Heated, Humidified High Flow Nasal Cannula Oxygen (HHHFNC)
Nursing Management Guidelines

Overview
Humidified high flow nasal cannula air / oxygen (HHHFNC) -defined as a flow greater than one L/min(Wilkinson et al, 2007) - can be used at flow rates of 2-6 L/min for premature infants who are spontaneously breathing to facilitate weaning from nCPAP (Wong et al, 2010; Lampland et al, 2009).

HHHFNC improves oxygenation and reduces the work of breathing by increasing the functional residual capacity and limits complications resulting from nCPAP (Robertson et al, 1996; Saslow et al, 2006; Finer et al, 2009). It also facilitates improved developmental care and parental interaction as it does not limit the infant’s interaction with the environment (Sreenan et al, 2001; Kubicka et al, 2008; Trevisanuto et al, 2009).

The use of the RT 329 Oxygen therapy system (Fisher & Paykel) therapy system provides warmth and humidification to the infant, improving mucociliary activity by limiting heat and moisture loss from the mucosa, decreasing nasal obstruction with hard, dry secretions and improving general comfort. (Kopelman et al, 2003).

Criteria for Use
Currently for use in infants less than 30 weeks gestation (in research trial) who are:
- on 5cms or less nCPAP (mouth closed) OR nCPAP any level but tolerating 6 hours with mouth open OR tolerating 6 hours off nCPAP (any level)
- maintaining oxygen requirements of 25% or less
- respiratory rate generally < 70
- no significant chest recession
- <3 episodes of apnoeas, bradycardias, desaturations in 1 hour for the previous 12 hours
- Average saturations >86% most of the time
- Not currently treated for PDA or sepsis

Patient Safety
- until infants are completely weaned off nCPAP they should be cared for by a registered nurse with additional skills in the use of nCPAP with a maximum of 2 infants to 1 nurse
- Continuous cardio respiratory and oxygen saturation monitoring must be used with hourly observations documented. All alarms must be set appropriately for gestational age.
- All infants are to have a T-piece resuscitation device (Neopuff, Fisher & Paykel) attached to a blended gas supply or a Laerdal bag with the appropriate size mask, checked each shift by the RN.
- Infection control – the circuit should be changed weekly with the date next change due clearly marked.
Flow Rates

- The starting flow rate for HHHFNC is between 2-6 L/min. This will be ordered for each infant by Hi Flow research team and will correlate with nCPAP pressure the infant is receiving. This flow rate will be continued until the infant is weaned off nCPAP. The flow rate will then be weaned gradually as tolerated, with no more than 1 L/min decrease per day.

Equipment

1. Humidifier base (F&P MR 850)
2. Oxygen therapy kit (RT 329) including the auto feed chamber (MR 290)
3. Water for Irrigation (2 Litre Bag)
4. Teledyne oxygen analyzer
5. Oxygen tubing
6. Connector (to bypass humidifier when alternating Hiflow / nCPAP circuits)
   - Outer diameter of both sizes = 2.4mm
   - Septum width 2.5mm or 3.5 mm

Commencing HHHFNC

- Confirm the circuit is correctly set up with appropriate size nasal cannula. Connect the 2 litre bag of sterile water to fill the water chamber. Connect the circuit to the blended gas supply and turn on to flow rate ordered.
- Ensure Teledyne oxygen analyzer is calibrated and inserted in the circuit, with the FiO2 level set at the infant’s current requirements – see oxygen protocol
- Insert nasal prongs into the nares, ensuring that a seal is not possible and the cannula only fill half the diameter of the nares.
- Secure the nasal cannula tubing to the infant’s face using comfeel on the skin and then brown tape, with the cannula sitting comfortably below the nares.
- Support the weight of the circuit tubing to prevent any drag on the nose. The infant must be able to move the head without restriction.
- Observe the response to HHHFNC – adjust oxygen to maintain appropriate oxygen saturation ranges. Assess changes in the work of breathing.

Observation / documentation

- On intensive care chart I/D 630727, record hourly the heart rate, respiratory rate, SpO2 range, HHHFNC settings – flow, temperature, water level- oxygen requirement, isolette temperature and humidity – see levels for oxygen targeting below.
- The axilla temperature should be checked at least 4 hourly / prn with the application of a skin probe to continuously monitor temperature if indicated.
- Calibration of the Teledyne Oxygen analyzer, equipment safety checks (suction, resuscitation devices, alarm settings) should be documented at the beginning of each shift on intensive care chart I/D 630727
- Document any changes in the infant’s condition including response to handling, administration of medications, fluid balance, procedures, investigations and parental interaction.
<table>
<thead>
<tr>
<th>Preterm infant &lt; 37 weeks</th>
<th>Target Oxygen</th>
<th>Alarm limits</th>
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<tbody>
<tr>
<td>Infant in air SpO₂%</td>
<td>Target greater than 90%</td>
<td>88-100%</td>
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<tr>
<td>Infant in oxygen SpO₂%</td>
<td>90 -95%</td>
<td>88-96%</td>
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<tr>
<td>Transcutaneous TcO₂ mmHg</td>
<td>50-60 mmHg</td>
<td>45-70 mmHg</td>
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<tr>
<td>Transcutaneous TcCO₂ mmHg</td>
<td>45-55 mmHg</td>
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<td>92-98%</td>
<td>91-99%</td>
</tr>
<tr>
<td>Transcutaneous TcO₂ mmHg</td>
<td>60 – 80 mmHg</td>
<td>50-90 mmHg</td>
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For the term infant with Persistent Pulmonary Hypertension of the Newborn (PPHN) then discuss target oxygen and alarm limits with staff specialist & document on NICU chart. Modify target oxygen only after discussion with staff specialist / Fellow.

| Transcutaneous TcCO₂ mmHg| 45-55 mmHg | 40-60 mmHg |

**Airway Management**

*Humidification of inspired gases*
- Misting should be observed in the circuit but there should not be excessive rainout
- Ensure the humidifier is set at core temperature (37º C) and there is adequate water in the humidification chamber. Empty the circuit of excess rain out every hour / as required.

*Suction*
Airway suction is not routine and performed on a needs only basis. Indications for suctioning may include: increasing frequency / severity of apnoea, bradycardia or desaturation, slowing of response to tactile stimulation and increasing secretions. The need for suction is assessed by the RN after first confirming the patency of the nasal cannula. If suction is needed the color, consistency and quantity of secretions should be documented.
Positioning and Handling / Developmental Care

The infant should be positioned to facilitate comfort and reduce work of breathing. See developmental care protocols for optimal positioning methods. Ensure the HHHFNC circuit is supported so that there is no drag on the nasal cannula and the infant can move their head without restriction. The use of HHHFNC may allow greater infant mobility than nCPAP. Longer skin-to-skin cuddles may be tolerated with easier interaction with parents and the environment, enhancing developmental outcomes (de Klerk, 2008).

Infant Feeding

Infants cycling on HHHFNC / nCPAP and higher flow rates of HHHFNC will remain on hourly intra gastric feeding to prevent aspiration. Once the infant has been weaned to lower levels of HHHFNC (< 3 L/min) the feed interval may be increased to 2nd hourly. The introduction of sucking feeds should be considered if the infant is demonstrating “ready to feed” signs and has no evidence of respiratory distress.

Prevention of complications

Excessive pressure delivery

If the nares are completely occluded by the nasal cannula and the infant’s mouth is closed it is possible to deliver excessive pressure to the infant’s airway, resulting in the potential for significant lung overexpansion (Wilkinson et al, 2007, Kubicka et al, 2008). Ensuring that the nares are not able to be occluded by using the correct size nasal cannula will prevent the delivery of excessive pressure. There has been a case report of subcutaneous scalp emphysema, pneumo-orbitis and pneumo-cephalus in a neonate on HHHFNC (Jason et al, 2008).

Infection / Nasal obstruction

The use of HFNC without adequate humidification or heat has been shown to increase infection rates, decrease mucocilliary action, create hard, dry secretions and / or nasal obstruction / or bleeding (Kopelman et al, 2003). The use of humidified gases at core temperature decreases the risk of these issues. Ensure that the humidifier is on with the temperature maintained at approx 37°C whilst HHHFNC is in use. Excessive rainout may also cause obstruction of the nasal cannula, potentially leading to apnoea, thus close observation of the circuit tubing and removal of excessive rainout is vital.

If rainout is unable to be controlled on lower flow rates the humidifier may be changed to the lower temp mode. Observe closely to ensure adequate humidification occurs and secretions do not change, as described above. If this occurs the infant may be able to trial cessation of HHHFNC and changing to low flow nasal cannula oxygen.

Nasal Irritation / trauma

Whilst much less likely, nasal irritation from the cannula is possible. If the taping holding the cannula in place becomes too tight or the nasal cannula move to rub on the nares, retape in a more appropriate position. In very preterm infants the use of extra comfeel may be indicated.
Gastric Distension
As with nCPAP, infants receiving HHHFNC, especially at the higher flows may develop gastric distension. All infants must have an intra gastric (IG) tube (size 5Fg if feeding / size 8Fg if NBM) in situ. Between the feeds the IG tube is attached to an open, elevated syringe to promote gastric venting of air. It may be necessary to close the IG tube immediately after feeds (maximum of 10 minutes) to promote the absorption of feeds.

On lower levels of HHHFNC (< 3L/min) the IG tube may remain capped unless the infant shows signs of gastric distension.

Retinopathy of Prematurity
Limiting the time oxygen saturations are outside appropriate range for gestation will reduce the risk of ROP (Martin & Janes, 2004). Ensure that alarms on the monitors are correctly set and acted on promptly if necessary.

Resumption of nCPAP
Infants may not tolerate cessation of nCPAP and should be observed closely for signs of increased respiratory effort. nCPAP should be recommenced if any 2 of the following criteria are demonstrated. Discuss with RN in charge of shift / registrar if unsure:

- ↑ work of breathing (intercostal recession and the use of accessory muscles) with a sustained respiratory rate maintained >75/min
- ↑ apnoea and / or bradycardia and / or desaturations >2 in 1 hour for the previous 6 hour period.
- ↑ oxygen requirements >25% to maintain SpO2 >86%
- pH < 7.2
- PaCO2 >65mmHg
- apnoea / bradycardia requiring resuscitation

All nurse clinicians should ensure they are familiar with the study protocol

High flow nasal cannula for weaning preterm infants from CPAP Trial (HiFloW Trial) – pilot study

RPA Newborn Care Clinical Practice Guidelines
Main author: Sue Oliver CNS, November 2010, revised July 2011
For revision November 2013.
References


Lampland AL, Plumm B, Meyers PA, Worwa CT, Mammel MC. Observational study of humidified high flow nasal cannula compared with nasal continuous positive airway pressure. J Paediatr 2009; 154: 177-82


Wong W, Rajsekhar H, Rastogi D, Gupta A, Bhutada A, Rastogi S, editors Prospective Randomised Control Trial of Weaning from CPAP in VLBW Babies. PSA-SPR: 2010