature and adjust heater output as required.
iv. Cover infant with warm blankets prior to transfer

3. **Apply pulse oximeter probe**. Start in air with the expectation that oxygen saturation should be 75% by 5 minutes of life and 85% to 95% by 10 minutes. [9 &13, 42] If saturation is below 40% before 5 minutes of age or the infant is not achieving the expected saturation, consider increasing oxygen slowly by titrating in steps of 5 to 10% as appropriate.

4. **Transition**-We aim to allow all infants to transition until spontaneously breathing and maintaining heart rate within normal limits for around 10 minutes. This may include supporting the infant with neopuff PEEP +/- IPPV (start with a low positive inspired pressure [PIP] of 25cmH_2O) via appropriate size face mask (see appendix 1 for sizing info) before making a decision to intubate. [10-11,31,41,45] Avoid intubation during this time unless it is felt the infant requires immediate intubation for a low HR (<60 b/min) not responding to incremental increases in pressure up to 30/5 cmH_2O (Consider intubation rather than increasing pressures above 26 cm H_2O in more immature infants, occasionally pressures higher than 30 are required but this is unusual), [ensure you have a patent airway, wean pressure as soon as there is chest wall movement /HR improvement] and use standard basic life support. Immediate intubation may also indicated in significantly compromised infant (pale, no spont movement and no resp effort, or where the infants is not slowly improving during the later transition period). Use a Peep of 5-6, not higher. NB's Argyl prongs will be available as they are sometimes useful in babies with difficult airways, Pierre Robin etc.

5. Subsequent intubation decision should be based on gestation cut off, infant's condition or need for transfer:
    a. Infants < 25 weeks PMA would generally be intubated electively without sedation.
    b. In infants ≥ 25 weeks PMA aim to avoid intubation unless the infant is felt to fit intubation criteria (see below).
    c. Need for transfer. SJH/Borders suggestion would be to attempt to transition all infants but electively intubate infants less than 29 weeks PMA.
    d. Some infants can be extubated very soon after surfactant treatment if they are vigorous and response to treatment is good. There is no set required duration of ventilation for infants' ≥ 25 weeks and extubation is at the discretion of attending Consultant.

6. Criteria for intubation in delivery room on clinical grounds:
    a. Poor respiratory effort following transition period leading to continued low oxygen saturation or HR.
    b. Significant work of breathing (WOB) following transitional period

c. FiO_2 >0.8 to achieve oxygen saturation as outlined previously (at discretion of attending consultant) [9,12-13]

7. Intubate infant and secure ETT using standard fixation techniques. Apply Pedi-cap. Ensure ETT tip is at the correct position according to gestation/weight (use the ETT length for gestation chart). Ensure endotrachael tube (ETT) and surfactant delivery equipment are kept clean.

8. Use of minimally invasive techniques for infants requiring intubation is optional at the discretion of the attending consultant [11, 14,16,31] but in general infants < 25 weeks PMA need longer term ventilation.

9. If ventilated with any significant oxygen requirement give surfactant in the delivery room, aim to administer surfactant within 20 minutes of delivery [31].

10. Surfactant administration guide:
    a. This is a 2 person technique to optimise administration and avoid contamination of equipment.
    b. Ensure that the ETT tip is at the correct position according to gestation/weight (use the ETT length for gestation chart).
    c. Draw up surfactant dose according to the monograph.
    d. Position the infant lying flat with neither chest side higher than the other. Have the infant's head in neutral position.
    e. Administer surfactant giving cricoid pressure during and after the procedure to avoid surfactant leaking from around tube.
    f. With larger volumes of surfactant in smaller infants, watch for surfactant filling the ETT – if this happens consider giving surfactant in 2 aliquots.
    g. Give 5 inflation breaths after surfactant administration maintain cricoid pressure.

11. After intubation and or surfactant administration, wean the PIP, F_iO_2 and rate to the minimum needed to keep infant saturated for transfer e.g. pressures 18-20/5 cmH_2O, and rate 30 breaths/minute.

12. Telephone the NNU to prepare admission space according to infant's needs. Transfer to the NNU on CPAP and nurse prone.

Early respiratory care from arrival to the NNU until 72 hours
Follow appropriate section: ventilated or non-ventilated on CPAP (no previous surfactant)

Ventilated

1. Plug in the resuscitaire and turn the heat back on if there is any delay in moving the infant into the incubator.
2. Administer further doses of surfactant or first dose if it has not been given in the delivery room and the infant has or develops a sustained significant oxygen requirement (FiO_2 >0.25-0.30, OR pressures >22/5

cmH_2O to achieve reasonable saturations-discuss with attending consultant). Consider CXR to confirm ET tip position first if any doubt.

3. Use SIMV [35] and targeted tidal volume ventilation [36, 37] as standard mode of ventilation. Standard settings include: Ti 0.3-0.35 seconds, targeted tidal volume (VT) to 5ml/kg, rate 30-40 breaths/minute, maximum pressure to 26-28 (a required pressure of more than 20-24 cmH_2O to achieve this target tidal volume should prompt review) and FiO_2 titrated to oxygen saturation within acceptable levels.
4. Administer loading dose of Caffeine to promote early extubation.
5. Maintain PCO_2 >4 kPa.
6. Obtain a blood gas (venous or capillary) within 30 minutes of admission, and repeat within 30-60 minutes after ventilation change where PCO_2 is <4 kPa.
7. Place a naso-gastric tube.
8. If giving additional oxygen, aim to obtain CXR early (<1 hour after admission) for diagnostic purposes and to confirm ETT tip is in the correct position (T 2-3, with 0.5cm from carina). CXR may be delayed in stable infants to reduce handling and radiation exposure if UVC and or UAC placement(s) are planned.
9. Document ETT size and length in Badger notes.
10. Avoid fluid overload:
    a. apply fluid management strategies based on fluid balance, electrolytes, weight and signs of fluid overload [30]
    b. avoid fluid boluses to control fluid balance, blood pressure (BP) or base excess [38] There is little evidence that fluid boluses in infants with low BP, in absence of other signs of poor perfusion, are associated better outcomes.

Non ventilated on CPAP (no previous surfactant)

1. Plug in the resuscitaire and turn the heat back on if there is any delay in moving the infant into the incubator. Measure infants OFC prior to placing CPAP hat on.
2. Minimise time break in CPAP pressure during transfer into incubator:
    a. Select and apply the correct CPAP hat and ECG electrodes before moving the infant from the resuscitaire.
    b. Weight the infant on ‘external’ scales.
4. Use Non-invasive Respiratory Support Nursing Guidance.
5. Nurse prone at all times from arrival incubator (unless UAC/UVC being sited, but once sited should be nursed prone-tilted).
6. Maintain PEEP 5-6 cmH_2O at all times; consider applying a chin strap to reduce air leak via the mouth.
7. Use mask CPAP rather than prongs.
8. Use of high flow nasal cannula (HFNC) ventilation in the more mature infants is at the discretion of the attending consultant.
9. OG tube in place
10. Insert a single peripheral intravenous line (IV).
11. Minimal handling-avoid CXR unless specific clinical concern e.g. after intubation or concern about alternative pathologies e.g. pneumothorax. Infants who are transferred to the neonatal unit in high oxygen levels to achieve target saturations of 90-95% should ideally be left for 30-60

mins with minimal handling (after nursing and medical admission procedures) to see if this will come down spontaneously.

12. Administer loading dose of Caffeine within one hour.
13. It is not routine to place a UVC unless the infant is intubated and less than 26 weeks gestation. Consider deferring UVC/UAC placement for the first 24 hours to allow prone lying until risk of RDS is reduced.
14. Take blood sample from IV line for gas analysis; if the result is not within acceptable limits, carry out capillary blood gas sampling.
15. Use intubation criteria (see below) and give rescue surfactant if appropriate
    a. Some infants can be extubated very soon after surfactant treatment if they are vigorous and response to treatment is good. There is no set required duration of ventilation for infants' ≥ 25 weeks and extubation is at the discretion of attending consultant. [14,16,31]
    b. Use of minimally invasive techniques for infants requiring intubation is optional at the discretion of the attending consultant [11, 14,16,31] but in general infants < 25 weeks PMA need longer term ventilation.
16. Avoid fluid overload:
    a. apply fluid management strategies based on fluid balance, electrolytes, weight and signs of fluid overload [30]
    b. avoid fluid boluses to control fluid balance, blood pressure (BP) or base excess [38] There is little evidence that fluid boluses in infants with low BP, in absence of other signs of poor perfusion, are associated better outcomes.

Intubation criteria (from ~1hour to 72 hours of life)

1. FiO_2 >0.35-0.40 (levels above 0.30 should prompt consultant discussion) but <0.5 for greater than 60 minutes to achieve target saturations of 90-95%[12,28,29,31]
2. FiO_2 > 0.5 at anytime
3. $PaCO_2$ >9-10 kPa more than once trending up
4. Persistent metabolic acidosis with pH <7.1
5. Recurrent apnoea (requiring intervention)
6. Consider WOB, oxygen saturation and respiratory rate trend

Thermal control

1. Leave the infant in the plastic bag.
2. Take axillary 'admission' temperature and document result in Badger notes.
3. Place toe and core temperature probes on the infant; monitor and adjust incubator temperature to maintain a neutro-thermal environment.
4. Avoid breaking into plastic bag until minimal handling required and infant is stable.

Early extubation/weaning guidance (GET THEM OFF)

1. Aim to extubate all infants within 4 hours of intubation and once they have met the extubation criteria (see below)[14]
    a. Give further doses of surfactant early where FiO_2 remains >0.3.

b. Actively wean from ventilator by reducing rate by 5-10 breaths/minute every 30 minutes. Blood gas sampling is not required unless FiO_2 increases.

2. Extubate as soon as extubation criteria are met.
3. Use Non-invasive Respiratory Support Nursing Guidance.

Extubation criteria - infant must meet all of the following in first 72 hours of life:

1. Infant is:
    a. PMA > 24+6 weeks
    b. spontaneously breathing over the ventilator
2. Ventilator support includes:
    a. FiO_2 < 0.3 (if not in air, consider whether a further dose of surfactant would be beneficial)
    b. mean airway pressure is <8 cmH_2O
    c. PIP is < 22 cmH_2O
    d. rate ≤ 30 breaths/minute

Re-intubation criteria following previous extubation

1. An acute unexpected deterioration causing significant cardio-respiratory compromise, and where the infant is not stabilised with standard measures.
2. Any other concerns that an infant may require intubation should be discussed with a consultant, these may include:
    a. Increasing oxygen requirement (with no specific oxygen cut off).
    b. Recurrent desaturation requiring IPPV to recover
    c. Persistent acidosis with pH <7.1, resistant to intervention.
3. Consider WOB, oxygen saturation and respiratory rate trend

Infants born at 22-24+6 weeks PMA

1. Not for extubation before 72 hours of life, assess extubation criteria once the risk of IVH has passed (after 72 hours of life).

Infants on Non-invasive ventilation who have previously received surfactant

1. Further CXR not routine unless specific clinical concern
2. Nurse prone/OG tube in place
3. Minimal handling
4. Use Non-invasive Respiratory Support Nursing Guidance
5. Use of mask CPAP rather than prongs
6. Maintain PEEP 5-6 cmH_2O at all times; consider applying a chin strap to reduce air leak via the mouth.
7. Consider higher Peep 7-9 cmH_2O in infants who have already received surfactant.
8. Use of high flow nasal cannula (HFNC) ventilation in the more mature infants is at the discretion of the attending consultant.
9. A trial of BiPAP or nasal intermittent positive pressure ventilation (NIPPV) can be considered in an attempt to reduce the risk of extubation failure at consultant discression (this may not offer any

significant long-term advantages[31])-in general a trial of increased CPAP pressure would precede this see 4c above.

10. Use intubation criteria and give rescue surfactant if appropriate, use fentanyl/suxamethonium pack if requires intubation when available

Criteria to trial off CPAP/HFNC or change to HFNC or nasal cannula oxygen (NC) (first 72 hours)

Eligible infants include those with (at consultant discretion):

1. oxygen saturation within acceptable limits in room air (low oxygen <25 %)
2. no increased work of breathing or raised RR.
3. no apnoea or bradycardia at rest or on handling

Criteria to restart CPAP/HFNC (first 72 hours)

1. FiO_2 >0.25-0.30 (consultant discretion) –clear increased oxygen requirement
2. increased work of breathing
    a. Respiratory rate consistently >60 breaths/minute
    b. Increased frequency of apnoea and bradycardia

Longer term ventilation strategies (>72hours)

1. Use triggered targeted tidal volume (TTV) mode of ventilation and moderate rates 20-40 breaths/minute [31,35]. TTV automatically weans inspiratory pressure as lungs become less stiff (lung compliance improves).
2. Otherwise monitor tidal volume closely (aiming for 5ml/kg) to avoid volutrauma, over ventilation and or atelectasis. In general wean pressures before rate as pressure is more likely to damage lungs than a high rate. Wean pressure as tidal volume allows on a regular basis.
3. Target blood gas values to achieve pH ideally above 7.2 but above 7.1 may be acceptable where there is a mixed acidosis.
4. Accept permissive hypercapnia but avoid a pH <7.1; otherwise allow PCO_2 to slowly climb over first few weeks of life[47].
5. Ventilation rates are usually started relatively fast with short inspiratory times (Ti) 0.35-0.4 seconds. When infants have established bronchopulmonary a longer Ti (0.5-0.6 seconds) may be tolerated better and should be used with slower rate 30-40 breaths/minute to avoid breath stacking.
6. Elevate head of incubator/cot as per ventilator associated pneumonia (VAP) prevention guidelines
7. Continue to use Caffeine as per guideline[31]
8. Consider extubation daily on ward rounds; this should be consultant decision, there are no exact extubation criteria that predict success but some indicators of extubation success include:
    a. Stable FiO_2 - the lower the better
    b. Low ventilation pressures to achieve normal VT's.
    c. Breathing over and above a low ventilator rate to achieve normal or near normal gas exchange.
9. A trial of BiPAP or nasal intermittent positive pressure ventilation (NIPPV) can be considered in an attempt to reduce the risk of

extubation failure at consultant discretion (this may not offer any significant long-term advantages[31])-in general a trial of increased CPAP pressure would precede.

10. Use Re-intubation criteria following previous extubation (Above)
11. Avoid fluid overload:
    a. Apply fluid management strategies based on fluid balance, electrolytes, weight and signs of fluid overload [30]
    b. Avoid fluid boluses to control fluid balance, BP or base excess [38] There is little evidence that fluid boluses in infants with low BP, in absence of other signs of poor perfusion, are associated better outcomes
12. Ensure optimal milk/energy intake:
    a. Promote breast milk expression (discussion with parents and midwives)
    b. Consider breast milk fortification as per guideline
13. Consider drug therapy:
    a. Azithromycin/clarithromycin where evidence of ureaplasma or mycoplasma and evidence of significant on going lung disease [32].
    b. Diuretics (in general) after 2-3 weeks of mechanical ventilation[33, 40]. In infants with a significant oxygen requirement. Assess response after 72 hours.
    c. A short tapering course of low or very low dose dexamethasone to facilitate extubation in babies who remain on mechanical ventilation after 2-4 weeks [31,39], generally after a trial of diuretics and multiple previous extubation attempts.

Research required

Azithromycin prophylaxis
Humidified gas delivery room
High flow delivery room
Pressure support mode ventilator
Transition
Surfactant with steroid
Minimally invasive techniques
Nursing prone in delivery room.
Fluid management daily weight goals
Oral betamethasone/hydrocortisone/sidenafil.

Audit:

Outcome

Rates of BPD

- BPD at 36 weeks – Test ?
- Or in oxygen or with Resp support to maintain our current sats
- NICHD defs /local unit measure
- Term oxygen
- Home oxygen

Nasal trauma

VAP
Pneumothorax
Length of ventilation
Length respiratory support
Length of hospital stay
Rates of hospital acquired pneumonia (see James Bundle to avoid this)
Failed extubations
Need for medical/surgical PDA treatment
Number of episodes of PCO_2 <4
Number of episodes of PCO_2 >14
Use of diuretics for respiratory disease
Postnatal steroids for respiratory disease
IVH
Death
CP

Process
Rate of delivery room intubations
Intubated in first 72 hours
Was extubation attempted in first 72 hours
Length of time before admission
Timing of curosurf

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See
J:\Respiratory Bundle

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Appendix 1- ET tube sizes, Laerdal and Fisher and Paykel Mask sizes

50th Centile weight by gestation		Tube diameter and length at the lip		Laerdal mask size	Fisher and Paykel mask size
Gestation (weeks)	Body wt (kg)	Diameter (mm)	Length at the lip (cm)		
23-24	0.5	2.5	6	00	35 mm
26	0.75	2.5	6.5	00	35 mm
27	1.0	2.5	7	00	42 mm
30	1.5	2.5	7.5	00	42 mm
33	2.0	2.5-3.0	8	00 or 0/1	42 mm
35	2.5	3.0	8.5	0/1	50 mm
37	3.0	3.0-3.5	9	0/1	50 mm
40	3.5	3.5	9.5	0/1	50 or 60 mm
	4.0	3.5-4.0	10	0/1	50 or 60 mm

Appendix 2:
See: Delivery Room Management Checklist document

Appendix 3:
Early respiratory care from arrival to the NNU until 72 hours doc