NHS Forth Valley

Consultation and Change Record

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<tr>
<th>Contributing Authors:</th>
<th>Dygas, Raeside, Greater Glasgow Guideline Group</th>
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Consultation Process:

Distribution:

Change Record

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This guideline is applicable to all medical and nursing staff caring for babies in neonatal intensive care units in FVRH. Permission has been granted from the Greater Glasgow Guideline Group to use this guideline in Forth Valley. All staff using this device must ensure they have received instruction in the safe use of this device.

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Introduction

High Flow Therapy (HFT) uses gas flow rates higher than the patient’s normal inspiratory flow rate. Entrainment of room air is reduced as the flow rate increases, and hence HFT can deliver oxygen at higher concentrations than is possible by low flow therapy or headbox.

Different modes of delivery of high flow gases have differing benefits and complications:

- **FACE MASKS** and **STANDARD NASAL CANNULAE** are uncomfortable and can cause irritation due to the use of dry, cold gas. Infants treated with nasal cannulae may require more suctioning which can lead to mucosal damage, bleeding and infection (there are reports of fewer instances of CONS sepsis in infants treated with oxihoods compared to nasal cannulae or NCPAP).

- **OXYGEN HOODS** can complicate the delicate thermoregulation of the newborn and they generate significant noise.

- **NCPAP** has been shown to cause barotrauma as well as injury to nose and head.
• BUBBLE HUMIDIFIERS do not significantly increase humidity and temperature (thus delivering gases at Ambient Temperature Pressure Saturated). They have been associated with mucosal trauma and nose bleeding.

The delivery of Humidified High Flow Nasal Cannula (HHFNC) minimise problems noted above and is increasingly being utilized in neonatal units throughout the UK as a means of providing respiratory support.

Humidified High Flow Nasal Cannula – HHFNC

Device: Vapotherm/Precision Flow
The Vapotherm device can deliver gases at flow rates 0-40 L/min (2-8 L/min for neonates, using paediatric size vapour transfer cartridge). It generates 3x more water than bubble systems and this is in molecular form (water vapour) which is the best form of humidification as gases delivered at Body Temperature Pressure Saturated (rather than ambient temperature pressure saturated) pose neither water volume nor heat energy challenge.

Vapotherm’s vapour transfer cartridges have pores of 0.01 micrometers which are considerably smaller than bacteria (0.2-5micrometers) and thus form a barrier for these pathogens.

Postulated mechanisms of action
Because, so far, there are no clear clinical indications for use, these mechanisms may be taken into account when considering the use of this method.

• Washout of nasopharyngeal cavity
  This is thought to be the primary mechanism, reducing the overall dead space and contributing to more effective CO2 elimination. Studies of comparable tracheal gas insufflation demonstrated reduced tidal volume and immediate effect on respiratory rate.
  HFT reduction of the dead space also has an effect on oxygenation – due to reduced entrainment of room air, the airway oxygen concentration is higher when compared to use of non-rebreathing masks and in patients with mouth opened.

• Reduction of inspiratory resistance
  CPAP reduces inspiratory resistance (up to 60%) by splinting open the airway while HFT by matching/exceeding patient’s inspiratory flow and this way eliminates increasing nasopharyngeal resistance caused by its inspiratory distensibility (retraction of nasopharynx during inspiration significantly increases its volume and thus resistance).
  Work of breathing on HFT at flow rates of 3-5 L/min has been shown to be equivalent to that of CPAP at 6 cmH2O in a 1kg patient despite significantly lower oesophageal pressure with HFT, suggesting that mechanisms other than simply the airway distending pressure affects work of breathing in HFT.
  (There is a speculation that HFT causes entrainment of gas during expiration, similar to the Infant Flow Driver).
• Warm, humidified gas improves respiratory mechanics
  Breathing cold, non-humidified gas for only five minutes decreases lung compliance and conductance. Cold, dry gas elicits bronchoconstriction (nasal mucosa receptors, muscarinic effect).

• Reduced metabolic cost of gas conditioning
  The nasopharyngeal cavity provides effective warming and humidification to inspiratory gas but this requires a significant amount of energy. Babies on HHFNC have been shown to gain weight quicker than on CPAP.

• Provision of end distending pressure
  High gas flow generates positive airway pressure (although very unreliably and depending on factors like body weight, mouth leaks, etc). It appears that larger babies require higher gas flow in order to maintain effective dead space washout and support inspiratory effort.

Summary of Advantages:

  Delivery of optimally humidified and warm gases
  Decreased work of breathing
  Decreased body energy expenditure
  Less problems with thickened secretions
  Less problems with nasal irritation/septal damage

• Similar effectiveness in initial management of mild RDS, prevention of intubation/re-intubation. (ref) It seems that HHFNC significantly shortens the time of NCPAP without increasing the overall length of non-invasive respiratory support in ELBWIs and produces equal respiratory outcome at discharge

• Patient/parent friendly

Potential Disadvantages
Currently, there is no way of monitoring end-distending pressure with the Vapotherm and therefore a theoretical risk of lung over-distension and pneumothoraces. There is some evidence that lung compliance is only increased at Vapotherm flow rates of > 5 L per minute. Such flow rates have bee associated with increased oesophageal pressure
In relation to weaning there is no published evidence on which to base practice.

Summary
Available literature suggests that the use of the Vapotherm offers several advantages, but also a number of possible disadvantages.

Reported benefits include a reduction in both ventilation days and re-intubations. As it is non-invasive, Vapotherm also helps to reduce ventilator-associated pneumonia and other lung injuries. Shoemaker et al (2007) showed in a small study that when the Vapotherm was used in babies aged less than 30 weeks, ventilator days per patient were reduced by almost 10 per cent. These results were supported by
Holleman-Duray et al (2007), the authors also reported a reduction in ventilator-associated pneumonia.

In a study comparing a standard high-flow nasal cannula with Vapotherm in 30 similar neonatal patients, Woodhead et al (2006) reported no re-intubations with Vapotherm. However when a standard high-flow nasal cannula was used, two infants had to be re-intubated and five were switched to Vapotherm. Improved blood gases on Vapotherm, along with a reduction in the fraction of inspired oxygen requirement, apnoeas and bradycardias were also reported.

These findings are also supported in an earlier study by Nair and Kama (2005) which reported no significant difference in respiratory failure rates for babies on either Vapotherm or CPAP.

Nasal CPAP has been associated with agitation and nasal trauma (Shanmugananda and Rawal 2007). Vapotherm is delivered via nasal cannula, which are available in three infant sizes. The tube sits comfortably just inside the nose, and is reported to be better tolerated by the baby.

In an observational study Roark et al (2006) found that only 27 per cent of patients required some sedation on the Vapotherm, concluding the device was well-tolerated. It has also been reported that nasal suctioning is reduced on the Vapotherm resulting in less nasal trauma and mucous plugging (Sun and Tero 2004).

A small study reported higher growth rates in neonates when the Vapotherm was used compared to other forms of respiratory support (Holleman-Duray et al 2007). Results could be incidental due to the small sample size, however could be related to better tolerance and reduced distress, leading to longer settled periods for the neonate.

Woodhead et al (2006) reflected that due to the temperature and high relative humidity, the flows delivered by Vapotherm do not dry the baby's nasal passages. The authors also reported that respiratory effort was lower on Vapotherm and, therefore, more effective than standard high-flow nasal cannula.
Indications for use

- Infants with Chronic Lung Disease (ability to wean flow over FiO2).
  As a mode of weaning NCPAP support: (continuous CPAP weaning is better
  than discontinuous weaning but delivery of CPAP below 3-4 cmH2O is difficult).
- Alternative to NCPAP in mild/moderate respiratory distress.
- Post-op respiratory support.
- Babies with nasal trauma from NCPAP
- Treatment or prevention of apnoea of prematurity.
- Supportive growth optimisation???

Consider HHFNC (Vapotherm) when:
- NCPAP 4 cm H2O for 24 h and
- O2 requirements < 40 %

Change to Low flow pernasal oxygen (NHLFNC) if:
- HHFNC flow 2 - 3 l/min for 24 h and
- O2 requirements < 30 - 40 %

Recommended Settings

- Prongs: MUST be smaller than 50% of patient’s nares (tight fit of nasal
  cannulae may generate pressure of 6-10cmH2O at flow as low as 1,5-2
  L/min)
- Flow 4-8 L/min (lower flow 5-6 L/min may be sufficient for smaller babies, flow
  rates > 6 L/min in infants < 1 Kg should be discussed with the duty consultant)
- Fio2 <40%
- Operating temperature set at 34 - 35º C for flow rate < 5 L/min and 36 - 38º C
  at > 5 L/min (to prevent condensation- manufacturer’s recommendation)
- Use appropriately sized nasal cannula. The following is a guide but the
  diameters of nares vary.

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<tr>
<th>Weight</th>
<th>Cannula type</th>
<th>Outer diameter</th>
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<tr>
<td>&lt; 1.4 Kg</td>
<td>Premature</td>
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<tr>
<td>1.4 to 2.6 Kg</td>
<td>Neonatal</td>
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<tr>
<td>&gt; 2.6 Kg</td>
<td>Infant</td>
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- If the baby is requiring FiO2 > 0.6 or has CO2 retention, acidosis or apnoea s/he is
  likely to need alternative support.
- Continuous monitoring of heart rate, respiratory rate and SaO2. TcCO2 as
  indicated. Blood gases if on supplemental oxygen or on clinical grounds.

- Weaning flow rates:
  - It may not be possible to wean flow rate if FiO2 > 0.3
  - Attempt to reduce by 1 L/min 24 hourly if FiO2 < 0.25-0.3 in babies >1.5Kg
  - Attempt to reduce by 0.5L/min 12 hourly if FiO2 < 0.25-0.3 in babies <
    1.5 Kg
  - Attempt to reduce by 0.5L/min 24 hourly if FiO2 = 0.25 – 0.3
  - Attempt to stop if requiring 2.0 L/min or less
Clinical instability, increased work of breathing or significant increase in FiO2 consider pneumothorax

- Simplified weaning
  - 1 L/min every 24h if FiO2 < 30%
  - 1 L/min every 12h if FiO2 = 21%

Contraindications:
- Upper airway abnormalities,
- ventilatory failure,
- severe cardiovascular instability,
- frequent apnoea (despite caffeine in preterms)

Non-Humidified Low Flow Nasal Cannula –NHLFNC (Pernasal Oxygen Therapy)
- Maximum 1 L/min
- Remember this is cold and non-humidified gas

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References


**Vapotherm ‘Precision Flow’ Setup Using Disposable Patient Circuit (DPC)**

Refer to Precision Flow Instruction Manual- **Setup should be performed by trained personnel only** – setup and operation [training video](#) is available:

1. Attach oxygen and air supply to wall outlets
2. Open Vapotherm disposable circuit. Connect cartridge to water path unit (either way up), lining up ports. Press firmly into place.
3. Attach delivery tube to bottom of water path unit first ensuring that the gasket seal is in place

![Gasket](image1.png) ![Missing Gasket](image2.png)

![Insert fully. Both latches must click shut](image3.png)
4. Insert disposable circuit into Vapotherm by sliding door forward, holding unit by handle slide in downwards motion until the unit is firmly in place.

4a Placement of Clamp Spacer – This will ensure the Disposable Patient Circuit is fully seated and mitigate the chance inadvertently unseating from the Precision Flow™. Slide the Water Tube Clamp down and over the white ring on the delivery tube. Place the Water Tube Clamp onto the surface of the disposable so it lays flat on the surface.

5. Close door completely
6. Plug in power cord – indicators will light and a self test will be performed.
   Standby mode starts and Water Out indicator flashes.
7. Connect spike to sterile water bag using aseptic technique and release clamp allowing water to flow into the patient water path unit.
8. Press Standby / Run to start gas flow, pump and heater. **May need to press twice if no display is seen.** The unit will bleep during this test. If all tests are passed the unit will enter Run mode and water will flow into patient delivery tube.

9. The green flashing LED will change to continuous when desired temperature is reached (**from last settings used**).

10. Adjust settings by pressing the control knob repeatedly for each parameter – to set value turn knob for desired value and press to enter

11. When set temperature reached, attach cannula to delivery tube, then to baby.

**Notes:**

- Cannula should be half the diameter of nares.
- Low flow cartridge used for preterm babies, neonates and infants (delivers 1-8 lpm).
- When using flow rates less than 5 lpm it is recommended to set temperature no higher than 34° to minimise condensation.

**Shutting down**

1. Stop the unit by pressing Standby / Run
2. Disconnect from patient
3. Clamp the water inlet tube
4 Open the sliding door, remove disposable patient circuit, discard as per hospital guidelines
5 Disconnect from AC power
6 Disconnect gas hoses

**Changing disposable circuit**
1. As above until step 4
2. Replace with new patient circuit
3. Follow set up instructions

**Changing sterile water**
1. Stop the unit by pressing Standby / Run
2. Clamp the water inlet tube
3. Attach new sterile water bag, unclamp tubing
4. Press Run

**Cleaning**
1. Clean inner housing with Azowipe before and after use
2. Clean outer housing and stand with general purpose wipes

The vapotherm does not have an on/off switch, when plugged in to wall the battery is charged (15 minutes battery life) and the unit is on Standby/Run. The disposable patient circuit can be used up to 30 days on single patient.

If left standing by the cot side the Vapotherm should be set at these settings:
**Flow**: 1 L/min, **Temp** 33°C, **FiO2** 21%. This should keep circuit operational (within 30 days from first use, of course)
1. Low battery or charging
2. Disposable water path faulty or absent
3. Vapor transfer cartridge type
4. Vapor transfer cartridge fault
5. Gas Supply fault
6. Status LED
7. Run / Standby
8. Setting control knob
9. Alarm mute button
10. Alarm muted LED
11. General fault
12. Water out
13. Blocked tube
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