

**DUKE UNIVERSITY HOSPITAL**  
**DEPARTMENT OF RESPIRATORY CARE SERVICES**

**SUBJECT:** ***HIGH FREQUENCY OSCILLATORY VENTILATION OF THE ADULT PATIENT PROTOCOL***

**MANUAL:** **INTENSIVE CARE**

**EFFECTIVE DATE:** FEBRUARY 24, 2004

**REVISION DATES:**

- I. **PURPOSE:** To provide consistent clinical practice and timely interventions in the management of patients requiring High Frequency Oscillatory Ventilation (HFOV).
- II. **PROVIDER:** Must be credentialed Respiratory Care Clinical Supervisor or Advanced Respiratory Care Practitioner meeting the requirements set in the Duke University Hospital Policy/Procedure manual for Advanced Respiratory Care Practitioner's credentialing and responsibilities (#150.2).
- III. **INDICATIONS:** A patient may be a candidate for HFOV if their oxygenation status is inadequate and not amenable to conventional mechanical ventilation as evidenced by the presence of three or more of the following:
  - A. Plateau Pressure  $\geq$  30 cmH<sub>2</sub>O
  - B. FiO<sub>2</sub>  $\geq$  50%
  - C. Presence of bilateral infiltrates consistent with ARDS
  - D. Presence of gross airleak with inability to adequately expand alveoli.
- IV. **GOALS:** The goals of the HFOV Protocol for Adult Patients include all of the following:
  - A. To maintain the patient's arterial pH between 7.20 and 7.50
  - B. To maintain the patient's PaO<sub>2</sub> between 55 and 80 mmHg
  - C. To maintain the patient's SpO<sub>2</sub> between 88 and 95%
- V. **PROTOCOL INITIATION:**
  - A. Physician writes an order for "High Frequency Oscillatory Ventilator Protocol" or "HFOV Protocol".
  - B. The Respiratory care practitioner (RCP) will
    1. Assess the patient to establish clinical indications and goals.
    2. Gather, setup, and calibrate all essential equipment (see Section V.C and D below)
    3. Initiate HFOV and manage the patient according to the guidelines set forth in this protocol (see Section V.E and following below)
    4. Assess the patient's response to therapy.
    5. Make adjustments as necessary and as defined by the protocol.
    6. Communicate oscillator settings and changes to other members of the patient care team.
    7. Document all changes in the medical record.
  - C. Gather all equipment
    1. Sensomedics 3100B Oscillator and circuit

2. Fisher-Paykel 730 Humidifier
3. Oxygen analyzer
- D. Set-up and calibrate the oscillator according to manufacturer's guidelines.
  1. Perform the 'patient circuit calibration test' as outline on the side of the unit.
  2. Perform the 'ventilator performance check' as outlined on the top of the unit (unit should be warmed up for five minutes prior to initiating the performance check).
- E. Pre-oxygenate the patient with an FiO<sub>2</sub> 1.0 and suction prior to initiation of HFOV
- F. Raise, or insure that, the head of bed is set at 30 degrees
- G. **INITIATE HFOV WITH THE FOLLOWING SETTINGS**
  1. FiO<sub>2</sub>: 1.0
  2. Frequency: 5 Hz (300 bpm)
  3. Bias flow: 30 Lpm
  4. % Inspiratory Time: 33%
  5. Power Setting: Start at 6.0 and adjust to achieve an adequate wiggle (from clavicle to mid-thigh).
  6. Mean airway pressure (mPaw): 5 cmH<sub>2</sub>O above mean airway pressure reading on the conventional mechanical ventilator.
  7. Set humidifier temperature to 38.5-39 degrees Celsius.
- H. Perform a recruitment maneuver (see Appendix 1)
- I. Create a partial cuff leak
- J. **Perform an initial assessment** of the patient immediately after initiating HFOV...
  1. Blood pressure
    - a) If a decrease in blood pressure is observed consult with the medical team to consider fluid resuscitation or administration of inotropic agents.
  2. Chest wiggle – Chest wiggle should be noticeable from clavicle to mid-thigh
    - a) If chest wiggle is inadequate, increase the Power Setting until an adequate chest wiggle is noted
  3. Oxygenation
    - a) If SpO<sub>2</sub> < 85%, repeat the recruitment maneuver (see Appendix 1)
    - b) If, following the second recruitment maneuver, the SpO<sub>2</sub> remains < 85%, increase the mPaw in 2-3 cmH<sub>2</sub>O increments until the goal is achieved (not to exceed a mPaw of 45 cmH<sub>2</sub>O)
      - i Observe blood pressure when increasing mean airway pressure
- K. Obtain an arterial blood gas within 30 minutes and a chest radiograph within 2 hours after initiating HFOV

VII. **SUBSEQUENT PATIENT ASSESSMENT, OSCILLATOR MONITORING AND MANAGEMENT STRATEGY**

- A. Assess the patient and monitor the oscillator function every 6 hours.
  1. Patient assessment
    - a) Chest wiggle
      - i Auscultate the patient's chest for the presence of oscillator sound transmission throughout all lung fields
    - b) Oxygen saturation
    - c) Physical appearance
    - d) Secretions
    - e) Cuff inflation
  2. Oscillator monitoring

- a) Verify and record settings and measures
  - i FiO<sub>2</sub>
  - ii % Inspiratory Time
  - iii Frequency (Hz)
  - iv Amplitude
  - v Power Setting
  - vi Bias Flow
  - vii ETT cuff inflation
  - viii Mean Airway Pressure

**B. OXYGENATION MANAGEMENT STRATEGY**

1. During the first 24 hours after initiation of HFOV...
  - a) Do not decrease mPaw
  - b) Wean FiO<sub>2</sub> if PaO<sub>2</sub> > 80 mmHg or SpO<sub>2</sub> > 95
2. After the initial 24 hours of HFOV
  - a) Consult with the medical team and titrate the mPaw and FiO<sub>2</sub> according to the table below:
    - Changes in mPaw and FiO<sub>2</sub> should fall within the established bands
    - Any increase in mPaw should be preceded by a recruitment maneuver (see Appendix 1).
    - Note: Decreases in oxygenation may be caused by an airway obstruction due to increased secretions. Before increasing mPaw assess for chest wiggle and the possible need for secretion clearance.

MEAN AIRWAY PRESSURE/FiO <sub>2</sub> TABLE	
GOAL: 55 ≤ PaO <sub>2</sub> ≤ 80	
GOAL: 88 ≤ SpO <sub>2</sub> ≤ 95	
MEAN AIRWAY PRESSURE	FiO <sub>2</sub>
<25	0.4-0.5
25-30	0.5-0.8
31-39	0.8-1.0
40-45	1.0

**C. ACID-BASE MANAGEMENT STRATEGY**

1. For pH < 7.20
  - a) Decrease frequency in increments of 0.5 Hz (to a minimum of 3 Hz).
  - b) Increase power setting in increments of 0.5 to a maximum of 10.
  - c) Increase % Inspiratory Time to 50%.
 

Note: If an increase in % IT results in an increase in PaCO<sub>2</sub>, return to a % IT of 33%.
  - d) Increase cuff leak to allow more passive exhalation
    - i Initiating a cuff leak may result in a decrease in mPaw. If this occurs increase the bias flow to maintain the desired mPaw

2. For pH > 7.50

- a) Decrease power setting in increments of 0.5
- b) Increase frequency in increments of 0.5 Hz
- c) % Inspiratory Time to 33%.
- d) Decrease cuff leak
  - i Decreasing the cuff leak may increase mPaw. If this occurs, decrease the bias flow to maintain the desired mPaw.

D. **TRANSITION (RETURN) TO CONVENTIONAL MECHANICAL VENTILATION**

1. Consider transition to conventional ventilation when  $FiO_2 = 0.40$  and mPaw is within the range of 20-22 cmH<sub>2</sub>O.

V. **ADVERSE EVENTS:**

- A. If the patient experiences an abrupt deterioration while being mechanically ventilated with the high frequency oscillator consider the following:
  1. Acute Airway Obstruction (mucous plug)
  2. Bronchospasm
  3. Pneumothorax
  4. Right Mainstream Intubation
- B. Response under these circumstances:
  1. Assess airway function/patency (e.g. ETT suctioning, auscultation, direct laryngoscopy, TCO<sub>2</sub> assessment, diminished chest wiggle)
  2. Recommend bronchoscopy
  3. Draw an ABG if the acute decompression results in profound hypoxemia (SpO<sub>2</sub> < 80), or acute hypotension (mean BP drop of >20 mmHg).
  4. Notify physician of these developments immediately and recommend a "stat" chest radiograph.
  5. Consider removing the patient from the oscillator and bagging.
- C. If a sudden increase in amplitude is noted...
  1. Remove the patient from the oscillator and complete the 'ventilator performance check' as outlined on the top of the unit.
  2. If the unit fails the ventilator performance check, remove the unit from clinical use and send to Clinical Engineering for service.
  3. If the unit passes the ventilator performance check, consider factors that may lead to an increase in resistance or decrease in compliance (See Sections V.A and B above).

## APPENDIX 1

### RECRUITMENT MANEUVER FOR ADULT PATIENTS SUPPORTED BY HIGH FREQUENCY OSCILLATORY VENTILATION:

1. Set FiO<sub>2</sub> to 1.0
2. Inflate cuff
3. Stop oscillations
4. Increase the mPaw to 40 cmH<sub>2</sub>O; then maintain that pressure for 40 seconds
5. Return to previous oscillator settings
  - a. Reestablish previous cuff leak
  - b. Resume oscillations
  - c. Decrease mPaw

### RECRUITMENT MANEUVER GUIDELINES

- Perform after any circuit disconnect
- Perform twice daily as long as FiO<sub>2</sub> > 0.4 and there is an increase in SpO<sub>2</sub> associated with the maneuver (even if transient).

### **CAUTION: DO NOT** perform a recruitment maneuver if...

- Pneumothorax is present with active air leak
- Patient is hemodynamically unstable... e.g.
  - MAP < 60 mmHg or
  - MAP falls > 20 mmHg during the maneuver
  - Heart rate > 140 < 60
  - New arrhythmias are noted
  - SpO<sub>2</sub> < 85%

**REFERENCES:**

1. Initial Clinical Guidelines for HFOV 3100B in Adults: VIASYS Healthcare. March 2002.
2. Derdak S, Mehta S, Stewart T, Smith T, Rogers M, Buchman T, Carlin B, Lowson S, Granton J. High-Frequency Oscillatory Ventilation for Acute Respiratory Distress Syndrome in Adults; A Randomized, Controlled Trial. *Am J Respir Crit Care Med* 2002; 166: 801-808.
3. Mehta S, Lapinsky S, Hallett D, Merker D, Groll R, Cooper A, MacDonald R, Stewart T. Prospective Trial of High-Frequency Oscillation in Adults with Acute Respiratory Distress Syndrome. *Crit Care Med* 2001; 29; 7; 1360-1369.
4. Fort P, Farmer C, Westerman J, Johannigman J, Beninati W, Dolan S, Derdak S. High-Frequency Oscillatory Ventilation for Adult Respiratory Distress Syndrome – A Pilot Study. *Crit Care Med* 1997; 25; 6: 937-947.