APPENDIX VI
HFOV Quick Guide

**Overall goal:** Maintain PH in the target range at the minimum tidal volume. This is achieved by favoring higher frequencies over lower ▲P (amplitude). This goal is also promoted by accepting mild respiratory acidosis rather than attempting to normalize pH.

**Monitor:** Obtain ABG at least 30 minutes after each change in settings. Check ABG BID in patient on stable settings.

**Target PH:** 7.25-7.35
**Target f:** 12 Hz

**Initial settings:**
- f=5Hz
- ▲P=PaCO2 on conventional ventilator + 20

**Subsequent adjustments:**

**PH in target range**
- Increase f and increase ▲P as follows:
  a) Increase f in increments of 1-2 Hzs to max. Of 12 Hz
  b) If PH falls below acceptable range at any f, increase ▲P in increments of 5 cm H2O to max. of 90 cmH2O.

**PH too high (Correct metabolic alkalosis, if indicated)**
- Increase f in increments of 1-2 Hz to max. Of 12 Hz, then
- Decrease ▲P in 5 cmH2O increments to minimum of 20.

**PH too low (Correct metabolic acidosis, if indicated)**
(Consider possible pneumothorax, partial endotracheal tube occlusion derecruitment)
  a) Increase delta P in increments of 5 cmH2O until 90 cmH2O, then
  b) Add 5-cmH2O cuff leak. A 5 cmH2O cuff leak is produced by deflating the endotracheal tube cuff until mPaw falls by 5 cmH2O, then increasing bias flow rate to restore mPaw to initial value.
  c) Decrease f in 1 Hz increments to minimum of 3 Hz.

**Management of Oxygenation**

**Overall goal:** Increase lung recruitment while avoiding overdistension; balance risks of overdistension versus oxygen toxicity. Mean airway pressure (mPaw) is used to recruit lung. Increased mPaw is favored over increased FiO2 unless patients have circulatory failure. Threshold for overdistension is unknown, but it may be more likely at mPaw > 35 cmH2O.

**Monitor:** SpO2 or PaO2; Observe SpO2 changes 5-10 minutes after a change in ventilator settings. Check ABG twice daily.

**Target:** PaO2 55-80 mmHg or SpO2 88-95%; use PaO2 for decisions if only one is out of target range.
Initial settings and adjustment:

- $\text{mPaw} = \text{mPaw on conventional ventilator} + 5 \text{ cmH}_2\text{O}$, but do not exceed $35 \text{ cmH}_2\text{O}$.
- $\text{FiO}_2 = 1.0$
- If oxygenation is below target, increase mPaw in $5 \text{ cmH}_2\text{O}$ increments to maximum of $45 \text{ cmH}_2\text{O}$. Consider recruitment 1-2 maneuvers. A recruitment maneuver consists of stopping oscillator and elevating mPaw to $45 \text{ cmH}_2\text{O}$. Maintain for 40-60 seconds. Monitor closely for hypotension or desaturation. Return to desired settings and restart oscillator.
- If oxygenation is above target, decrease $\text{FiO}_2$ to reach a $\text{FiO}_2$/mPaw combination on scale.

Subsequent adjustments:

**Oxygenation in target range**
- No change required

**Oxygenation above the target range**
- Decrease down $\text{FiO}_2$/mPaw scale in 1-2 increments

**Oxygenation below target range**
- Increase up $\text{FiO}_2$/mPaw scale in 1-2 step increments
  (Consider recruitment maneuvers)
  (Higher mPaw may depress venous return; assure adequate volume.)
  (At mPaw $> 35$ or $\text{FiO}_2 > 0.9$, consider prone positioning or iNO) scale.

Initial settings and adjustment:

- $\text{mPaw} = \text{mPaw on conventional ventilator} + 5 \text{ cmH}_2\text{O}$, but do not exceed $35 \text{ cmH}_2\text{O}$.
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- If oxygenation is below target, increase mPaw in $5 \text{ cmH}_2\text{O}$ increments to maximum of $45 \text{ cmH}_2\text{O}$. Consider recruitment 1-2 maneuvers. A recruitment maneuver consists of stopping oscillator and elevating mPaw to $45 \text{ cmH}_2\text{O}$. Maintain for 40-60 seconds. Monitor closely for hypotension or desaturation. Return to desired settings and restart oscillator.
- If oxygenation is above target, decrease $\text{FiO}_2$ to reach a $\text{FiO}_2$/mPaw combination on scale.

Subsequent adjustments:

**Oxygenation in target range**
- No change required

**Oxygenation above the target range**
- Decrease down $\text{FiO}_2$/mPaw scale in 1-2 increments
Oxygenation below target range
- Increase up FiO2/mPaw scale in 1-2 step increments
  - Consider recruitment maneuvers
  - Higher mPaw may depress venous return; assure adequate volume
  - At mPaw > 35 or FiO2 > 0.9, consider prone positioning or INO scale

mPaw/FiO2 Scale for HFOV
Adjust FiO2 or mPaw according to the scale to maintain oxygenation in target range.

(for patients without circulatory failure)

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Worsening Arterial Oxygenation →
Improving Arterial Oxygenation ←

- Oxygenation Goals: Oxygen Saturation 88-95% or PaO2 55-80 mmHg
- Circulatory failure = mean arterial pressure < 60 mmHg or vasopressors; note that CVP 15-20 mmHg may be needed to achieve adequate RV filling.

High Frequency Oscillatory Ventilation (HFOV) Policy

Purpose: Respiratory Therapist will be responsible for the set-up and management of the HFOV based on the protocol outlined below as customary practice at the Medical College Of Georgia Health Inc. All patients requiring HFOV will be brought to the attention of the Lead Therapist and they will be responsible for contacting the Intensivist and Attending. Patients will be closely monitored utilizing arterial blood gases, continuous oximetry, blood pressure, chest x-rays and chest wiggle.

Clinical Guidelines: (When to initiate HFOV)
- Patients with severe ARDS who are requiring an Fio2 greater than or equal to 0.6 with a mPaw > 24 may be considered for a trial of HFOV especially if a “lung protective” target Pplat < 30-35cmH20 cannot be maintained.
- Oxygen Index > 13 (100 x FiO2 x Paw/PaO2)
Preparing to initiate HFOV

- Prior to setting up the HFOV, it is imperative that the patient’s airway is suctioned and known to be patent. If bronchoscopy is contemplated it should be done prior to the initiation of the HFOV.
- Narrowing or obstruction of the endotracheal tube with mucus or blood clots may greatly impede the delivery of the oscillatory waveform and make ventilation difficult.
- Adequate titration of sedation, analgesia and neuromuscular blockade should be performed while the patient is still on conventional ventilation.
- The patient’s intravascular volume status should be assessed keeping in mind the higher mPaw that will be used with HFOV and the potential for hypotension secondary to elevated intrathoracic pressures and reduced preload.
- Maintain normal Mean Arterial Pressure (minimum 60 mmhg).

HFOV initial parameters

- FiO2 100%
- Paw 4-8cmH2O above Paw on conventional ventilator (consider initial alveolar recruiting maneuver with 40cmH2O for 40-60 secs if severe hypoxemia exists.)
- Increase Paw 1-2cm. to achieve optimal lung volume. Check CXR for adequate lung expansion with changes.
- Flow rate start 20L/M (only increase flow if Paw is not reached)
- Frequency starts at 5-6 Hz.
- Delta P set power to achieve sufficient chest wiggle or “20+PaCO2”. (pt should wiggle from chest to mid thigh.)
- I Time % 33 % may increase to 50% if difficulty with oxygenation. (this may further raise carinal pressure)
- Only suction on a prn basis for visible airway secretions or if high risk for mucous plugs. DO NOT use an inline suction catheter.

Cautionary Criteria:

- Increased airway resistance
- Elevated ICPs
- Mean Arterial Pressure <65mmhg
- BP fistulas

Adverse Effects:

HFOV, as with conventional positive pressure ventilation, has inherent risks. These possible adverse effects include:

- Under/over ventilation
- Over/under humidification
- Chronic obstructive lung disease
- Necrotizing tracheal bronchitis (NTB)
- Atelectasis
- Hypotension
- Pneumothorax
- Pneumopericardium
- Pneumomediastinum
- Pneumoperitoneum
- Pulmonary interstitial emphysema (PIE)

**Recommended Monitoring Frequency:**
The recommended minimum frequency for monitoring the key pulmonary status parameters is the following.

**Arterial Blood Gases**
- Every 2 hours for 8 hours.
- Every 4 hours for 16 hours.
- Every 8-12 hours depending on institution policy during treatment.
- Within 1 hour after major setting change, or as clinically indicated.

**Chest X-Ray**
- Within 4 hours of start of use
- Every 12 hours next 24 hours
- Every 24 hours for the next 5 days
- Every 48 hours next 8 days
- Every week thereafter
- Whenever lung over inflation is suspected

**Information Prior to Starting HVOF**
- Measure and record C.O., PCWP, SVO2
- CVP -at least 8 mmHg
- A-Line MAP and ABG’s

**Failure Criteria**
- Failure to improve oxygenation (FiO2 decreased by 10 % in 24 hours)
- Failure to improve or maintain adequate ventilation (inability to maintain PCO2 < 80mmHg with pH > 7.25)

**Weaning**
- Wean FiO2 for arterial saturation > 90%
- Once FiO2 is < 60%, may decrease Paw in increments of 2-3cmH2O q4-6 hours until 22-24cmH2O
- Delta-P(Power) is weaned by increments of 5cmH2O for PCO2 < desired goal.
- Once optimal frequency is found in initial set-up, leave frequency the same throughout HFOV run.
- If you encounter problems with CO2 retention at maximum Delta P (Power), decrease frequency to a minimum of 3 Hz.
Parameters for Conversion from HFOV to PCV
- If Fio\textsubscript{2} is 40%, Paw 22-24 cmH\textsubscript{2}O and Delta-P < 40cmH\textsubscript{2}O, patient can cross back over to CMV.
- Switch to PCV- initial settings: peak pressure titrated to achieve delivered TV 6 ml/kg, Pplat<30 35cmH\textsubscript{2}O, I:E 1:1, PEEP 12cmH\textsubscript{2}O, Rate 20-25, mPaw should be 20 cmH\textsubscript{2}O (+/-2 cmH\textsubscript{2}O).

Before returning to CMV
- Set conventional ventilator at settings which approximate those necessary to manually ventilate the patient.
- Set FiO\textsubscript{2} 10% higher than HFOV.

References


2. Froese, Alison P., High-frequency oscillatory ventilation for adult respiratory distress syndrome: let’s get it right this time! Crit. Care Med 1997, 25: 906-908