Nasal High flow for respiratory support
(Vapotherm Precision Flow)

Background:

Nasal High Flow (nHF) refers to the delivery of humidified heated and blended oxygen/air at flow rates greater than 1L/min via nasal cannula.
nHF can be used for
- Non-invasive ventilation of extremely preterm / preterm infants
- Non-invasive ventilation for infants with parenchymal lung disease (HMD/pneumonia/CLD/ MAS/ pulmonary hypoplasia/ bronchiolitis)
- Treatment/prevention of apnoea of prematurity

This guideline describes our experience and use of the Vapotherm Precision with a low flow cartridge installed (range 1-8 L/min) to deliver non-invasive ventilation (NIV) from extremely preterm to term infants. We have used this for several years, and it is our routine first line tool for non-invasive ventilation. Our standard policy is to extubate most preterm babies within an hour or two of birth if possible, regardless of gestational age depending on condition. Below 600g BW however NIV is more frequently unsuccessful and it can be difficult to predict which babies can avoid prolonged invasive ventilation. Our aim, as always, is to use the least invasive support possible to achieve stabilisation and minimise adverse outcomes.

How does HF work?
The mechanisms of how nHF works are multiple and probably have differential contributions at different gestations and disease cycles.

- Flush is an important and novel concept, and flush is improved by having small nasal prongs to allow leak. This also means that we never use chin-straps etc as flush relies on the flow of gas escaping!
- Gas conditioning – the evidence is that unconditioned (i.e. gas that is not fully humidified or at 37 degrees) causes adverse compliance changes in lung tissue
- nHF provides some PEEP – the evidence is that nHF gives about 4-5 cm H2O (Pharyngeal pressure) up to 8 L/min. However it is not a CPAP device, and we are not controlling nor weaning PEEP.

How does CPAP compare?

- Reduced work of breathing through chest wall stabilisation, preservation of surfactant, reduction of atelectasis etc
- Some babies seem to be more stable at high mean airway pressures (8-10cm H2O measured at the nares), although there is limited evidence that this is transmitted at alveolar level.
- Stabilisation / opening at a larger airway level.
- PEEP may improve gas exchange at alveolar level
- Other mechanisms may involve e.g. stimulation of nasal mucosa.

Work of breathing may also be reduced by humidification of gases, a particular feature of nHF delivery. There is no difference in the work of breathing between CPAP and nHF.
There is some evidence that synchronised BiPAP (SnIPPV) use in infants at greatest risk of BPD or death (500-750 g) was associated with decreased BPD, BPD/death, neurodevelopmental impairment and death when compared with infants managed with NCPAP. Our experience of successful use of Vapotherm in extremely preterm babies is considerable and we routinely manage babies of 500-600 grams upwards using nHF.

Benefits include

- Babies on nHF appear to be well settled and more comfortable than babies on CPAP.
- Less abdominal gaseous distension than CPAP
- Babies do not require “time off” for nose breaks or changes between nasal prongs / masks, reducing the amount of handling.
- Some evidence for better weight gain and improved feed tolerance.
- Parents have reported preferring being able to see more of their babies face.
- Easier access for cranial ultrasound scans and head circumference measurements.

When to use Vapotherm for non-invasive ventilation:

The recent trials data (Manley/Collins/Yoder etc.) show that nHF and CPAP have very similar overall outcomes. Therefore any baby can be considered suitable for nHF treatment, at any age/gestation, provided they are breathing, do not have congenital abnormalities that make nHF impossible to administer and are not likely to require imminent mechanical ventilation.

We no longer withhold nHF if a baby is from another NICU/SCBU that does not have nHF on the basis that we wish to offer the best treatment, in the judgement of the clinician, to all babies regardless and also that the number of units using nHF is increasing all the time – all Surrey and Sussex SCBU now have at least one nHF unit.

When to decide Vapotherm is not providing sufficient support:

- Recurrent / persistent apnoeas
- Increasing FIO2
- Increasing work of breathing
- Increasing pCO2 / TcCO2 causing acidosis

may indicate that the baby is not responding well to Vapotherm treatment.

Unless intubation and ventilation is required, it is suggested that sNIPPV (BiPAP with trigger) is used as a more aggressive technique of non-invasive ventilation. However babies who are becoming apnoeic due to sepsis etc, will require ventilation and the clinician should not automatically elevate to sNIPPV as intubation may be more appropriate

Our experience is that many babies escalated to BiPAP progress to full ventilation. The failure rate is no worse with nHF than with nCPAP and may be better.

MIST (Minimally Invasive Surfactant Treatment) can be carried out with a baby on nHF with ease.
Setting up the Vapotherm for nHF:

- Wait for desired operating temperature to be reached before placing the cannula on the end of the patient delivery system: Set at 37°C for all flows unless in an open cot, where condensation may become an issue at flows <4l/min.
- Attach appropriate sized nasal cannula. Cannula should ideally not obstruct or be larger than ½ the diameter of the nares.

<table>
<thead>
<tr>
<th>Weight</th>
<th>Cannula type</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.0 kg</td>
<td>Premature</td>
</tr>
<tr>
<td>1.0 - 2.0</td>
<td>Neonatal</td>
</tr>
<tr>
<td>&gt;2.0 kg</td>
<td>Infant</td>
</tr>
</tbody>
</table>

- Adjust the flow to the desired rate and place the cannula on the patient. Operational flow rates range from 1-8 L/min

**Start at flow rate of 7-8 L/min in preterm babies**

- Increasing flow (maximum 8L/min): flow can be increased in increments of 0.5-1 L/min to try to treat increasing oxygen requirements or apnoea of prematurity. However other causes (sepsis, worsening RDS, pneumothorax, exhaustion etc should be considered)
- If the baby is requiring FiO₂ >60%, or has significant persisting respiratory acidosis (pH<7.2) or apnoea s/he is likely to need alternative support.

- Nursing:
  - Minimal handling, quiet and dark appropriately humidified (see guideline) environment
  - Monitoring of heart rate, respiratory rate and SaO₂ as a minimum
  - Transcutaneous pCO₂ monitoring is very useful
  - Blood pressure monitoring intermittently unless UAC/arterial line in place
  - Prone position, tilted head up to minimise work of breathing
  - Orogastric tube preferred initially at least. Nasogastric tube should ensure that nostril not occluded and than tube does not ‘pull’ nares towards cheek.

- Medical checks:
  - Blood gases are indicated if on supplemental oxygen or on clinical grounds. A stable baby in air does not require blood gases to be checked from a respiratory perspective
  - Coordinate examinations, blood tests and procedures with nursing care to minimise handling
Weaning a baby on Vapotherm:
The purpose of weaning is to find the **minimum required level of support** and this process should begin once the baby is stable. This is a clinical decision. Weaning can begin when the baby is stable, which may take hours or days.

**Term Babies and ex-preterms >1.0kg – weaning**
- More proactive weaning should be attempted, aiming to see if the baby will tolerate a reduction towards about 3 L/min which would permit switching off or to low-flow/ambient support. The table below provides a guide to weaning thresholds.

<table>
<thead>
<tr>
<th>FiO2&lt; 0.25</th>
<th>FiO2 0.25 – 0.30</th>
<th>FiO2 &gt; 0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce by 1 L/min 24-48 hourly</td>
<td>Reduce by 0.5L – 1.0L/min 24 hourly depending on stability</td>
<td>Weaning &lt;4L/min usually not indicated</td>
</tr>
</tbody>
</table>

**Preterm Babies – weaning**

*For babies <1.0 kg*
- Babies on flow rates > 6L/min should have these re-evaluated regularly (minimum daily). Preterm infants are at high risk of pneumothorax, RDS and IVH in the first few days postnatally, and stability during that time is particularly crucial.
- For a stable babies, it is suggested that clinicians attempt to wean according to the criteria below until the flow rate is about 4-6 L/min.
- Once the baby is settled in the target range of 4-6L/min we often do not aggressively wean the respiratory support further, unless the baby is in air. Instead, we concentrate on achieving growth and stability, using the Vapotherm to minimise energy expenditure on breathing. Opportunistic weaning may be possible, and babies should have this discussed and documented regularly.

<table>
<thead>
<tr>
<th>FiO2&lt; 0.25</th>
<th>FiO2 0.25 – 0.30</th>
<th>FiO2 &gt; 0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce by 0.5 L/min 24 hourly if stable</td>
<td>Reduce by 0.5L/min 48 hourly, sometimes 24 hourly if stable</td>
<td>Weaning &lt;6L/min usually not indicated but may be possible</td>
</tr>
</tbody>
</table>

At lower flows (less than about 4 L/min), babies being nursed in open-cots may experience “spitting” of water from the nasal prongs due to condensation of the humidified gas. Turning the temperature down to 36 degrees C is usually sufficient to solve this.
For any baby being weaned on Vapotherm

• If a significant and sustained increase in
  o Respiratory rate
  o Oxygen requirement
  o Work of breathing

  is seen in the 24 hours after weaning, then it is a clinical decision whether to revert back to
  the previous flow rate, or to continue at the new flow rate with close observation.

• If weaning has been halted, then it should be recommenced after 24-48 hours if there is no
  other clinical reason to delay.

• Once a baby is on minimal flow (2.5-3 L/min) and clinically stable, then extubation to ambient
  oxygen/air should be attempted. Sometimes babies can be taken off higher flows.

• Attempt to stop if in air and requiring 2.5-3 L/min or less

• Attempt switch to Low Flow Oxygen if in oxygen and requiring 2.0L/min. Some babies may
  rarely need to be weaned to 1 L/min before switching to low flow oxygen.

• Low flow nasal prongs should only be used if there is a persisting oxygen requirement.

• Vapotherm should be disinfected according to guidelines

• The nasal prong circuit is changed weekly

• The disposable patient flow circuit which includes the low-flow cartridge is changed monthly.

• The machine is disinfected after every patient use according to manufacturers guidelines

Contraindications:

• Upper airways abnormalities precluding the placement of prongs

• Need for intubation: ventilatory failure, severe cardiovascular instability, unstable respiratory
  drive with frequent apnoeas

Guideline Details
Written by Dr. Peter Reynolds, Neonatal Consultant
Reviewed by Clinical Management Group March 2010
Approved for use June 2010, Revised June 2011
Reviewed and updated October 2014, next review Oct 2019

References:

5. Armfield M Use of Vapotherm for respiratory support with neonates