VENTILATION: HIGH FREQUENCY OSCILLATORY VENTILATION (HFOV) ● 1/3

Decision to initiate HFOV must be made by a consultant. Do not start HFOV unless you have been trained to do so and have demonstrated your competence

INDICATIONS

- Rescue following failure of conventional ventilation (e.g. PPHN, MAS)
- To reduce barotrauma when conventional ventilator settings are high
- Airleak (pneumothorax, PIE)

Less effective in non-homogenous lung disease

TERMINOLOGY

Frequency	High frequency ventilation rate (Hz, cycles/sec)
MAP	Mean airway pressure (cm H_2O)
Amplitude	Delta P or power is the variation around the MAP

MECHANISM

Oxygenation and CO_2 elimination are independent

Oxygenation is dependent on MAP and FiO_2	MAP provides constant distending pressure equivalent to CPAP, inflating the lung to constant and optimal lung volume, maximising area for gas exchange and preventing alveolar collapse in the expiratory phase
Ventilation (CO_2 removal) dependent on amplitude	The wobble superimposed around the MAP achieves alveolar ventilation and CO_2 removal

MANAGEMENT

Preparation for HFOV

- If significant leakage around ETT, insert a larger one
- Optimise blood pressure and perfusion, complete any necessary volume replacement and start inotropes, if necessary, before starting HFOV
- Invasive blood pressure monitoring if possible
- Correct metabolic acidosis
- Ensure adequate sedation
- Muscle relaxants not necessary unless already in use

Initial settings on HFOV

MAP

Optimal (high) lung volume strategy (aim to maximise recruitment of alveoli)	• If changing from conventional ventilation, set MAP 2–4 cm H_2O above MAP on conventional ventilation • If starting immediately on HFOV, start with MAP 8 cm H_2O and increase in 1–2 cm H_2O increments until optimal SpO_2 achieved • Set frequency to 10 Hz
Low volume strategy (aim to minimise lung trauma)	• Set MAP equal to MAP on conventional ventilation • Set frequency to 10 Hz

- Optimal (high) volume strategy preferred but consider low volume strategy when air leaks present

Amplitude (delta P on SLE ventilator)

- Gradually increase amplitude until chest seen to wobble well
- Obtain early blood gas (within 20 min) and adjust settings as appropriate
- **Change frequency only after discussion with consultant**

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Making adjustments once HFOV established

	Poor oxygenation	Over-oxygenation	Under-ventilation	Over-ventilation
Either	Adjust MAP (+/- 1–2 cm H_2O)*	Decrease MAP (1–2 cm H_2O) when FiO_2 <0.4	Increase amplitude	Decrease amplitude
Or	Increase FiO_2	Decrease FiO_2		

* both over and under-inflation can result in hypoxia. If in doubt, perform chest X-ray

MONITORING

- Amplitude maximal when chest 'wobbling', minimal when movement imperceptible
- Frequent blood gas monitoring (every 30–60 min) in early stages of treatment as PaO_2 and $PaCO_2$ can change rapidly
- If available, transcutaneous $TcPCO_2$
- CO_2 diffusion coefficient (DCO_2)
  - indicator of CO_2 elimination which correlates well with $PaCO_2$ for an individual baby
  - calculated as frequency × (tidal volume)^2

Chest X-ray

- Within 1 hr to determine baseline lung volume on HFOV (aim for 8 ribs at midclavicular line)
  - if condition changes acutely and/or daily to assess expansion/ETT position, repeat chest X-ray

TROUBLESHOOTING ON HFOV

Chest wall movement

- Suction indicated for diminished chest wall movement indicating airway or ETT obstruction
- Always use an in-line suction device to maintain PEEP
  - increase FiO_2 following suctioning procedure
  - MAP can be temporarily increased by 2–3 cm H_2O until oxygenation improves

Falling DCO_2

- Suggests rising $PaCO_2$

Low PaO_2

- Suboptimal lung recruitment
  - increase MAP
  - consider chest X-ray
- Over-inflated lung
  - reduce MAP: does oxygenation improve? Check blood pressure
  - consider chest X-ray
- ETT patency
  - check head position and exclude kinks in tube
  - check for chest movement and breath sounds
  - check there is no water in ETT/T-piece
- Air leak/pneumothorax
  - transillumination (see **Transillumination of the chest** guideline)
  - urgent chest X-ray

High $PaCO_2$

- ETT patency and air leaks (as above)
- Increase amplitude, does chest wall movement increase?
- Increased airway resistance (MAS or BPD) or non-homogenous lung disease, is HFOV appropriate?

Persisting acidosis/hypotension

- Over-distension
  - reduce MAP: does oxygenation improve?
- Exclude air leaks; consider chest X-ray

Spontaneous breathing

- Usually not a problem but can indicate suboptimal ventilation (e.g. kinking of ETT, build-up of secretions) or metabolic acidosis

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WEANING

- Reduce FiO_2 to <0.4 before weaning MAP (except when over-inflation evident)
- When chest X-ray shows evidence of over-inflation (>9 ribs), reduce MAP
- Reduce MAP in 1–2 cm decrements to 8–9 cm 1–2 hrly or as tolerated
- If oxygenation lost during weaning, increase MAP by 3–4 cm and begin weaning again more gradually. When MAP is very low, amplitude may need increasing
- In air leak syndromes (using low volume strategy), reducing MAP takes priority over weaning the FiO_2
- Wean the amplitude in small increments (5–15%) depending upon PCO_2

Do not wean the frequency

- When MAP <8 cm H_2O, amplitude 20–25 and blood gases satisfactory, consider switching to conventional ventilation or extubation to CPAP