How to....

Set up HFO (High Frequency Oscillation) Ventilation

Description

A form of mechanical ventilation in which small tidal volumes, at or just less than the anatomical dead space, are delivered at very rapid rates, typically 5Hz – 15Hz (300-1200 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

Commencement of HFO

Currently the high volume strategy is recommended when using 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 SaO_2 and blood pressure. It is recommended that a transcutaneous CO_2 monitor be used whenever possible.

Observations

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

SaO_2. If it remains high reduce FiO_2 first before adjusting MAP.

If the SaO_2 drops check chest wall movement, maybe a chest X-ray. NB over-distension and under-inflation will both produce a drop in SaO_2.

Blood gas analysis is required on a regular basis. If transcutaneous CO_2 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.

pulmonary capillary endothelium, alveolar and airway epithelium and basement membranes. This damage causes fluid, protein and blood to leak into the airways, alveoli and interstitial spaces. This in turn reduces 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.

Persistent neonatal respiratory failure associated with:

RDS

Pneumonia

Meconium Aspiration Syndrome

Lung Hypoplasia

Congenital Diaphragmatic Hernia

Persistent airleaks

Lung disease where levels of CO_2 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 $PaCO_2$, decreasing O_2, visible secretions.
A closed system suction device is preferred.

Hand bagging is ineffective in re-recruiting lung volume. MAP needs to be increased until pre-disconnection SaO_2 is achieved.

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

The weaning process:

Reduce O_2 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, 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..." is 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.

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