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Heated Humidified High Flow Nasal Cannula Therapy is a Well-Tolerated Oxygen/CPAP Therapy that can be used with Bronchodilators and/or Heliox for Patients with Acute Respiratory Distress

Abstract

Heated Humidified High Flow Nasal Cannula systems are effective at providing acute respiratory failure patients with oxygen, bronchodilators, and even heliox. Within the past five years heated humidified high flow nasal cannula systems (HFNCs) have been shown to be effective as a first line therapy, a daily therapy, and even as a bridge to lung transplantation, intubation, and/or intubation avoidance. This review goes over the physiological effect of HFNCs, the use of bronchodilators through HFNCs, and an example of a successful heliox therapy using an HFNC system to avoid re-intubation in an infant.

Keywords: CPAP; Heliox; HFNC

Mini Review

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Introduction

Heated Humidified High Flow Nasal Cannulas or HFNCs can now be used as first line oxygen therapy, daily oxygen therapy, and bridge oxygen therapy for patients with acute respiratory distress based on recent scientific evidences. This is currently relevant because many recent studies have been published with evidence of oxygen therapy effectiveness coupled with high patient comfort while using a HFNC system.

In many cases patients with a 'DNI' or 'Do Not Intubate' order are given HFNCs because they refuse intubation. HFNCs in this regard have been very successful. In April 2013, a study on HFNC therapy on 'Do not Intubate' DNI patients with Hypoxemic Respiratory Distress. They used a HFNC system to delivery oxygen at flows ~ 42.6 liters per minute. They found that HFNC oxygenation reduced the hypoxemia in DNI patients and also reduced the need for non-invasive positive pressure ventilation. 82% of their HFNC patients did not require escalation to NIPPV or mechanical ventilation [1]. This review shows how HFNCs may be used not just as a 'DNI' patient's therapy but as a first line, daily, and adjunct therapy for patients with respiratory distress.

Physiologic Effects of HFNC

We guessed that Continuous Positive Airway Pressure or CPAP was produced by HFNC and that action was first noticed in 1993 by Locke et al. Wettstein illustrated that HFNC typically is used from 30 to 50 Lpm and can produce about a 3-5 cm H_20 CPAP pressure [2]. But these were just estimates.

Until recently there was little evidence explaining the likely mechanisms of action attributed to HFNCs, namely the delivery of positive airway pressure, active humidification, and nasopharyngeal wash-out. We know now that the HFNC produces nasopharyngeal airway pressures around [(For 30 Lpm) 1.5 cm H_20 + .6 cm H_20, (for 40 Lpm) 2.2 cm H_20 + .8 cm H_20, and (for 50 Lpm) 3.1 cm H_20 + 1.2 cm H_20] [3].

Studies have shown that adult and child flow rates are from 30 to 60 lpm, infant flows up 8 lpm, and neonatal flows up to 5 lpm.

For infants with bronchiolitis they found that, "On average, nasopharyngeal pressure increased by 0.45 cmH2O for every 1 L/min increase in flow rate." They used flow rates > 6 lpm [4].

In Hanlon's article on HFNC therapy for infants and young children with bronchiolitis he quotes Beggs, Wong, Ogen, and Walters in 2014, describing HFNC systems for infants with bronchiolitis, 'This is known as high-flow nasal cannula therapy and it allows the comfortable delivery of these high flow rates, which may improve ventilation, and may lead to a reduced need for invasive respiratory support.' [5].

The mean nasopharyngeal pressure that shows clinical improvement is 3.4 cm H_20 [6]. Figure 1 illustrates the experimental setup that the researchers came up with for their pressure values.

Bronchodilator Therapy through a Heated Humidified High Flow Nasal Cannula Heated Humidified High-Flow Nasal Cannulas (HFNCs) are great for non-compliant patients with hypoxemia who need high flows and a small amount of PEEP, yet can we given them an effective Bronchodilator treatment through one? The HFNC flow is 20-60 liters per min., the fear of using these high flows for short acting beta agonists is that the medication will simply be deposited in nasopharyngeal and large airways, or flushed out of the lungs before the patient has a chance to get lower airway deposition. A study in 2014 by Golshahi et al. used a submicrometer particle generated by a condensational growth

technique to enhance the dose reaching the lower respiratory tract while using a HFNC during realistic breathing cycles. They found that intermittent aerosol delivery can be used and is efficient in delivering nasally administered drugs, such as Albuterol to patients using HFNC [7].

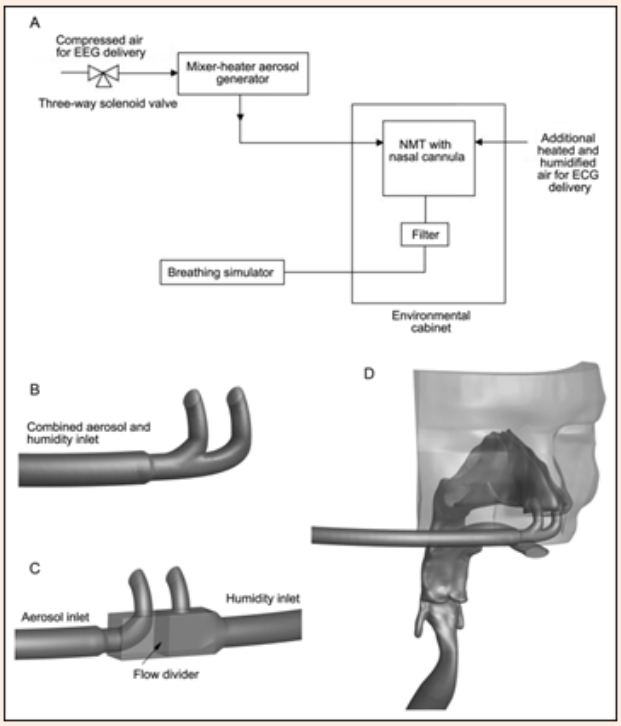

Figure 1: The experimental setup for in vitro controlled condensational growth.

A: Schematic diagram.

B: Excipient-enhanced growth (EEG) nasal cannula.

C: Enhanced condensational growth (ECG) nasal cannula.

D: Nose-mouth-throat (NMT) model, including the facial structure, shown with EEG nasal cannula.

Heliox delivered through HFNC

In a case study of a 10-month-old male infant, HFNC was already in place post extubation and as a last resort pre re-intubation Heliox was administered through the HFNC. Earlier the infant had been intubated in the field and then transported to a local ED in Chicago for seizures. When his seizures were stabilized and the patient was extubated the patient was placed onto HFNC (Heated Humidified High-Flow Nasal Cannula). The patient's work of breathing increased to the point of the pediatric intensive care unit team's concerns increased about the patient's impending intubation. This patient was infected with the Coronavirus and it had caused a severe acute air-flow obstruction and almost lead to the infant's re-intubation. Patients with airflow obstruction can be very hard to manage on a mechanical ventilator, therefore a trial of Heliox via HFNC was used. "The lower density and higher viscosity of heliox relative to nitrogen oxygen mixtures can significantly reduce airway resistance when an anatomic upper air-flow obstruction is present and gas flow is turbulent." The patient's breath rate was 60-70 bpm with +4 to +5 suprasternal chest retractions and nasal flaring, which improved to 31-36 bpm with +2 and +3 subcostal retractions with improved nasal flaring within the first 1 minute. They used a 60/40 Heliox mix but later changed it to a 70/30 helium to oxygen mix. They were able to discontinue Heliox by day 3 and by day 10 the patient was discharged from the ICU. Seven days after ICU discharge the patient was discharge home. They only had one incidence of the patient experiencing desaturation and/or tachypnea, but that was because the helium line had been disconnected, when the line was replaced the patient's breath rate and saturation returned to acceptable levels [8]. Figure 2 shows a HFNC heliox setup.

Figure 2: Setup for delivering heliox via a HFNC in the center and the heliox tank is on the right.

Patient Tolerance

How can we aid the patient in breathing if the patient is unable to tolerate the treatment being given? HFNC therapy increases patient therapy tolerance. In a 2015 study, they showed that subjects with acute hypoxemic respiratory failure are easily treated with a heated humidified high-flow nasal cannula (HFNC) and noninvasive positive pressure ventilation (NIPPV), but HFNC is tolerated by patients more than standard oxygen therapy and NIPPV with a higher level of comfort reported by the patients [9].

HFNC as a first line, daily, and/or bridge oxygen therapy

HFNCs reduce ventilatory requirements by flushing the anatomical dead space and improves oxygenation by meeting inspiratory flow demands with higher levels of patient comfort.

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In an observational study this February 2015, the researchers found that after 1 year that ¼ of their HFNC patients didn't need ventilatory escalation to NIPPV or standard intubation and mechanical ventilation. They showed that HFNC can be used for first line treatment of ARDS in patients who do not require intubation and also in all phases of the management of ARDS [10].

Conclusion

A greater knowledge has been accrued within the past five years on how to effectively deliver oxygen, bronchodilators, and helium with a heated humidified high flow nasal cannula system that may relieve patients with respiratory distress with high levels of patient comfort. Wettstein states that 'therapists need to actively promote wider usage of this treatment modality.'2 Heated Humidified High Flow Nasal Cannulas should be used for first line, daily, and bridge oxygen therapy for patients with acute respiratory distress.

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