VENTILATION: CONVENTIONAL

NICE NG124 recommends that preterm babies having invasive ventilation are given volume-targeted ventilation in combination with synchronised ventilation
***Refer to separate guideline* Ventilation: Volume-targeted**
This guidance is for babies where volume targeted modes cannot be used at the time

INTRODUCTION

Oxygenation

- Increase oxygenation by increasing:
- FiO_2
- peak end expiratory pressure (PEEP)
- peak inspiratory pressure (PIP)
- inspiratory time (T_{insp})

CO_2

- Reduced by:
- increased PIP
- increased rate
- occasionally by reducing excessive PEEP (beware of effect on oxygenation)

VENTILATOR PARAMETERS

PIP

- Use lowest possible PIP to achieve visible chest expansion and adequate gas exchange on blood gas analysis
- to minimise lung injury from barotrauma and inadvertent over-distension, avoid excessive PIP
- need for higher pressures [e.g. mean airway pressure (MAP) >12 cm] could lead to consideration of high frequency oscillatory ventilation (HFOV) [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]

PEEP

- Use a PEEP ≥4 cm and increase incrementally up to 8 cm for improving oxygenation but when PEEP >6 cm necessary, take senior advice

T_{insp}

- Usually between 0.3–0.4 sec
- Avoid T_{insp} >0.5 sec except in term babies with parenchymal lung disease where a T_{insp} up to 1 sec may be used

Rate

- Fast-rate (≥60/min) ventilation is associated with fewer air leaks and less asynchrony compared to slow (20–40/min) rates
- If rate >70/min required, HFOV may be a more appropriate option [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]

Flow

- Flow 5–8 L/min is generally sufficient
- Consider higher flows at faster ventilatory rates or shorter inspiratory times
- SLE ventilator has a fixed flow (5 L/min) that cannot be altered

Tidal volume (V_t)

- **Target is 4–6 mL/kg**
- **Confirm that baby is receiving intended tidal volume before and after adjusting ventilation**

SETTING UP VENTILATOR

- Switch on humidifier and follow manufacturer's recommended settings for optimum temperature and humidity

Setting 1

- When an admission of a preterm baby requiring ventilatory support (for recurrent apnoea, see **Setting 2**)
- rate 60/min
- PIP 16–18 cm H_2O
- PEEP 5 cm H_2O
- T_{insp} 0.3–0.4 sec
- FiO_2 as required
- flow 6–8 L/min (not applicable to SLE)
- Adjust ventilatory settings depending on chest movement, SpO_2, and measured V_t
- Sample blood gas within 30 min of commencing ventilatory support

Setting 2

- For babies with **normal** lungs requiring supportive ventilation such as term babies with respiratory depression (asphyxia or drugs), babies with neuromuscular disorders or, in the post-operative period, and preterm babies with recurrent apnoea, set ventilator at following settings:
- rate 40/min
- PIP/PEEP 14–16/4 cm H_2O
- T_{insp} 0.35–0.4 sec
- FiO_2 as required (often 0.21–0.3)

ADJUSTING VENTILATORY SETTINGS

Adjusting FiO_2

- Oxygen is a drug and should be prescribed as with other medications. This should be done by specifying intended target range of SpO_2 on baby's drug chart
- Suggested target SpO_2 ranges (see **Oxygen saturation targets** guideline)
- preterm babies: 91–95%
- term babies: generally 96–100% but adjust according to the pathology (see **Pulmonary hypertension** and **Congenital heart disease: duct-dependent lesions** guidelines)

Target pCO_2

- Day 1–3: 4.5–8.5 kPa
- Day 4 onwards: 4.5–10 kPa provided pH remains >7.22 if allowing for permissive hypercapnia in preterm babies
- Try to avoid pCO_2 <4.7 kPa when ventilated
- If low PCO_2 wean ventilation without delay and recheck within 1 hr of low measurement

Altering ventilatory settings according to blood gases

If blood gases are outside the targets, first check the following:

- **Reliability of blood gas:**
- is the blood gas result reliable?
- has there been a sudden unexpected change from previous blood gas values?
- did sample contain an air bubble?
- was it obtained from a poorly perfused site?
- **Baby's status:**
- is baby's chest moving adequately?
- how is the air entry?
- **Ventilator and tubing**
- is there an air leak? [transilluminate to exclude (see **Transillumination of the chest** guideline)]
- what is the V_t?
- are the measured ventilatory values markedly different to the set ones?

- is there a large (>40%) endotracheal tube (ETT) leak?

Remember to exclude airway problems (blocked/displaced ETT) and air leaks in case of deterioration of blood gases. If available, use Pedicap® or end-tidal CO_2 monitoring to exclude ETT malposition

- Small frequent changes are more appropriate than large infrequent ones

Blood gas scenario	Recommended action *in order of preference*
Low PaO_2/SpO_2	• Exclude air leak/displaced ETT/over-inflation • Increase FiO_2 • Increase PEEP • Increase PIP (but be aware of effect on $PaCO_2$) • Increase T_{insp} [but ensure adequate expiratory time (T_{exp}), especially at fast rates] • Consider further surfactant [see **Surfactant replacement therapy – including less invasive surfactant administration (LISA) technique** guideline] • If above measures unsuccessful, discuss with consultant (may need HFOV/iNO)
High PaO_2	• Decrease FiO_2 (unless already in air) • Decrease PEEP (if >5 cm) • Decrease PIP (especially if $PaCO_2$ is also low)
High $PaCO_2$	• Exclude air leak/displaced or blocked ETT • Increase PIP • Increase rate (if chest not moving well). Do not use rates above 60/min • Decrease PEEP (only if oxygenation adequate and PEEP >6 cm) after taking senior advice
Low $PaCO_2$	• Decrease PIP • Decrease rate
Low PaO_2/SpO_2 and high $PaCO_2$	• Exclude displaced/blocked ETT • Exclude air leak • Increase PIP • Consider further surfactant • If no response, consider HFOV [see **Ventilation: high frequency oscillatory ventilation (HFOV)** guideline]

All ventilator changes must be prescribed and signed for on the intensive care chart

Load all babies ≤30 weeks' gestation with caffeine as early as possible after birth and ideally before aged 3 days. Give maintenance doses thereafter. Do not delay loading until the weaning stage

WEANING

- While weaning baby off ventilator:
- reduce PIP (usually by 1–2 cm) until MAP 7–8 cm reached
- thereafter, reduce rate to 20/min, usually in decrements of 5–10 breaths/min

Extubation

- Extubate babies <30 weeks' gestation onto nasal CPAP or HFNC – for mode, see **Ventilation: Continuous positive airway pressure (CPAP)** or **Ventilation: High-flow nasal cannulae (HFNC)** guideline
- more mature babies with no significant chest recessions can be extubated directly into incubator oxygen

BABIES FIGHTING VENTILATOR

If baby in asynchrony with the ventilator (fighting)

- Ensure baby is not hypoxic or under-ventilated
- Exclude blocked ETT
- Look for obvious pain e.g. necrotising enterocolitis
- If possible, change to synchronised form of ventilation (VTV/HFOV/SIMV)
- If sedation required, ensure it is adequate. Muscle relaxation seldom necessary and used only if IV morphine infusion (usually 10–20 microgram/kg/hr) already commenced

CARE OF VENTILATED BABY

Ventilated babies to have:

- Continuous electronic monitoring of heart rate, ECG, respiratory rate, SpO_2 and temperature
- Transcutaneous monitoring can be useful in preterm infants on invasive ventilation who are clinically unstable. Discuss with consultant
- Blood pressure
  - consider continuous measurement of arterial blood pressure in babies ≤28 weeks' gestation, and those >28 weeks needing FiO_2 >0.6
  - cuff measurement 4-hrly in acute phase where arterial blood pressure not being measured
- 6-hrly blood gas (arterial or capillary) measurement during acute phase of disease
- Hourly measurement of colour, and measured ventilatory parameters. If sudden drop in V_t, check air entry
- Daily monitoring of intake, output and weight
- Do not routinely use morphine for babies on respiratory support
  - if commenced regularly assess baby to ensure it is stopped as soon as possible

PARENT INFORMATION

Offer parents the following information, available from:
https://www.bliss.org.uk/parents/in-hospital/about-neonatal-care/equipment-on-the-unit-1