Ventilatory Management of the Preterm Infant

**NB: High-frequency ventilation is in a separate guideline**

This guideline aims to guide you through an appropriate order of actions for the first two hours of a very preterm baby's life. There are several fundamental principles:

1. To keep the baby appropriately oxygenated and ventilated. Taking particular care to avoid hypoxia or over-ventilation.
2. To keep the baby warm.
3. To maintain normal blood glucose.
4. To establish if the baby has HMD and administer surfactant within 2 hrs of birth.

**Resuscitation**

- There are size 00 (very small) fibre-optic laryngoscopes in the bottom drawer of the resuscitation trolley on JSN. Take one with you if you are expecting a very small baby.
- If the baby is breathing well try to help lung inflation with 5cmsH2O of face mask CPAP.
- Otherwise the less mature and the smaller the baby, the lower should be your threshold for intubating the baby.
- If you are confident at nasal intubation try to place a nasal tube immediately. If not or this proves difficult, dont persist, go for an oral tube.
- Try to inflate the lungs gently, particularly in babies born before 29 weeks. As long as the heart rate is OK, it does not matter if it takes a minute or two to pink the baby up.
- Tape the tube in place at the length shown in the Endo-tracheal tube length chart and place the baby on the ventilator built into the Air-Shields resuscitaire with settings as shown below, then reduce the FiO2 making sure the baby remains pink.

**USE AND TRANSFER BABIES ON AIR SHIELDS RESUSCITAIRE! MAKE SURE TURN DOWN THE HEATER POWER TO 60% AND YOU COVER THE BASE WITH GLAD-WRAP BEFORE MOVING THE BABY TO NICU.**

**Conventional ventilation**

Draeger Babylog 8000 will be used in synchronised intermittent mandatory ventilation (SIMV) or synchronised intermittent positive pressure ventilation (SIPPV) synchronized mode paying particular attention to optimising tidal volume and inspiratory times using the respiratory function monitoring.

**Definitions:**
- **SIMV:** The ventilator delivers a set number of breaths per minute with each breath synchronised with one of the baby's respirations.
- **SIPPV:** The ventilator delivers a breath synchronised with every breath that the baby makes. The operator sets in a minimum number of breaths per minute (the backup rate).

Current evidence suggests using synchronised ventilation during the acute period results in shorter ventilation times.\(^1\), \(^2\) While there is trend to shorter weaning times by reducing pressure, as in SIPPV, as opposed to weaning rate, as in SIMV,\(^2\), \(^3\) the latter is more in keeping with our traditional weaning method on this nursery. So in the acute period SIPPV will be used, SIMV will be used during weaning.

**Initial stabilisation settings:** Assessing the settings when first placing a baby on a ventilator can be difficult and requires some experience. Clues as to the severity of the lung disease can be derived from how quickly the baby responded to resuscitation particularly the pressures needed for the baby to pink up and, once pink, the pressure needed to achieve chest movement. Once in the NICU, a saturation monitor should be placed immediately and then settings adjusted according to the oxygen needed to maintain 90-95% saturation.

- **Initial settings, minimal lung disease** (FiO2<0.3, good chest movement or tidal volumes).
PIP = 20 cmH$_2$O
- PEEP = 5 cmH$_2$O
- Inspiratory time = 0.3 sec
- Backup rate = 40 bpm

- **Initial settings, significant lung disease (FiO$_2$>0.3, poor chest movement or tidal volumes).**
  - PIP = 25 cmH$_2$O
  - PEEP = 5 cmH$_2$O
  - Inspiratory time = 0.3 sec
  - Backup rate = 60 bpm

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**Stabilisation adjustments**

Tidal Volumes, aim for 4mls/kg with pCO$_2$ between 40-50 mmHg:

Early attention to tidal volumes is important. Aim for the lowest tidal volume consistent with adequate ventilation. Adjust PIP to achieve desired volumes also paying attention to the minute ventilations (normal range 200-300 mls/kg/min). As soon as arterial access is available check the pCO$_2$ to monitor appropriateness of settings, aim for 40-50 mmHg.

In babies with very stiff lungs, higher pressure may not increase tidal volume. This can be diagnosed by beaking on the pressure volume loop. In this case, reduce PIP to eliminate the beak and increase rate to improve ventilation.

![Beaking: Extra PIP has not improved tidal volume.](image)

Inspiratory/ Expiratory time: The time needed to maximally inflate a premature infant's lungs is often very short, <0.3 sec. The flow waveform should be used to optimise the inspiratory time. Also ensure there is adequate time for complete expiration i.e. the flow returns to baseline.
Oxygenation, aim for 90-95% saturation, \( \text{paO}_2 \) 50-80 mmHg: this is mainly controlled by FiO2, but if the FiO2 starts to increase above 0.3 despite adequate ventilation this can signify inadequate volume recruitment which may be helped by increasing the PEEP to 6 cmH2O.

**Surfactant.** The aim should be to deliver surfactant (Survanta 4mls/kg) as early as possible to babies with evidence of surfactant deficient lung disease. This should be based on:

- Results of the click test if available.
- Ventilatory evidence of significant lung disease, FiO2>0.25 and PIP³ 20 cmH2O or MAP³ 7 cmH2O.
- If uncertain on the basis of the above 2 criteria, the radiological changes of HMD.

### Sedation and muscle relaxation

- Morphine at 20 micrograms/kg/hr should be used routinely during the acute phase of ventilation unless it looks as thought the baby might come off the ventilator quickly.
- Titrate the dose to the baby's response, reduce if baby is very unresponsive or doing little triggering of the ventilator, increase in steps up to 40 micrograms/kg/hr if activity is making management difficult.
- If still not working replace morphine with midazolam (1 microgram/kg/min). There is no reason to use both.
- Aim to stop sedation at the point that the baby is changed to SIMV for weaning see below.
- Only use muscle relaxation (pancuronium 100 micrograms/kg pm) in babies whose respiratory status cannot be managed with the above sedation guideline.

### Weaning

- While in SIPPV this is done initially by dropping PIP then by dropping the backup rate.
- In very small babies (<27 weeks) who are unlikely to extubate early, it is may be prudent to leave them on SIPPV.
- Otherwise, once PIP is less than 15 cmH2O and backup rate is less than 30 bpm, change to SIMV and wean further on rate.

### Methyl-xanthines prior to extubation
There is good evidence that prophylactic caffeine or theophylline will increase the chance of successful extubation. 

Therefore babies born before 30 weeks gestation should be loaded with a methyl-xanthine. At the time of writing this should be as part of the Caffeine trial unless consent is refused when Theophylline should be used.

Extubation

Use of nasal CPAP increases the likelihood of maintaining successful extubation. The smaller the baby the greater the indication for post-extubation nasal CPAP.

- Extubate to CPAP, when the baby has been stable for at least 12 hours on SIMV rate of 10 with an FiO₂ < 0.25.
- Babies < 29 weeks or < 1250 grams (ie likely to need long term CPAP) put immediately onto the EME CPAP flow driver.
- Babies born after 28 weeks and unlikely to need long term CPAP either extubate to CPAP through the ventilator until it is clear that the baby will have a longer term need for CPAP (ie >24 hours) or extubate to headbox oxygen.

Key Points

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<tr>
<th>Ventilating preterm babies with short inspiratory times (&lt;0.4 sec) and fast rates (&gt;40 bpm) improves outcomes.</th>
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<tr>
<td>Outcomes from synchronised ventilation are as good as non-synchronised.</td>
<td>⭐⭐⭐⭐⭐ 1,2</td>
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<td>Optimise tidal volume to 4 ml/kg, minute ventilation to 200-300 mls/kg and inspiratory time to minimise &quot;no flow&quot; time.</td>
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<td>Extubation from IMV (10 bpm) to nasal CPAP will optimise the chance of success.</td>
<td>⭐⭐⭐⭐⭐ 5,7</td>
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References.

6. OCTAVE Study Group. Multicentre randomised controlled trial of high against low frequency positive


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