

High Frequency Ventilation: Nursing Care of Infant

Procedure Responsibilities and Authorisation

Department Responsible for Procedure	NICU
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Target Audience	Nurses
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Procedure Review History

Version	Updated by	Date Updated	Summary of Changes
3	Joyce Mok	Dec 2015	3 yearly update
4	Richard Pagdanganan	March 2020	3 yearly update
4.1	Richard Pagdanganan	Nov 2021	Added image HFOV using SLE 6000

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High Frequency Ventilation: Nursing Care of Infant

1 Overview

1.1 Purpose

To outline the specific procedure for the care of babies needing High Frequency Oscillator Ventilation (HFOV) specifically for the ventilator used in Neonatal Intensive Care Unit (NICU). This procedure is based on the best practice guidelines according to Lippincott Procedures.

1.2 Scope

Waikato District Health Board staff working in Neonatal Intensive Care Unit (NICU).

1.3 Patient group

Babies in NICU

1.4 Indications

- Severe HMD not responding to moderate conventional ventilator settings (PIP >25cm H₂O in babies below 1500g and 30cm in babies above 1500g)
- Severe parenchymal lung disease (e.g. meconium aspiration syndrome, pneumonia, etc.) with or without PPHN
- Pulmonary hypoplasia (e.g. PROM, diaphragmatic hernia)
- Cystic Pulmonary Interstitial Emphysema (PIE), pneumothorax

NOTE: Caution is needed when the HFOV is used with high airway pressures as this may result in impaired cardiac output causing hypotension requiring inotropic support or volume expansion. Some infants poorly tolerate extra handling involved in switching ventilators or may not respond to HFOV.

1.5 Definitions

Delta-P/Amplitude	The peak-to-trough swing across the mean airway pressure, resulting in a volume displacement and a visual CHEST WIGGLE. HFOV = CPAP with chest wiggle. Chest wiggle factor is a visible vibration of the chest wall from the shoulder to the umbilicus.
Gas exchange in HFOV	Oxygenation is directly related to FiO ₂ and the lung volume. In HFOV, the 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 HFOV = f x VT ₂ (where f is frequency and VT ₂ stroke volume of the ventilator)

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<p>High Frequency Oscillator</p>	<p>A machine which uses a piston to generate oscillatory wave form at the airway opening with the following characteristics:</p> <ul style="list-style-type: none"> - 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)
<p>High frequency oscillator ventilation (HFOV)</p>	<p>HFOV is an alternative way to give respiratory support to the newborn baby with respiratory failure. It is a type of mechanical ventilation that uses constant distending pressure with pressure variations oscillating around the mean airway pressure at a very high rate (up to 900 cycles per minute).</p> <p>It could be used as a first or primary mode of ventilation. However in NICU it is more frequently used when conventional ventilation does not produce the desired result.</p>
<p>Stroke volume</p>	<p>It is determined by the oscillation amplitude, also called delta pressure. The stroke volume increases if the amplitude increases thus bringing the pCO₂ down. In HFOV the alveolar ventilation paradoxically increases with decrease in frequency because as the frequency decreases the stroke volume increases. (Please note – this is the opposite of a conventional ventilator).</p>

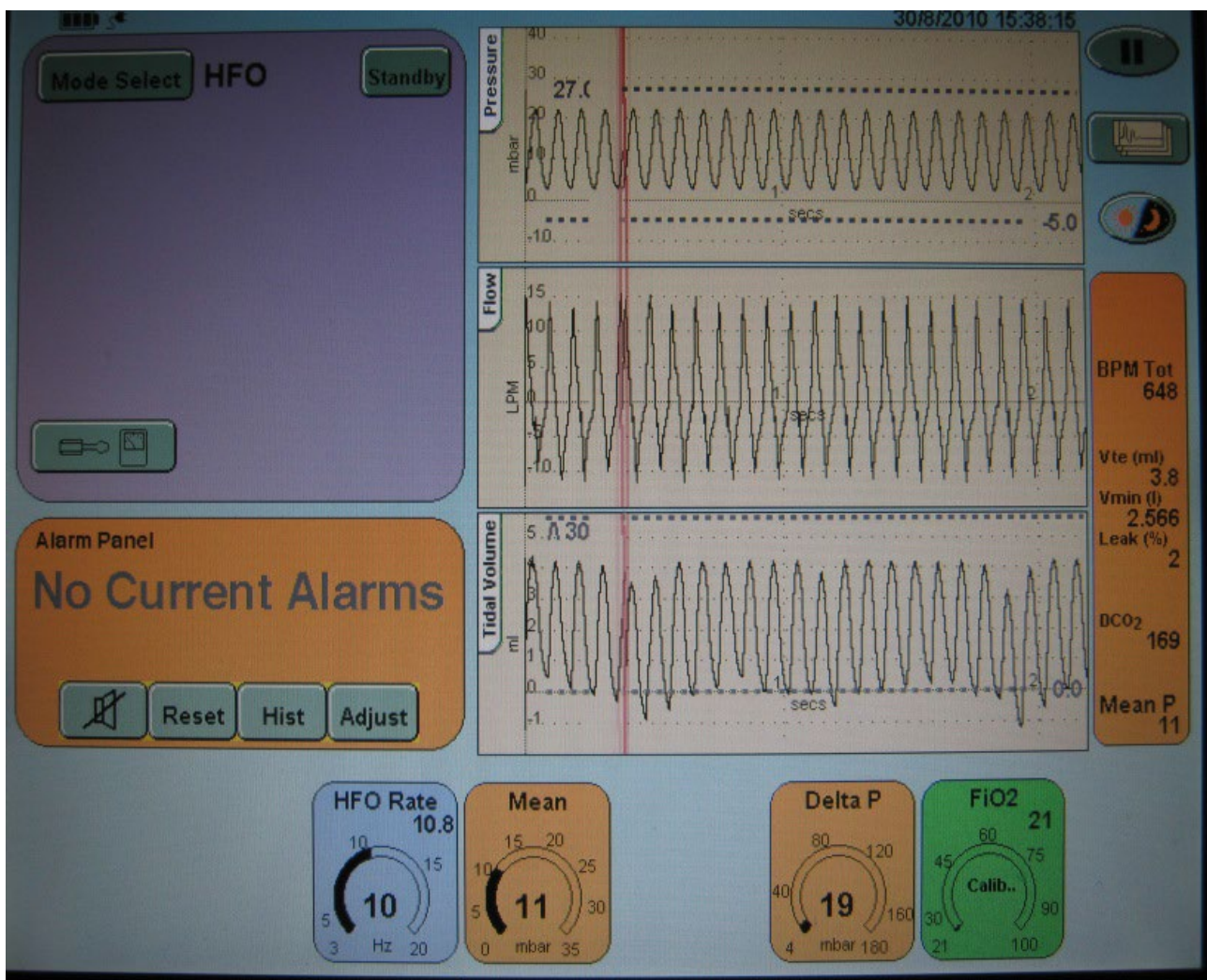


Figure 1. High Frequency Mode in SLE5000

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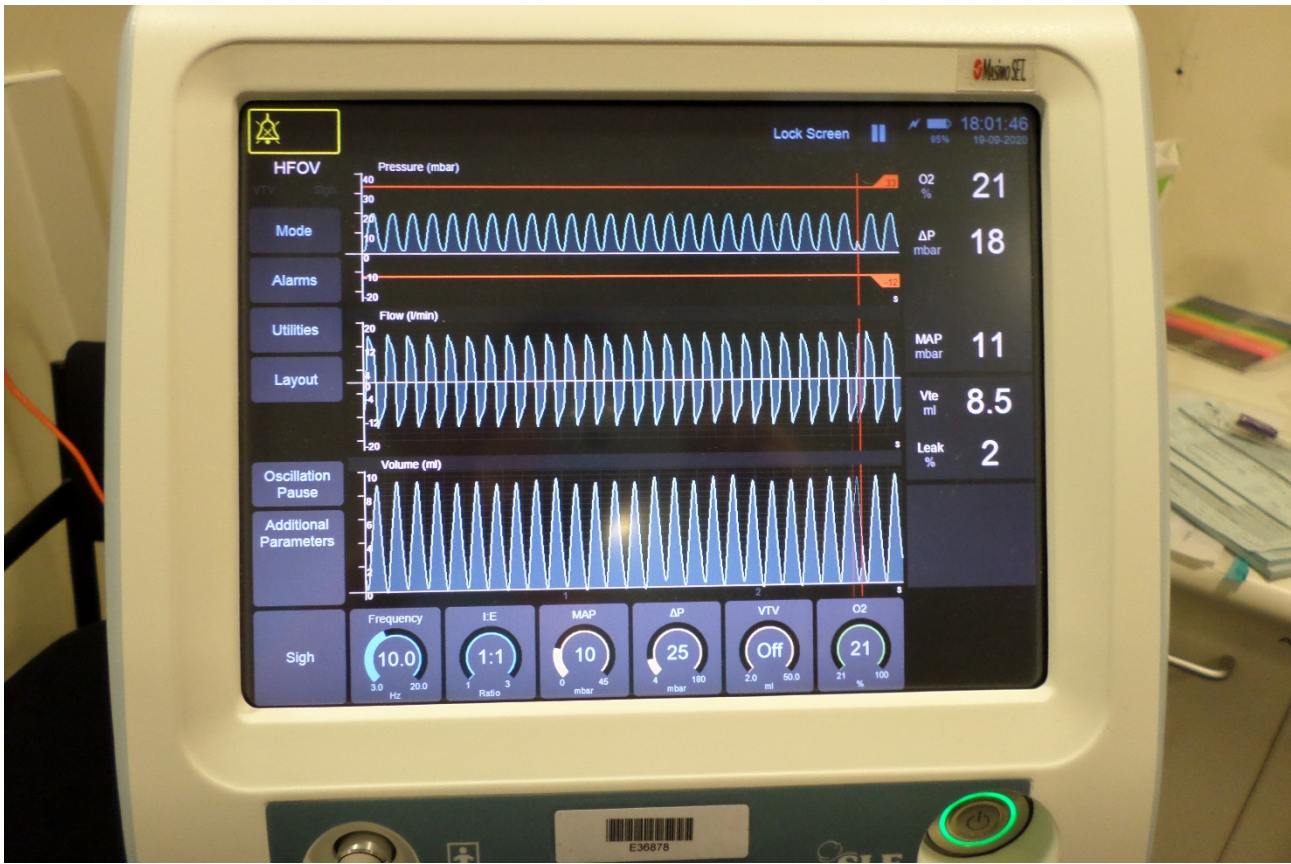


Figure 2. High Frequency Mode in SLE6000

2 Clinical Management

2.1 Competency required

- Registered nurse who has completed ventilator orientation and obtained competency
- Registered nurse who is a preceptee under the supervision of a preceptor

2.2 Equipment

- Ventilator with HFOV mode, e.g. SLE 5000 or SLE 6000
- In-line suction catheter in situ before initiating HFOV, if time permits.
- Sterile water 1 litre bag for humidification

2.3 Procedure

1. Initiating HFOV

- Initiating HFOV is the responsibility of the medical staff and prescription documented in the NICU flow chart.
- Check settings as per prescription.
- PaO₂ is affected by adjusting MAP or FiO₂.
- PaCO₂ is controlled by amplitude or frequency.

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2. Monitoring

- a. Visibly assess infant's chest vibration and note changes:
 - Chest vibration is an indicator of tidal volume. Even small changes in the vibrations may indicate a change in the neonate's condition.
 - Vibration mainly in the neck could indicate a dislodged endotracheal (ET) tube.
 - Asymmetric chest vibration could indicate pneumothorax, or ET tube may have slipped down the main bronchus.
 - Decreased or absent chest vibration may indicate ET secretion, pneumothorax, ET tube is obstructed, circuit or air leak, reduced lung compliance.
 - Chest vibration on one side of the infant's chest may indicate ET tube may have slipped down a primary bronchus or pneumothorax may have developed.

- b. Recording and documentation of infant on HFOV
 - Frequency (Hz)
 - Amplitude (Delta-P)
 - Mean Airway Pressure (MAP)
 - Monitoring for ventilated infants as per NICU Nursing Procedure: [Nursing care of ventilated infant](#) (0432)

- c. Chest x-ray for infant before, and 2 - 4 hours later to ensure adequate alveolar expansion and to check that hyperinflation has not occurred.
 - Over-expansion is shown by the presence of more than 9 posterior ribs and could cause a decrease in CO₂ which leads to a drop in blood pressure (BP) and oxygenation.
 - Under-expansion is shown by fewer than 9 posterior ribs and poor aeration of the lungs.

- d. Observe infant for potential complications:
 - Hyperinflation may result and is manifested by decreased cardiac output. Sign & symptoms: decreased peripheral pulse, peripheral shutdown, decreased BP and desaturation.
 - Atelectasis is a potential complication that results in alveolar collapse and fluid trapping.
 - Air trapping may occur as a result of rates that are excessively high, allowing air to enter alveoli without sufficient time to exit.
 - Pneumothorax may be gradual over several hours. Signs & symptoms: deterioration of ABG, SpO₂, ↓BP, decreased vibration on affected side.
 - Intraventricular haemorrhage
 - Necrotising tracheal bronchitis
 - Under/over humidification

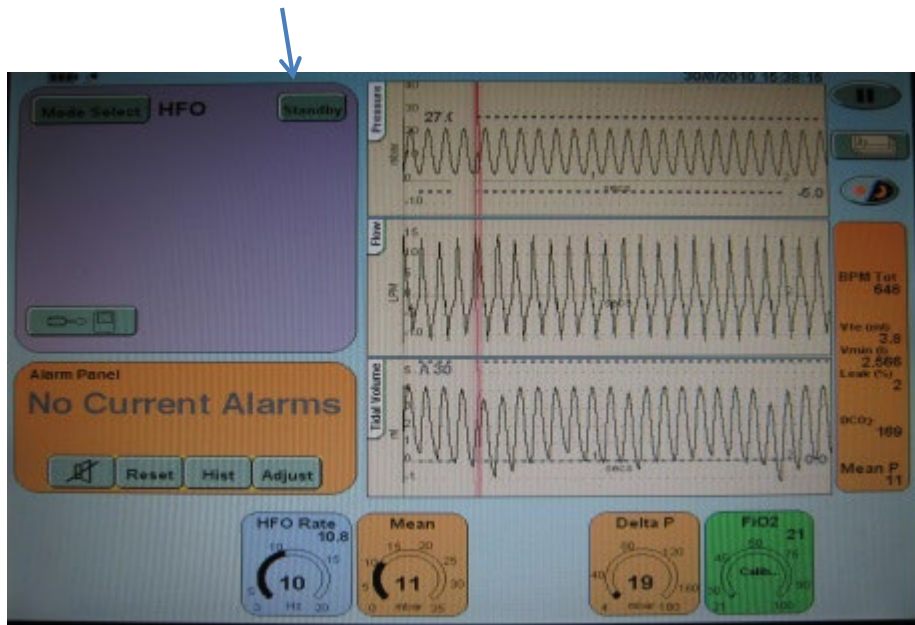
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3. Maintain patent airway

- Check in-line suction catheter is in situ.
- Perform ET suction as indicated, e.g. 4 hourly/PRN, by infant's condition and the nurse's clinical assessment such as decreased chest wiggle, changes in vital signs coughing, increase in spontaneous respiration and increase in PaCO₂.
- Do not disconnect for suction or changing suction catheter because it is important not to lose Mean Airway Pressure. Refer to NICU Procedure: [Endotracheal Suctioning in Newborn Intensive Care Unit \(5962\)](#)
- Do not need daily change of in-line suction catheter to ensure MAP is maintained throughout.
- Press the "Standby" button while briefly inserting and withdrawing catheter.

Diagram: "Standby" button on SLE



Note: If infant requires disconnection, e.g. for suction, for resuscitation:

- Two persons are required, one to suction and the other to return the infant to the ventilator or manually ventilate.
- Remember: disconnection from HFOV may lead to alveolar collapse.
- Pressure may need to be increased during the procedure or immediately afterwards to recruit collapsed alveoli.
- Any changes to pressure must be prescribed or undertaken under medical orders.

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4. Positioning

- Two nurses are required for repositioning: one to turn the infant and stabilise the ET tube, and one to reposition the circuit and ventilator.
- Repositioning should be individually assessed, e.g. infant physiological status and condition of skin integrity.
- Do not disconnect tubing during repositioning.

5. Disconnection is discourag

- Unless mechanical failure or severe deterioration of infant's condition because disconnection can cause alveolar collapse and loss of lung volume.

6. Sedation

- Infant may be sedated to facilitate ventilation and promote comfort: refer to NICU Nursing Procedures, e.g. [Care of ventilated infant](#) (0432) and [Neonatal pain and sedation: assessment and nursing management](#) (1684).

7. Support for family

- Provide accurate, consistent information.
- Parents to participate in cares as infant's condition allows.
- Cuddles are not common as baby's condition is usually unstable.

2.4 Potential complications

- Hyperinflation
- Atelectasis
- Air trapping
- Pneumothorax
- Intraventricular haemorrhage
- Necrotising tracheal bronchitis
- Under/over humidification

3 Audit

3.1 Indicators

- All infant's on HFOV have a documented prescription including a clear description of the required settings
- Physiological assessments of infant's on HFOV are taken in accordance with this procedure
- All complications and incidents associated with HFOV are fully investigated and actions taken to prevent or reduce the risk of a reoccurrence in the future.

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4 Evidence base

4.1 References

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- Wolters Kluwer (2018). High-frequency ventilator use, neonatal. Retrieved from <https://procedures.lww.com/lnp/view.do?pld=1233086&hits=ventilation,ventilator,frequency,high,mechanical,ventilators&a=false&ad=false&q=High-frequency%20ventilator%20use>

4.2 Associated Waikato DHB Documents

- Waikato DHB SS NICU Nursing Procedure: [Nitric oxide management in NICU](#) (4938)
- Waikato DHB SS NICU Nursing Guideline: [Nursing care of ventilated infant](#) (0432)
- Waikato DHB SS NICU Drug Manual
- Waikato DHB SS NICU Medical guideline: [Nitric oxide usage](#) (1553)
- Waikato DHB SS NICU Medical Protocol: [High frequency ventilation of neonates](#) (2625)
- Waikato DHB SS NICU Nursing Procedure: [Arterial lines: nursing management, sampling and removal in NICU](#) (1638)
- Waikato DHB SS NICU Nursing Procedure: [Neonatal pain and sedation: Assessment and nursing management in NICU](#) (1684)
- Waikato DHB SS NICU Nursing Procedure: [Endotracheal Suctioning in Newborn Intensive Care Unit \(NICU\)](#) (5962)

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