International Journal of Advances in Medicine
Patel A et al. Int J Adv Med. 2019 Apr;6(2):460-463
http://www.ijmedicine.com
pISSN 2349-3925 | eISSN 2349-3933

DOI: http://dx.doi.org/10.18203/2349-3933.ijam20191159

Original Research Article

Is high flow nasal cannula as an effective oxygen delivery alternative in intensive care unit?

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Received: 13 March 2019
Accepted: 15 March 2019

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ABSTRACT

Background: High-flow nasal cannula (HFNC) oxygen therapy is carried out using an air/oxygen blender, active humidifier, single heated tube, and nasal cannula. It is an oxygen delivery system which uses air blender to deliver accurate oxygen concentration to the patient from 21% to 100% at desired temperature. It can be administered via wide bore nasal cannula or to the tracheostomy tube via connector. It can give upto 60L/min flow hence can generate positive end expiratory pressure between 2 to 7 cmH20. By providing humidified oxygen along with the high flow rates it satisfies air hunger and reduces work of breathing for the patient.
Methods: This is a retrospective observational study. Patients with persistent hypoxia in spite of conventional oxygen therapy were treated with HFNC. Patients with possible need for immediate invasive ventilator support were excluded. Clinical respiratory parameters and oxygenation were compared under conventional and HFNC oxygen therapy.
Results: Thirty patients, aged more than 18 years admitted in intensive respiratory care unit with acute hypoxemic respiratory failure from June 2017 to January 2018 were included in the study. Study period was of 6 months. Etiology of acute respiratory failure (ARF) was mainly pneumonia (n = 17), interstitial lung disease (n = 5), bronchial asthma (n=3) and others (n = 5). There was statistically significant reduction in respiratory rate (29.40 before Vs 23.50 after; P- <0.0001) and significant improvement in comfort level of the patient after HFNC therapy. Median duration of HFNC was 48 hrs (24-360) hours. Five patients were intubated later on and 4 died in the intensive care unit.
Conclusions: Use of HFNC in patients with persistent ARF was associated with significant and sustained improvement of clinical parameters (respiratory rate). It can be used comfortably for prolonged periods.

Keywords: HFNC, Pneumonia, Respiratory failure

INTRODUCTION

Supplemental oxygen administration is the first-line treatment for acute hypoxemic respiratory failure. Oxygenis usually delivered through high-Flow devices such as non-rebreathing face mask.[1-3] Using conventional devices, oxygen flow is limited to no more than 15L/min. Another limitation with conventional oxygen administration is the substantial mismatch between oxygen flow and the patient's inspiratory flow leading to difficulty in titration and delivering exact FiO2. In acute hypoxemic respiratory failure patient's inspiratory flow varies from 30L/min to 120L/min. With the conventional oxygen devices maximum flow achieved is 15 lit/min. This results in significant mismatch between supply and demand. An alternative to conventional oxygen therapy is known as HFNC (High Flow Nasal Cannula). High-flow oxygen therapy through a nasal cannula is a technique whereby heated and humidified oxygen is delivered to the nose at high flow rates up to 60lit/min. These high flow rates generate low levels of positive pressure in the upper airways, and the fraction of inspired oxygen (Fio2) can be adjusted by changing the fraction of oxygen in the driving gas from 21% to 100% as per change in minute ventilation. These devices are increasingly used with success in neonates but their beneficial effects in adults with respiratory failure are yet scarcely reported.[4-6]

The device consists of an air/oxygen blender connected via an active heated humidifier to a nasal cannula, through a single-limb heated inspiratory circuit. It delivers a fraction of inspired oxygen (FiO2) from 21% to 100%, with a flow rate up to 60L/min. FiO2 adjustments are independent of the setting flow rate, so that the patient is administered heated humidified high-flow oxygen, with a flow that can be set above the patients maximum inspiratory flow rate, thus increasing confidence about the accuracy of FiO2 being delivered to the patient.[7]

There are several proposed mechanism by which HFNC provides benefit to the patient. HFNC therapy provides nasophayngeal gas flow that is equal to or greater than the patients peak inspiratory flows hence washing out nasopharyngeal dead space and decreasing airflow resistance which translates into reduction in work of breathing. This has immediate impact on respiratory rate and oxygenation. Energy costs are higher when gas is cool and dry; warm and humidified gas produced by HFNC reduces the energy required for gas conditioning.[8] Active humidification improves mucociliary function, facilitates secretion clearance and decreases atelectasis, all of which improve the ventilation perfusion ratio and oxygenation.[9]

It also provides positive end expiratory pressure which helps in recruitment of lung and also improves ventilator mechanics by providing distending pressure to lungs. All the above lead to improvement in lung compliance and gas exchange.[10]

METHODS

A retrospective, observational study was conducted in a tertiary care hospital to investigate the effects of HFNC on respiratory parameters of patients with acute hypoxemic respiratory failure who were not improving with conventional oxygen delivery devices. Patients more than 18 years of age admitted to Intensive Respiratory Care Unit (IRCU) from June 2017 to January 2018 were included in the study.

Inclusion criteria

- Acute hypoxemic respiratory failure (defined by PaO2/FIO2 <300mmHg on oxygen, with or without lung infiltrates),
- Respiratory rate >24 with respiratory distress,
- Patients not improving on conventional oxygen delivery devices.

Exclusion criteria

- Age <18yr,
- Chronic retention of CO2,
- Respiratory acidosis (pH <7.35 and PaCO2 >45mmHg),
- Requiring Immediate Intubation.

Patient characteristics were collected along with etiology of Acute Respiratory Failure. Indications for subsequent need for non invasive or invasive mechanical ventilation were noted. Respiratory parameters were continuously monitored before and after application of HFNC. Oxygen saturation was measured by pulse oximetry. Subjective comfort of the patient was also noted in form of oral intake, communication and participation with physiotherapy session. Data of patients requiring simultaneous intermittent noninvasive ventilation was also collected. Total duration of HFNC therapy, too was noted. Results obtained before and after HFNC regarding improvements in respiratory rate were compared and statistical analysis was done using paired t test. Difference was considered significant if P<0.05.

RESULTS

Thirty patients were included in the study. Their baseline characteristics are detailed in Table 1. Thirteen were male, seventeen were female and the median age was 59 years (32-79 years). 16 patients (>50%) were more than 60 years of age. Etiology of ARF was mainly pneumonia (n = 17), of which 6 were of H1N1 pneumonia, bronchial asthma (n = 3), interstitial lung disease (n=5) and others including patients of RTA, pancreatitis and malignancy. (n = 5). 3 patients with malignancy on palliative treatment also received HFNC.

Table 1: Baseline characteristic of the patients.

Patients characteristics	N=30
Sex ratio (M/F)	13/17
Age (yrs)	59 (32-79)
Indication Pneumonia	17
Asthma	3
Interstitial lung disease	5
Others (malignancy, pancreatitis, RTA, CKD)	5
Duration of HFNC	48hrs (24-360)
Outcome Cured	15
Required Intubation	5
Died	4
Not Known	6
Use of NIV with HFNC	12
Post extubation	3

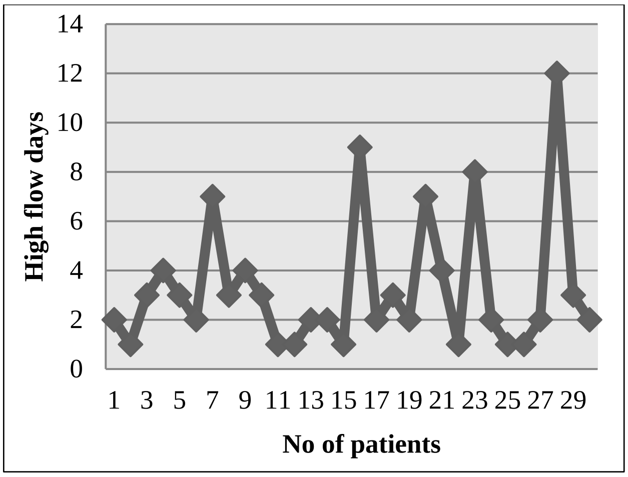

Figure 1: Duration of the HFNC received by patients.

Estimated delivered FiO2 was similar. Use of HFNC enabled a significant reduction of respiratory rate, 29.40 (24-36) vs. 23.50 (18-30) per minute (P<0.001) and increase in oxygen saturation. Participation of patient was better with HFNC. Median duration of HFNC was 48 hrs (24-360) hours. The maximum duration was 360 hours, and more than 50% of patients received more than 48 hours of continuous use as shown in Figure 1. Five patients were subsequently intubated after HFNC initiation. Reasons for intubation were septic shock, increase in Fio2 requirements, radiological deterioration-multilobar consolidation with multiorgan involvement and deterioration of their respiratory status. Benefits of HFNC technique were sustained in the other patients as depicted in Table 2 which shows significant differences in respiratory parameters between baseline and different time points after HFNC initiation.

Table 2: Improvement in respiratory rate before and after HFNC.

	Respiratory rate (before HFNC)	Respiratory rate (after HFNC)
Mean	29.40	23.50
P- Value	<0.0001 (Significant)	

Of the 30 patients, 15 patients including one patient with tracheostomy received HFNC therapy alone. 12 patients were given HFNC with intermittent NIV as they had multilobar involvement with high FiO2 requirements. 3 patients received post extubation HFNC. It was well tolerated and there was no need for reintubation.

DISCUSSION

This study shows the beneficial effects of HFNC as first-line treatment for ICU patients with Acute Hypoxemic Respiratory Failure. Its main results can be summarized as follows: (1) all respiratory parameters significantly improved after HFNC; (2) use of HFNC lead to significant improvement in oxygenation; (3) HFNC was well tolerated for long periods with sustained benefits especially in do not intubate palliative care patients. (4) It was especially helpful in preventing weaning failure in tracheostomized patients and preventing reintubation in patients at high risk of extubation failure. This technique offers an effective alternative to conventional oxygenation.

As stated earlier, there is very limited published experience with HFNC in adults with ARF. Roca et al, were the first to present promising data on respiratory and oxygenation parameters in ICU patients.[10] They showed significant improvement in both clinical and biologic parameters after 30minutes of HFNC in comparison with standard facemask oxygen therapy. Of note, the median duration of conventional treatment before HFNC initiation was more than 4 days, which precludes from any conclusion on the effect of HFNC in the immediate management of ARF. In addition, HFNC was used for 30 minutes only, providing no data on the long term effects of this device. Sztrymf et al, carried out a study in 29 patients of ARF admitted in ICU and monitored respiratory rate before and after HFNC which was similar to our study along with monitoring of heart rate and ABG.[11] They concluded that Use of HFNC in patients with persistent ARF was associated with significant and sustained improvement of both clinical and biologic parameters. Rello et al, applied HFNC to subjects with acute hypoxemic respiratory failure due to influenza A/H1N1:9 of 20 were successfully treated with HFNC, and the 11 others were subsequently intubated.[12]

Studies have also been done comparing HFNC with conventional oxygen devices and non invasive ventilation. Ou X et al, performed a meta-analysis of randomized controlled trials (RCTs) to evaluate its effect on intubation rates and found that the intubation rate with HFNC oxygen therapy was lower than the rate with conventional oxygen therapy and similar to the rate with non-invasive ventilation among patients with acute hypoxemic respiratory failure. This finding is similar to our observation.[13]

The limitations of our study were small sample size and lack of comparison or control arm.

CONCLUSION

It is time to think beyond conventional oxygen devices. HFNC can act as an alternative to NIPPV in acute hypoxemic respiratory failure or can provide NIPPV free hours. It provides significant patient comfort for longer periods and better oxygenation with less work of breathing.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Patel A, Atram J, Dumra HS, Dandnaik M, Raval G. Is high flow nasal cannula as an effective oxygen delivery alternative in intensive care unit?. Int J Adv Med 2019;6:460-3.