Mini Review

The Role of High Flow Nasal Oxygen Therapy in Adult Intensive Care Unit

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Abstract

Hypoxemia is the most life threatening condition experienced in the intensive care units. The health care professionals should be well versed with the management of hypoxemia. There are several oxygen therapy devices used starting with Low flow systems, high flow systems and reservoir system. Each oxygen therapy device has its own pros and cons and the clinician choses the best device based upon the experience as well as evidence based practice. Recently a device known as High Flow Nasal Cannula oxygen Therapy (is been used to improve oxygenation in critically ill patients. High Flow nasal cannula has control over three parameters such as flow, Fio2, and temperature. All these parameters are important for the patient where high flow oxygen is going through the nasal cannula. HFNC is used in the conditions such as early ARDS, Hypoxemia, acute COPD, postextubation, sleep related disorders, acute heart diseases. However more studies should be conducted in patients with High Flow nasal cannula oxygen therapy to use it more frequently in intensive care units.

Keywords: Oxygenation; High flow nasal cannula; Life threatening; Intensive care unit

Abbreviations: HFNC: High Flow Nasal Cannula; NIV: Noninvasive Ventilation; Fio2: Fraction of Inspired oxygen; COPD: Chronic Obstructive Pulmonary Disease; ARDS: Acute Respiratory Distress Syndrome ICU: Intensive Care Unit; PEEP: Positive End Expiratory Pressure; CPAP: Continuous Positive Airway Pressure

Introduction

Oxygen therapy devices are often used in intensive care units to provide oxygen support. The devices are classified into three categories namely low flow, High flow and reservoir systems. A device known as High flow nasal cannula oxygen therapy is used in the treatment of hypoxemic respiratory failure [Figure 1].

High-Flow Nasal Cannula (HFNC) oxygen therapy consists of an air/oxygen blender, an active humidifier, a single heated circuit, and a nasal cannula. It delivers adequately heated and humidified medical gas at up to 60 L/min of flow [1,2] Evidence of the use of high flow nasal cannula with critically ill adults are poor; however, physicians often make use of this therapy in different patient conditions such as hypoxemic respiratory failure, COPD, post-extubation, pre-intubation sleep disorders and heart failure. [2,3] There are few publications which suggest that HFNC reduces the respiratory rate, work of breathing and decreases the requirement of ventilator assistance with different disease condition. [3] There are few vital problems which are not resolved such as indication, timing of initiation and discontinuation of HFNC. Despite these issues, HFNC oxygen therapy is a very effective and important therapy for the early management of the patients with respiratory failure associated with lung diseases. [3]

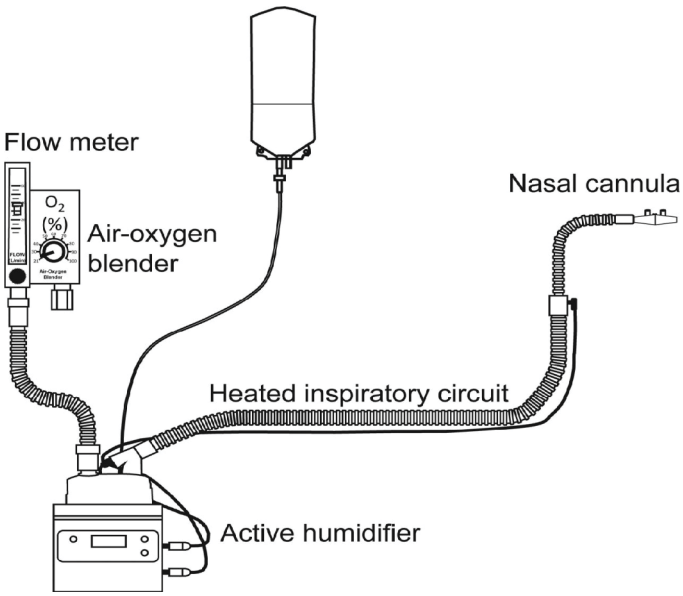

Figure 1: Schematic representation of High Flow Nasal Cannula (HFNC) device with its components (Flowmeter, air oxygen blendor, active humidifier, heated inspiratory circuit, and nasal cannula).

Physiological Mechanism

High flow nasal cannula has been getting wide popularity as a replacement for providing breathing assistance in serious ill patients. High flow nasal cannula has three control parameters which are temperature, Inspiratory flow, and Fio2. Temperature can be set at 37°C, and Fio2 between 0.21 to 1.0, flows till

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60 l/m. The warm and humidified gas has delivered at high flows have a potential physiological effects. [4] High flow nasal cannula oxygen therapy provides the supplemental oxygen therapy to the lungs and humidifies the patient's airways. The oxygen percentage values given through nasal high flow are more accurate, fixed and more eminent as compared with conventional oxygen therapy devices. [5,6] The main reason of delivering high Fio2 and high flows is to generate a positive pressure which is related with the flow rate. [5-8] The calculation of the pressure produced throughout the respiratory cycle shows that elevated pressures are found during the phase of respiration are mainly flow dependent. [9] This type of process is similar to the implementation of positive pressure which leads to opening of the collapsed alveolar area and causes increase the lung volumes at the end of exhalation by 25%. Patients with higher body mass index will have increased lung volumes despite change in the body position. [10] Further there is increase in the lung compliance and patient breathes at a very slower rate with 10% higher tidal volumes. The other mechanism of action of HFNC is reduced dead space ventilation that reduces the rebreathing of the exhaled air in a flow dependent fashion that leads to increased gas flow. The gas flow forwarded by this device is confirmed in the studies with upper airways models and on healthy subjects. [11,12] Sleep and awake stages also varies the ventilator response in patients. In wakefulness the frequency is reduced and tidal volume is increased whereas during sleep the respiratory rate remains the same but there is a decrease in tidal volume. This results in 20% decrease in minute volume. The implementation of high flow nasal cannula oxygen therapy has different results on the respiratory system such as increased exchange of gas, reduction in breathing frequency and effort, escalation of the lung volumes, improved compliance and trans pulmonary pressures. [13]

Clinical Implications Hypoxemic Respiratory Failure

Low flow and high flow oxygen therapy devices are primarily used to treat hypoxemic respiratory failure. Unfortunately both the types of devices do not heat and humidity the inspired oxygen at high flows, and the increased entrainment of the room air also causes dilution of the FIO2. [14] The beneficial effects of high flow nasal cannula oxygen therapy are seen in in patients with acute respiratory failure on oxygen mask and high flow nasal cannula. [15] Sztrymf et al. conducted a study on outcome and immediate application of high flow nasal cannula oxygen therapy in critical care unit with hypoxemic respiratory failure showed significant reduction in respiratory rate, heart rate, thoraco abdominal synchrony and increase in oxygen saturation measured by the pulse oximeter. These improvements were seen in first 15-30 min of application of high flow nasal annual without any side effects. [16]

Immuno compromised patients

The risk of mechanical ventilation is highest due to the complications assosciated with mechanical ventilation due to immunosuppressive status. Therefore it's very necessary to opt for noninvasive method of ventilation in these victims. Noninvasive ventilation is the therapy to avoid complications related to endotracheal intubation and mechanical ventilation. [17] Two studies were done in an immune compromised patient on both NIV as well as HFNC. In both the studies the rate of mortality and intubations were much lower with HFNC as compared to NIV. [17,18] Type II Respiratory Failure- the patients of such category are connected to non- invasive ventilation that prevent the risk of ventilator dependency in intubated patients. Some patients may not be comfortable with mask and related complications such as pressure sores, and claustrophobia. [19] HFNC can be the other alternative in such cases to maximize the comfort by increasing the tidal volumes. [20] Nillius et al. [21] revealed that individual responses to HFNC in COPD patient varies in some patients breathing frequency decreased and in some PaCo2 is decreased. HFNC is definitely a worthy therapy in hypercapnic respiratory failure.

Post extubation respiratory failure

Intubation is the common encountered problem in the intensive care units, leading to longer stays in hospital with increased mortality. There are different causes for reintubation such as unplanned extubation, unresolved underlying condition, vocal cord edema, upper airway obstruction and stridor HFNC improves oxygenation and reduces the need of increasing the ventilator support and reintubation. [22,23]

NIV is used to improve oxygenation in a critically ill patient to avoid complications during endotracheal intubation, HFNC could be used to deliver high percentage of oxygen and prevent any disconnections during the apniec period of endotracheal intubation [24-26] Miguel montanes et al. conducted a clinical trial to study the effects of high flow nasal mask and non-rebreathing mask. In his study he found that the median saturation of non-rebreathing mask was 94% whereas saturation median on HFNC was 100%. [27]

Heart failure

There are various methods to improve oxygenation in heart failure patients. HFNC is an alternative to provide supplemental oxygen through nasal cannula. A study was done to observe the effects of HFNC on subjects with dyspnea and hypoxia post NIV. Carratala pearles et al. observed that the patients showed clinical improvements and were successfully treated by HFNC [28,29] Sleep apnea-obstructive sleep apnea is caused due to upper airway collapse with hypoxia, neurocognitive dysfunction and cardiovascular diseases. CPAP is the best treatment for obstructive sleep apnea. [30] Mcginnley et al. found that HFNC was effective in reducing the arousals Sleep related breathing abnormality is very frequent in stroke cases which in turn can lead to neurological worsening and increased mortality. HFNC of 18 l/m of flow has been shown to decrease the apnea/hypopnea index and oxygen desaturation. [31]

Adverse effects of HFNC

Noninvasive ventilation to some extent can delay the endotracheal intubation. HFNC provides humidified inspired gases at higher flows. [32] More recently HFNC was compared with NIV and has shown similar effects in regards to frequency of intubations, survival rate in critical care units, ICU mortality and breaks in ventilators support. [33] Hegde and prodhon documented three life threatening conditions of air leak syndrome related to HFNC. A two month old infant had a pnuemothorax on the

right lung that was diagnosed with respiratory viral dieases with bronchiolitis who was on 8 l/m flow of oxygen the second case had Pnuemomediastinum in a sixteen year old male who was diagnosed with cerebral disorders and was receiving 20 l/m flow. The third case was a 22 month patient with no comorbidities who had right sided pnuemothorax with sub dural heamatoma who was on 6 l/m flow. Such complications can occur in adults also. [34]

Conclusion

There is various oxygen delivery systems used to prevent hypoxia in a critically ill patient. Non-invasive ventilation is also used to treat severe hypoxia and hypercapnia. The mask interface on the patient sometimes feels uncomfortable and claustrophobic for the patient. According to the current trends High flow nasal cannula oxygen therapy has become very popular in intensive care units. Although it's been mainly used in neonatal and pediatric ICU, some studies have shown positive outcomes in adult intensive care unit.

HFNC provides high FiO2 and flows through an active humidifier with a single limb ventilator circuit. The three control parametres which can be set are temperature, Inspiratory flow and FiO2. HFNC is basically used in a hypoxemic respiratory failure, early ARDS, hypercapnic respiratory failure, obstructive sleep apnea and post extubation support to prevent reintubation. HFNC is also used for pre-oxygenation of the patients according to some studies. However there is lot of financial constraints for the use of the device. The accessories of the device are costly as well as it is difficult to convince the relatives for the beneficial effects considering the cost. Last but not the least, HFNC is definitely a promising therapy which can be used in any age group most of the successful studies have been done in hypoxemic respiratory failure. Several multi center studies should be conducted for the assessing the utility of the high flow nasal cannula oxygen therapy. Several multi center studies should be conducted for the assessing the effectiveness of the high flow nasal oxygen therapy.

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