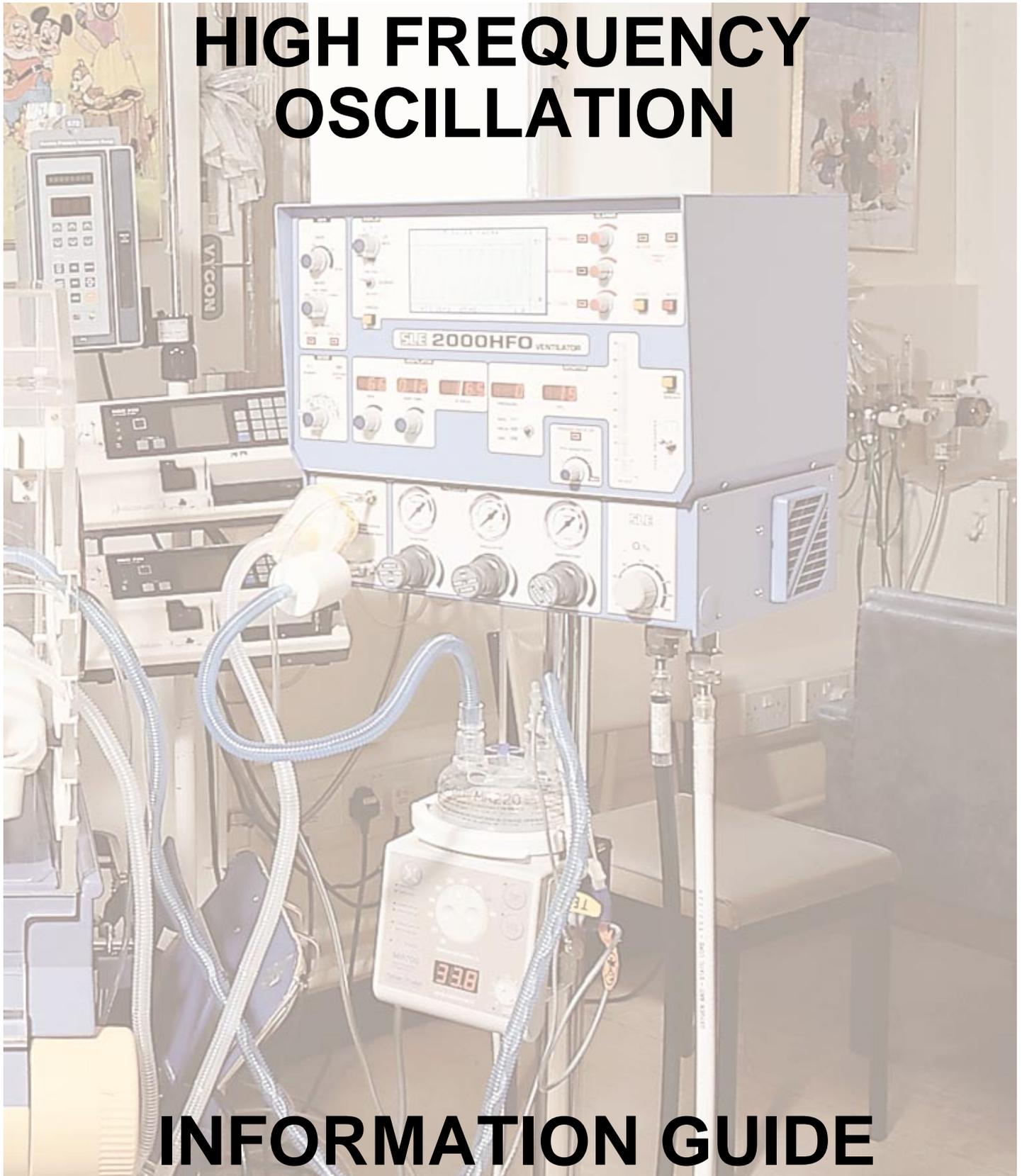


HIGH FREQUENCY OSCILLATION



INFORMATION GUIDE



High Frequency Oscillation Ventilation

What is High Frequency Oscillation (HFO) Ventilation?

HFO ventilation is the delivery of small tidal volumes to the infant at fast frequencies. Both Inspiration and expiration are active, therefore reducing the likelihood of gas trapping.

Some Terminology

HFO	High Frequency Oscillation.
Amplitude	The maximum extent of a vibration or oscillation from a point of equilibrium.
Hertz	SI unit of frequency, equal to one cycle per second.
CMV	Conventional ventilation.
CPAP	Continuous positive airway pressure.
I:E	Inspiratory : expiratory ratio.
IMV	Intermittent mandatory ventilation.
MAP	Mean airway pressure.
MAS	Meconium aspiration syndrome.
paO₂	Arterial oxygen tension.
paCO₂	Arterial carbon dioxide tension.
PEEP	Positive end expiratory pressure.
PFC/PPHN	Persistent fetal circulation also called persistent pulmonary hypertension caused by a sustained increase in pulmonary vascular resistance after birth, preventing the transition to a normal extrauterine circulatory pattern.
PTV	Patient triggered ventilation.
PVL	Periventricular leukomalacia. A decrease in cerebral blood flow causing anoxia resulting in necrosis of periventricular white matter.
RDS	Respiratory distress syndrome.
SIMV	Synchronous intermittent mandatory ventilation.

Applications

There are two strategies used in delivering oscillation.

1. **High Volume** and **Low Oxygen**
2. **Low Volume** and **High Oxygen**

High volume Strategy

This is used where there is uniform lung disease e.g., Hyaline membrane disease. The alveoli need to be expanded, therefore the MAP is increased by 2-3cmH₂O above what is being achieved in CMV.

In cases of severe respiratory failure and HFO is employed as a rescue therapy very high MAP e.g.. 30cmH₂O may be required.

If oxygenation does not improve within 6 hrs. alternative or additional therapy should be used e.g.. HFO + Nitric Oxide therapy, HFO + pulmonary vasodilator.

Low volume Strategy

This is employed where there is non homogeneous lung disease i.e.. Meconium aspiration or even where there is no lung disease i.e.. PPHN. In these instances over distension of the alveoli must be prevented.



Commencing Oscillation

Set up when switching over from CMV

1. Turn HFO to continuous.
2. Turn mode select switch to CPAP
3. Increase MAP to 2-3 cmH₂O higher than the MAP during CMV if employing high volume strategy.
4. Turn oscillator knob until you see and feel chest wall "bouncing" or vibrating. other parts of the body may vibrate before chest wall movement is seen. A rough guide as to the level of Delta P is approximately 10 cmH₂O above PIP on CMV --- this is just a rough guide.
5. Set the Hertz button to 10Hz.

When commencing HFO electively

The principle remains the same but bear in mind the MAP and PIP that would have been used in CMV and set HFO parameters accordingly.

As soon a chest wall bouncing if felt.

X_Rays must be taken to determine the correct level of HFO.
Lung fields must be expanded to the 8th rib posteriorly.

High volume Strategy - Uniform lung disease

MAP 2-3 cmH₂O increase CMV level.

Frequency - 10Hz

Amplitude - To point where chest wall bouncing or vibrating.

Fio₂ - as when in CMV and adjust accordingly.

High volume Strategy - Uniform lung disease

MAP at same level as CMV Fio₂ remains.

Amplitude - to point where chest wall bouncing.



Oxygenation

This is determined by MAP level and lung volume. If there is no improvement in oxygenation within a few hours then HFO alone still not work and HFO + Nitric Oxide or HFO + vasodilators should be considered.

Overinflation

Diaphragm flattened

Lung fields expanded to greater than 8th rib posteriorly

Thin cardiac silhouette

Underinflation

Lung fields "whiteout"

Lung fields expanded to less than 6th rib posteriorly

PaO₂ too high

reduce oxygen in concentration in increments 30%. If Pao₂ still high then reduce MAP.

PaO₂ too low

Chest x-ray to check appearance

- Overdistension - reduce MAP
- Underdistension - increase MAP
- Measure BP as hypotension due to hypovolaemia may occur during HFO



Carbon dioxide elimination

PaCO₂ too high

Check chest wall "bouncing".

Check that the largest possible sized endotracheal tube has been used.

Increase oscillatory power.

If oscillatory power is at its maximum reduce the frequency (Hertz)

PaCO₂ too low

Reduce oscillatory power

NB: Medical and nursing staff should be aware of the implications of using HFO in non-homogeneous lung disease.

Meconium aspiration syndrome

As there is gas trapping with chemical inflammation and atelectasis it is felt that it is better to wait 48hrs until the chest x-ray shows a more homogenous appearance. The settings will then be the same as for RDS.

Persistent Pulmonary Hypertension

Where there are no additional respiratory problems, it is easy to cause overdistension. A low volume strategy should be used here.



Septicaemia

These infants tend to be hypotensive. Their BP must be checked and normalized before commencing HFO.

Air Leak Syndrome

The aim here is to reduce gas flow through the leak, therefore the HFO settings are different to the norm.

MAP equal to or less than during CMV

FiO₂ increased to 100% to maintain a PaO₂ at 50-55 mmHg.

When the leak/institial emphysema has been absent for 48hrs then RDS type settings can be used.



Weaning

Maintenance of lung volume during weaning is essential for successful weaning.

Reduce FiO_2 in increments until 30% is reached. If oxygenation deteriorates do chest x-ray to determine level of distension. If MAP is maintained too long during weaning overdistension will result thus impairing oxygenation.

Once FiO_2 is down to 30%, reduce MAP by 1 - 2cmH₂O every 2-4hrs. The infant needs to be closely monitored thereby determining the speed of weaning. If MAP is reduced too rapidly atelectasis will develop and blood gases will deteriorate. If this occurs then increase MAP 2cmH₂O above the level at which weaning commenced. Weaning should perhaps then be at a slower rate.



Nursing an Infant on HFO

- Ensure largest size endotracheal tube is used internally
- Maintenance of lung volume is critical.
- Disconnections must be discouraged. Auscultation of the infant when oscillator switched off and not disconnected. This prevents rapid drops in MAP.
- Suction only when absolutely necessary. Avoid handbagging. If oxygenation deteriorates after suctioning it may be necessary to re-recruit lung volume therefore increase MAP temporarily.
- Physiotherapy. During HFO there is intrapulmonary percussion and so physio is less frequently required.
- Changes in infant position must be well planned to minimise any disconnections.
- Humidification must be set at 39°C to enable at least 37°C to be delivered. There are more secretions during HFO therefore appropriate humidification will prevent blocking of the ET tube.
- Neuromuscular blocking agents. It is not necessary to paralyse infants during HFO. Their own respiratory efforts do not really interfere with effective HFO. Indication for sedation would be extreme agitation and obvious vigorous respiratory efforts.



Advantages of SLE 2000 HFO Ventilator

Modes	SLE	Draeger	Sensormedics	Infrasonics
Active Inspiratory only	Yes	Yes	Yes	Yes
Active Expiratory only	Yes	Yes	No	No
Active on both only	Yes	Yes	Yes	Yes
Pure Oscillator only	Yes	No	Yes	No
Conventional Vent Only	Yes	Yes	No	No
User friendly	Yes	No	No	Yes
Valvless System	Yes	No	No	No
Standard & Osc Pat. Crts (Reuseable or single use)	Yes	No	No	No
Visual Display Waveforms	Yes	Yes	No	No

1. Quiet operation
2. Valvless operation prevents build-up or retention of CO₂ (during expiration)
3. No valves or diaphragms to wear out or replace.
4. Minimal servicing.
5. Oscillator can be switched off, then used as a conventional ventilator, no need to change software.
6. No nursing problems due to using standard (flexible) SLE patient circuits (Reuseable or single use).
7. Ideal system when used with Nitric Oxide systems or surfactants etc. (no valves to stick).
8. Valvless, therefore pneumatically far superior and efficient to any other system.

When used in the oscillatory mode:

1. Can oscillate on inspiration only.
2. Can oscillate on expiration only.
3. Can oscillate on both.
4. Can be used as a pure oscillator ventilator.
5. Oscillations can be switched off and the system used as a standard ventilator (no need to transfer the neonate to a conventional ventilator, makes for easier nursing).
6. Use normal SLE 2000 flexible patient circuits, (reusable or single use).
7. Can be used on neonates up to 10Kg on oscillatory mode or 20Kg in conventional ventilation. (Software upgrade available to enable HFO up to 20Kg).
8. HFO+ can oscillate to 20Kg.
9. built in PTV and SIMV.

As a valveless system also has the following advantages:

10. No inadvertent PEEP.
11. No retention or build up to CO₂
12. No valves and diaphragms to wear out.
13. Minimal servicing.
14. Quiet operation.
15. Clear visual display.
16. Very competitively priced. (Compared to Sensor Medics)

Competition

Sensormedics

1. Uses a large diaphragm
2. Noisy
3. Uses short (30cms) rigid patient circuit (approx cost \$300) creating nursing problems. (has to be inclined to avoid "Rainout").
4. Can only be used as an Oscillator. Therefore Neonates have to be transferred to other vent when oscillations not required.
5. Initial outlay more expensive and with (4) more expensive as effectively 2 vents will be required.
6. Still uses valves/diaphragm.

Draeger

1. Not a true "Oscillator" ventilator (a Flow interruptor" software has to be changed).
2. Oscillates neonates up to 2 KGM only.
3. Used only as a high frequency vent. (HFV) once the software has been changed.
4. Not user friendly" - nursing difficulty.
5. More Expensive.
6. Still uses valves etc.

Infrasonics

1. Still uses valves.
2. Flow interrupter not true oscillator.
3. service problem - long down time.
4. Not new technology.
5. Options required to try and make it compatible.
6. Could end up more expensive.



Notes



Notes

