

VENTILATION HIGH FREQUENCY OSCILLATORY VENTILATION

Supporting information

This guideline has been prepared with reference to the following:

NICE. Specialist neonatal respiratory care for babies born preterm - quality standard (QS193). 2020. London. NICE

<https://www.nice.org.uk/guidance/qs193>

NICE. Specialist neonatal respiratory care for babies born preterm. 2019. London. NICE

<https://www.nice.org.uk/guidance/ng124>

What are the indications for the use of HFOV in term and in preterm infants?

A 2019 review commented that in the neonatal population, HFOV is indicated for patients with neonatal air leak syndrome, persistent pulmonary hypertension and meconium aspiration (Meyers, 2019).

Meyers M, Rodrigues N, Ari A. High-frequency oscillatory ventilation: A narrative review. *Can J Respir Ther.* 2019 May 2;55:40-46

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6591785/>

Evidence Level: IV

Should HFOV be used as a first line treatment or as rescue treatment?

A Cochrane Review (De Paoli, 2009) found no randomised controlled trial data to support the routine use of rescue HFOV in term or near term infants with severe pulmonary disease. Only 2 trials (involving 199 infants) were identified in the review (Clark, 1994 and Rojas, 2005). Neither trial showed evidence of a reduction in mortality at 28 days or in failed therapy on the assigned mode of ventilation requiring cross-over to the other mode. Neither study reported significant differences in the risk of pulmonary air leak, chronic lung disease (28 days or more in oxygen) or intracranial injury. In the study of elective HFOV, there was no difference noted in days on a ventilator or days in hospital. In the one rescue study (Clark, 1994), there was no difference in the risk of needing extracorporeal membrane oxygenation.

Another Cochrane Review by the same team (Bhuta, 1998) found a similar lack of evidence in preterm infants and recommended that “any future use of HFOV as rescue therapy for preterm infants with severe RDS should be within randomized controlled trials and address important outcomes such as longer term pulmonary and neurological function”.

A “BestBETS” report (Shah, 2003) concluded that “HFOV is probably not superior to conventional ventilation as primary mode of ventilation in preterm infants with respiratory distress syndrome for prevention of chronic lung disease or mortality at 36 weeks. However, use of HFOV is safe and not associated with increased risk of intraventricular haemorrhage or airleaks”.

This report included data from two multicentre, randomised trials in 500 infants (Courtney, 2002) and 400 infants (Johnson, 2002) respectively that appeared after the most recent Cochrane update.

A prospective study in 77 infants (Ben Jaballah, 2006) found that HFOV as an early rescue intervention resulted in rapid and sustained decreases in mean airway pressure, F IO₂, OI, and P AO₂ – Pa O₂ (P ≤ 0.01). The authors also identified a need for RCTs to confirm the perceived benefits of HFOV vs conventional ventilation.

Ben Jaballah N, Mnif K, Khaldi A, et al. High-frequency oscillatory ventilation in term and near-term infants with acute respiratory failure: early rescue use. *Am J Perinatol* 2006;23:403-11

De Paoli A, Clark R & Bhuta T. High frequency oscillatory ventilation versus conventional ventilation for infants with severe pulmonary dysfunction born at or near term. *The Cochrane Database of Systematic Reviews* 2009. Art. No.: CD002974

<http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD002974.pub2/full>

Bhuta T, Henderson-Smart DJ. Rescue high frequency oscillatory ventilation vs conventional ventilation for pulmonary dysfunction in preterm infants. *The Cochrane Database of Systematic Reviews* 1998, Issue 2. Art. No.: CD000438

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<http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD000438/full>

Clark RH, Yoder BA, Sell MS. Prospective, randomized comparison of high-frequency oscillation and conventional ventilation in candidates for extracorporeal membrane oxygenation. *J Pediatr* 1994;124:447-54

Courtney SE, Durand DJ, Asselin JM, et al. High-frequency oscillatory ventilation versus conventional mechanical ventilation for very-low-birth-weight infants. *N Engl J Med* 2002;347:643-52
<http://www.nejm.org/doi/full/10.1056/NEJMoa012750#t=articleTop>

Johnson AH, Peacock JL, Greenough A, et al. High-frequency oscillatory ventilation for the prevention of chronic lung disease of prematurity. *N Engl J Med* 2002;347:633-42
<http://www.nejm.org/doi/full/10.1056/NEJMoa020432#t=articleTop>

Rojas MA, Lozano JM, Rojas et al. Randomized, multicentre trial of conventional ventilation versus high-frequency oscillatory ventilation for the early management of respiratory failure in term or near-term infants in Colombia. *Journal of Perinatology* 2005;25:720-4.

Shah S. Is elective high-frequency oscillatory ventilation better than conventional mechanical ventilation in very low-birth-weight-infants?
<http://www.bestbets.org/cgi-bin/bets.pl?record=00586>

Evidence Level: I

What should the starting settings be when commencing HFOV?

Although frequencies between 3-50 Hz may be used during HFOV, 7-15 Hz "is most commonly employed" (Greenough, 1999). 10-20 Hz is also mentioned frequently as producing the best results (Chan, 1993; Hoskyns, 1991; Froese, 1987). New Zealand guidelines (Battin, 2001) recommend 10 Hz as an appropriate starting frequency.

Battin M. Newborn services clinical guidelines: High frequency ventilation (HFV). 2001
<http://www.adhb.govt.nz/newborn/guidelines/respiratory/hfov/hfov.htm>

Chan V, Greenough A. Determinants of oxygenation during high frequency oscillation. *Eur J Pediatr* 1993;152:350-3

Froese AB, Butler PO, Fletcher WA, et al. High-frequency oscillatory ventilation in premature infants with respiratory failure: a preliminary report. *Anesth Analg* 1987;66:814-24

Greenough A, Robertson NR. Acute respiratory disease in the newborn. In: Rennie JM, Robertson NR, eds. *Textbook of neonatology*, 3rd ed. Edinburgh, Churchill Livingstone, 1999. p569

Hoskyns EW, Milner AD, Hopkin IE. Combined conventional ventilation with high frequency oscillation in neonates. *Eur J Pediatr* 1991;150:357-61

Evidence Level: V

Should a high volume strategy be used?

A Cochrane Review (Cools, 2014) concluded: "There is evidence that the use of elective high frequency oscillatory ventilation compared with conventional ventilation results in a small reduction in the risk of chronic lung disease, but the evidence is weakened by the inconsistency of this effect across trials. Probably many factors, both related to the intervention itself as well as to the individual patient, interact in complex ways. In addition, the benefit could be counteracted by an increased risk of acute air leak. Adverse effects on short-term neurological outcomes have been observed in some studies but these effects are not significant overall. Most trials reporting long-term outcome have not identified any difference."

In certain situations (gas trapping, severe lobar emphysema), a low-volume strategy appears to be more appropriate (Greenough, 1999).

Greenough A, Robertson NR. Acute respiratory disease in the newborn. In: Rennie JM, Robertson NR, eds. *Textbook of neonatology*, 3rd ed. Edinburgh, Churchill Livingstone, 1999. p569

Cools F, Offringa M & Askie L. Elective high frequency oscillatory ventilation versus conventional ventilation for acute pulmonary dysfunction in preterm infants. *The Cochrane Database of Systematic Reviews* 2014. Art. No.: CD000104

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<http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD000104.pub4/epdf>

Evidence Level: I

What are the indications for endotracheal suction during HFOV?

No information with which to answer this question has been identified.

How should an infant be weaned from HFOV?

New Zealand guidelines (Battin, 2001) recommend the following:

- Reduce FiO₂ to < 40% before weaning MAP (except when over-inflation is evident)
- Reduce MAP when chest x-ray shows evidence of over-inflation (> 9 ribs)
- Reduce MAP in 1 -2 cm increments to 8-9
- In air leak syndromes (low volume strategy), reducing MAP takes priority over weaning the FiO₂
- Wean the amplitude in 4 cm H₂O increments
- Do not wean the frequency
- Consider switching to conventional ventilation when MAP < 10 cm H₂O, Amplitude 20 - 25 and blood gases satisfactory
- Suction is indicated for diminished chest wall movement indicating airway or ET tube obstruction or if there are visible/audible secretions in the airway
- Avoid in the first 24 hours of HFV, unless clinically indicated
- Avoid hand-bagging during the suctioning procedure: use PEEP protector and continue with patient on the ventilator
- Increase FiO₂ following the suctioning procedure
- MAP may be temporarily increased 2-3 cm H₂O until oxygenation improves

A review (Mehta, 2004) states that "Routine scheduled assessments of readiness for weaning and extubation may be more important than specific weaning modes and weaning criteria."

Battin M. Newborn services clinical guidelines: High frequency ventilation (HFV). 2001

<http://www.adhb.govt.nz/newborn/guidelines/respiratory/hfov/hfov.htm>

Mehta NM, Arnold JH. Mechanical ventilation in children with acute respiratory failure. *Curr Opin Crit Care* 2004;10:7-12

Evidence Level: V

Should an infant be extubated directly from HFOV or weaned to conventional ventilation first?

Weaning to conventional ventilation is common clinical practice (Courtney, 2002), although a technique known as "sprinting" (Seller, 2001) has been used in some difficult cases to achieve extubation directly from HFOV.

An observational study from Italy concluded that direct extubation from HFOV at mean airways pressure ≤ 6 cm H₂O with FiO₂ ≤ 0.25 is feasible (Tana, 2018). One hundred and eight extremely low birth weight infants of 26.2 ± 1.4 weeks of gestational age were directly extubated from HFOV. Ninety patients (83%) were successfully extubated and 18 (17%) required reintubation.

Courtney SE, Durand DJ, Asselin JM, et al. High-frequency oscillatory ventilation versus conventional mechanical ventilation for very-low-birth-weight infants. *N Engl J Med* 2002;347:643-52

<http://www.nejm.org/doi/full/10.1056/NEJMoa012750#t=articleTop>

Seller L, Mullahoo K, Liben S, et al. Weaning to extubation directly from high-frequency oscillatory ventilation in an infant with cystic lung disease and persistent air leak: a strategy for lung protection. *Respir Care* 2001;46:263-6

Tana M, Lio A, Tirone C et al. Extubation from high-frequency oscillatory ventilation in extremely low birth weight infants: a prospective observational study. *BMJ Paediatr Open*. 2018;2:e000350

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6242018/>

Evidence Level: IV

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