52 Heated Humidified High Flow Nasal Cannula

The use of heated humidified high-flow nasal cannula (HFNC) has emerged as an alternative to CPAP in recent years. Its popularity is related to its ease of application and maintenance, less nasal trauma, better tolerance, and most importantly better access for care giving, skin-to-skin care and feeding.[1]

HFNC therapy refers to the administration of oxygen or blended oxygen and air to neonates via nasal cannulae at higher flow (greater than 1 L/min.).[2] Just as a CPAP, the delivery of gas flow rates between 2 and 10 L/min to the nasopharynx has been shown to develop positive distending pressure in both preterm and term neonates. However, the pressure delivered is unpredictable and is dependent on the size of nasal cannula, gas flow rate, size of the patient's airway, and the amount of air egress around the nares and mouth.[3]

Mechanism of action of HFNC is similar to other modes of non-invasive respiratory support and includes:

1. Support to the pharynx and splinting of the upper airways
2. The heated and humidified gas decreases the metabolic work of breathing and reverses the dryness and mucosal injury that would otherwise occur at high gas flow rates
3. Delivery of positive distending pressure to the airway recruits alveoli and stabilizes the both large and small airways and the alveoli at end-expiration thus maintaining FRC. This in turn improves oxygenation and decreases the work of breathing.
4. The high gas flow rate washes the nasopharyngeal dead space of carbon-dioxide and entrains fresh gas mixture.

Equipment: The Precision Flow (Vapotherm, Exeter, NH, USA) and the Optiflow Junior (Fisher & Paykel, Auckland, New Zealand) are two common devices used for the delivery of HFNC. The essential parts of a Fisher and Paykel HFNC system are described below:

1. Oxygen and air source
2. Blender: FiO_2 can be adjusted in increments of 1% from 21-100%
3. Flow meter: Standard (0-15 L/min) flow meter is used. In neonates, flow rates should not exceed more than 8 L/min.
4. Humidifier: Should be set at 37^0C. At flow rates of 1-4 L/min, both Optiflow and Vapotherm devices achieve an oro-pharyngeal temperature of $33\text{-}34^0$ C and relative humidity (RH) of > 96%. At high flow rates, the temperature and RH achieved by these devices are lower than that by bubble CPAP or ventilator CPAP.[4]
5. Circuit tubing to attach to humidifier
6. Nasal cannula (prongs) to attach to humidifier circuit tubing
7. Water bag for humidifier

Indications for use of HFNC in neonates

1. Post extubation support: HFNC used as alternative to CPAP for post-extubation support in preterm neonates has shown similar rates of treatment failure and re-intubation rates[5]. Neonates treated with HFNC had reduced nasal trauma rates by 36%. Though the failure rate was similar across different gestational groups, the number of preterm neonates < 28 weeks' gestation studied was small.
2. To aid in weaning from CPAP in preterm neonates: Although the best way to wean CPAP is to take the neonate off CPAP and to reinstate the therapy if indicated, HFNC has been used in the interim as a bridge to transition to room air. Two studies found that preterm neonates randomized to HFNC had reduced duration of hospitalization compared with those who remained on CPAP with no difference in success of weaning.[5]
3. As an alternative to CPAP in stable preterm neonates who are at risk of or have established nasal trauma or for better nursing care to promote mother-infant bonding, kangaroo care and oral feeding.
4. As a primary mode of support in preterm neonates with

RDS: Three[6,7,8] non-inferiority trials compared the use of HFNC versus CPAP as a primary mode of respiratory support among neonates 28 weeks with RDS. While two trials showed a significantly higher rate of treatment failure with HFNC, the third trial showed an efficacy and safety similar to those of nCPAP. The available evidence does not support the use of HFNC as a primary treatment of RDS for neonates 28 weeks' gestation.

Contra-indications

Neonates with severe RDS, recurrent apnea, pneumothorax and cranial and airway anomalies are not suitable candidates for HFNC therapy.

Initiation and escalation and weaning of HFNC therapy[9]

1. Choosing an appropriate sized nasal cannula: Nasal cannula should occupy ***less than 50%*** of the area of the aperture of the nostril to allow ample egress of expired gas. A snugly fitting or tight nasal cannula can lead to generation of inadvertently high distending pressures in the nasopharynx.
2. Setting flow rates: An initial flow rate of 4-6 L/min is recommended. Our unit policy is to begin flows based on current weight of the neonate as follows: for 1000 to 1999 g = 3 L/min, for 2000 to 2999 g = 4 L/min, and for ≥3000 g = 5 L/min.
3. FiO_2: Begin at 40% or FiO_2 similar to ventilatory or CPAP settings. Pulse oximeter should be used to titrate FiO_2.
4. Conditioning of respiratory gases: The humidifier should be set at 37^{0}C. However if there is 'rain out' in the circuit at flow rates <4 L/min, it may be necessary to lower the set temperature to 34^{0}C - 35^{0}C.
5. Monitoring during therapy: Neonates on HFNC requires the same level of monitoring as those on CPAP. Monitoring should include respiratory rate, heart rate, chest retractions and degree of chest-in drawing. Use of an objective scoring system like the Silverman score is recommended.
6. **Escalation of therapy**: Flow rates can be increased in

increments of 1 L/min up to a maximum of 8 L/min in response to increased chest retractions, tachypnea and increased oxygen requirement.

7. **Failure of HFNC:** Increasing FiO_2 requirement >40%, respiratory acidosis (pH 7.2 and pCO_2> 60 mm Hg) or recurrent episodes of apnea requiring positive pressure ventilation should be considered as failure of HFNC and an alternative respiratory support (CPAP/ intubation) is mandated.
8. **Weaning of HFNC:** Once the neonate is stable on HFNC for 12-24 hours, one can consider weaning. FiO_2 is weaned first and then the flow rate in decrements of 1 L/min every 12 or 24 hours, guided by work of breathing and oxygen requirement. Once a flow rate of 2 L/min is reached, HFNC can be discontinued. Neonates requiring minimal oxygen prior to discontinuation may need to be placed on low flow titrated oxygen therapy.

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