

High Frequency Oscillation

How to set it up on the SLE5000

SLE "How to's..." are published as a guideline by SLE Ltd, and should only be carried out by suitably trained and qualified staff.

It is strongly recommended all Operatives have read and understood the User Manual before attempting these tasks.

Description

A form of mechanical ventilation in which small tidal volumes, at or just less than the anatomical dead space and therefore can be seen as lung-protective, are delivered at very rapid rates, typically 10Hz – 15Hz (600-1200 BPM)

Mechanisms of gas exchange

Removal of Carbon Dioxide:

- Molecular diffusion is the most important mechanism at the alveolar-capillary membrane
- As in CMV, bulk convection may play an important part in ventilating the most proximal alveolar units
- Longitudinal dispersion (Taylor) in which turbulent air currents occur when convective flow is superimposed on diffusion. Increased gas exchange may occur as some fresh gas may mix with alveolar gas.
- Pendeluft effect. Regional differences in time constants may cause gas to recirculate among lung units thereby increasing gas exchange
- Asymmetric velocity profiles in inspiration and expiration enhances gas exchange
- Cardiogenic mixing. Agitation from the contracting heart contributes to gas mixing especially in lung units closest to the heart

Despite the delivery of very small tidal volumes, changes in delivered tidal volume may be more effective at carbon dioxide removal than during CMV.

Oxygen Exchange:

Improving oxygenation, avoiding atelectasis and preserving surfactant is achieved by maintaining adequate lung volume. The strategy for improving oxygenation in both HFO and CMV is similar, as ventilation/perfusion matching has to be improved and cardiac impairment avoided. In CMV high tidal volumes recruit lung volume and PEEP avoids atelectasis; In HFO PEEP (MAP) recruits alveoli and maintains lung volume above FRC. Therefore HFO maintains lung volume at a constant level and uses small changes in tidal volume to achieve ventilation.

Lung injury continues to be an issue with regard to morbidity in infants requiring mechanical ventilation. Various studies have shown that mechanical positive pressure ventilation with large tidal volumes damages pulmonary capillary endothelium, alveolar and airway

Commencement of HFO

If HFO is being considered, it is advisable to intubate with the largest ET tube possible for that particular infant.



As a guide to settings when commencing HFO, the MAP can be set at 2 mbar more than the conventional MAP. The frequency can be commenced at 10Hz. The delta pressure is increased until there is adequate chest wall movement. Once HFO has been commenced these settings can then be customised for the particular infant being ventilated.



A chest X-ray should be taken within one hour of commencement of HFO, as should an arterial blood gas.



At all times there should be continuous monitoring of SaO₂ and blood pressure. It is recommended that a transcutaneous CO₂ monitor be used whenever possible.



Observations

Chest X-ray to ascertain over distension or under inflation of the alveoli.



SaO₂. If it remains high reduce FiO₂ first before adjusting MAP.



If the SaO₂ drops check chest wall movement, maybe a chest X-ray. N.B. over-distension and under-inflation will both produce a drop in SaO₂.



Blood gas analysis is required on a regular basis. If transcutaneous CO₂ monitoring is being used then a blood gas daily to correlate the monitor reading.



The pH needs monitoring especially if a policy of permissive hypercapnia is employed.



epithelium and basement membranes. This damage causes fluid, protein and blood to leak into the airways, alveoli and interstitial spaces. This in turn activates the inflammatory cascade reducing surfactant activity and leads to further lung damage.

It appears that cyclic changes in lung volume rather than changes in airway pressure cause the damage. Ventilation strategies where small tidal volumes are delivered, thereby avoiding large changes in lung volume, may reduce lung injury. Therefore HFO could be considered to be one of the optimal lung protective strategies as it provides very small tidal volumes, provides lung recruitment and maintains lung volume without over distension. For HFO to be successful lung volume must be recruited, and this may not be always achievable when HFO is commenced after lung injury has already occurred.

Indications for using High Frequency Oscillation Ventilation

Lung protection

By its very definition, HFO offers lung protection by delivering tidal volumes at or just above the dead space. However, in many centres HFO is used as a rescue therapy when Ventilator Induced Lung Injury has already occurred.

Neonatal respiratory failure is associated with:

- RDS
- Pneumonia
- Meconium Aspiration Syndrome
- Lung Hypoplasia
- Congenital Diaphragmatic Hernia
- Persistent air leaks
- Lung disease where levels of CO₂ are difficult to control
- Persistent Pulmonary Hypertension of the Newborn

Blood pressure. Appropriate HFO increases mean lung volume. As lung volume increases, right atrial volume decreases which may cause a reduction in cardiac output.



Routine sedation for the comfort of the infant is encouraged, but not necessarily to prevent spontaneous breathing. Spontaneous breathing is encouraged.



Suctioning

It is of great importance that recruited lung volume is maintained, and disconnections of the patient circuit are strongly discouraged.



As HFO tends to increase secretions, careful attention must be given to appropriate humidification to prevent blocking of the ET tube.



Suctioning should only be performed as per the individual infants requirements. It should only be performed when clinically indicated i.e. increasing PaCO₂, decreasing PaO₂ or visible secretions.

A closed system suction device prevents total de-recruitment, although some de-recruitment will still be evident.

Hand bagging is ineffective in re-recruiting lung volume. MAP needs to be increased until pre-disconnection levels of SaO₂ is achieved.



Chest physio is not required as this is achieved by the oscillation.

The weaning process:

Reduce O₂ concentration before adjusting MAP.

Reduce MAP by 2 mbar 2 hourly in accordance with observations.

If weaning is too rapid atelectasis may occur and MAP will need to be increased to above pre-weaning level.

When MAP has been effectively decreased to an acceptable CPAP level and the infant is spontaneously breathing, the infant can be extubated and placed on Nasal CPAP.

If the infant was conventionally ventilated prior to HFO, it does not necessarily follow that the infant has to go back to conventional ventilation before extubation to nasal CPAP.

"How to's..." are published as a guideline by SLE Ltd, and should only be carried out by, or on the orders of a Registered Physician.

It is strongly recommended that all treatments are tailored to the individual patient.

