High Frequency Ventilation of Neonates

Protocol Responsibilities and Authorisation

Department Responsible for Protocol	
Document Owner Name	
Document Owner Title	
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Protocol Review History

Version	Updated by	Date Updated	Description of Changes

High Frequency Ventilation of Neonates

1. Overview

1.1 Purpose

High frequency oscillator (HFO) ventilation is an alternative way to give respiratory support to the newborn baby with respiratory failure. It could be used as a first or primary mode of ventilation. However in our unit it is more frequently used when conventional ventilation does not produce the desired result.

High frequency oscillator is a machine which uses a piston to generate oscillatory wave form at the airway opening with the following characteristics[1]:

- Frequency above 2 Hz (1 Hz = 60 breaths/min)
- Active inspiration and expiration
- Tidal volumes less than the anatomical dead space (0.1 – 3 mL/Kg)

Gas exchange in HFO:

- Oxygenation - It is directly related to FiO_2 and the lung volume. In HFO, mean airway pressure is used to distend the lung volume to the optimal limits (best point of compliance) by recruiting the atelectatic lung units.

- Carbon dioxide level (pCO_2) –Inversely related to the alveolar ventilation

Alveolar Ventilation in HFO = $\mathbf{f \times V_T^2}$

(Where **f** is frequency and $\mathbf{V_T^2}$ stroke volume of the ventilator**)**

Stroke volume is determined by the oscillation amplitude also called delta pressure. The stroke volume increases if the amplitude increases thus bringing the pCO_2 down. In HFO the alveolar ventilation paradoxically increases with decrease in frequency because as the frequency decreases the stroke volume increases[2] (**Please note** - this is the opposite of a conventional ventilator).

Indications:

- Severe HMD not responding to moderate conventional ventilator settings (PIP > 25cm H2O in babies below 1500g & 30cm in babies above 1500g)
- Severe parenchymal lung disease (Mec. Aspiration Syndrome / Pneumonia etc.) with or without PPHN
- Pulmonary Hypoplasia (PPROM / Diaphragmatic Hernia)
- Cystic Pulmonary Interstitial Emphysema - PIE)

Initiation and Management of HFO[3] :

For optimal results it is imperative that the following supportive care is in place to correct:

- Hypotension
  - Repletion of intravascular volume
  - Good myocardial contractility
  - Adequate venous return

- Pulmonary Hypertension
  - Correct acidosis and normalise pCO_2
  - Bolster systemic blood pressure
  - Nitric oxide

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Initial Settings:

A. Frequency (varies with the disease process)

- Severe HMD - (Bwt < 1500g) 12 – 15 Hz
  > 1500g) 8 – 12 Hz
- MAS/ Pneumonia - 6 – 10 Hz
- Pulmonary Hypoplasia* - 10 - 12 Hz
- Cystic PIE - 5 – 6 Hz

B. Amplitude (Delta Pressure)

- Start at about one and half times the maximum PIP on conventional ventilator or twice the maximum MAP on the HFOV.
- Adjust the pressure to get an adequate chest wiggle (wiggle visible up to the upper abdomen)

C. Mean Airway Pressure (MAP)

- HMD & MAS/Pneumonia – (Start with alveolar recruitment manoeuvre).
  Set the MAP at 1 – 2cm of H_2O above the MAP on conventional ventilator and increase by 2cm every 10 minutes (maximum 25cm of H_2O) till no further increase in oxygen saturation. Wean down FIO_2 to the minimum as allowed. Then slowly decrease the MAP in steps of 1 cm every 10 minutes, keeping the oxygen saturation within the target range.

- Pulmonary Hypoplasia * & Cystic PIE - (Strictly no recruitment manoeuvre).
  Set the MAP 10 – 15cm of H_2O
  (* For Diaphragmatic Hernia also see the CDH protocol please)

Further Management:
After the baby is stabilised on the initial setting obtain a blood gas. Readjust the settings if need be as follows:

- PaO2 : If high - decrease FIO_2 or MAP. Aim to decrease FIO2 to <70% before reducing MAP, unless air leak is present.
  If low - increase FIO_2 or MAP

- PaCO2: If High - increase amplitude or decrease frequency
  If Low - decrease amplitude or increase frequency

(Always look for mechanical and other iatrogenic reasons like blocked/ displaced tube, pneumothorax, over-inflation or atelectasis before making changes in the setting).

Weaning and Extubation:

- When - FIO_2< 40% ; MAP <12cm H_2O
- How - Increase frequency to 10 to 14 Hz
  Decrease amplitude until $PaCO_2$ starts rising
  Decrease MAP to 8 to 10cm H_2O

At this point either extubate to CPAP if the work of breathing is satisfactory or switch over to conventional ventilation.

Monitoring:

- Cranial ultrasound in preterm babies before commencing HFO and monitor closely thereafter.
- Chest xray- before and 2 - 4 hours later
  (Ideal inflation - diaphragm between 7th and 9th rib posteriorly)
- Suctioning – (no routine suctioning).
  When – Decreased chest wiggle
  Changes in vital signs
  Coughing/increase in spontaneous respiration
  Increase in PaCO2
  How - (Avoid losing recruited alveoli)
  Use closed system
  Increase supplemental oxygen
  Increase ventilation frequency
  Increase MAP

1.2 References

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