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Original Article

# HIGH-FLOW NASAL CANNULA OXYGEN THERAPY IN ACUTE RESPIRATORY FAILURE DUE TO ACUTE EXACERBATION OF FIBROTIC INTERSTITIAL LUNG DISEASE

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## ABSTRACT

High flow nasal cannula oxygen therapy (HFNC) has become frequent in the treatment of patients with acute hypoxemic respiratory failure. Methods. Eleven patients with acute exacerbation of fibrotic interstitial lung disease (ILD) were treated with HFNC after failure of conventional therapy (SatO<sub>2</sub> < 90% offering 100% FiO<sub>2</sub> by non-rebreathing mask or noninvasive ventilation). Ten patients had success with HFNC (not requiring orotracheal intubation) during emergency department admission. HFNC significantly improves clinical variables after 2h: respiratory rate decreased from 33 ± 6 breaths/min to 23 ± 3 breaths/min; PaO<sub>2</sub> increased from 48.7 (38-59) mmHg to 81.1 (76-90) mmHg; PaO<sub>2</sub>/FiO<sub>2</sub> ratio increased from 102.4 ± 32.2 to 136.6 ± 29.4; SatO<sub>2</sub> increased from 85 (66-92)% to 96 ± (95-97)%. HFNC could be an effective alternative in the treatment of acute respiratory failure from acute exacerbations of fibrotic ILD.

**Keywords:** *Respiratory failure; interstitial lung disease; high flow nasal cannula*

Fibrotic interstitial lung diseases (ILDs) represent a pathologically heterogeneous group of diseases in which impaired tissue oxygen delivery occurs. ILDs involve interstitial pulmonary histologic abnormalities that lead to profound impairment of lung physiology and function. Gas exchange is impaired secondary to V/Q mismatching, shunting, and decreased diffusion across the abnormal interstitium<sup>1</sup>. Acute exacerbation of fibrotic ILD is a leading cause of death, often complicated by severe hypoxemia<sup>2,3</sup>.

Noninvasive ventilation (NIV) has been a viable option as it results in better patient survival and lower high-care unit use<sup>4</sup>. However, the increased work of breathing due to decreased lung compliance may be an important factor for poor NIV tolerance in these patients during acute exacerbations<sup>5</sup>. High-flow nasal cannula oxygen therapy (HFNC) provides an alternative to conventional oxygen therapy whereby heated and humidified oxygen is delivered to the nose at high flow rates and the fraction of inspired oxygen (FiO<sub>2</sub>) can be adjusted by changing the fraction of oxygen in the driving gas<sup>6-9</sup>. HFNC has been commonly used in the treatment of patients with acute hypoxemic respiratory failure as it results in greater comfort and oxygenation than standard oxygen therapy delivered through a face mask, also helping decrease the work of breathing<sup>6</sup>.

HFNC might potentially be an alternative to conventional oxygen therapy in patients requiring both high flows and high oxygen concentrations, such as patients with acute exacerbation of fibrotic ILD, to correct hypoxemia and control dyspnea; however, evidence is still scarce<sup>7</sup>. In this prospective analysis, we assessed short-term effects (need for endotracheal intubation, clinical outcomes, arterial blood gases, and length of hospital stay) in patients with acute respiratory failure due to acute exacerbation of fibrotic ILD in the emergency department (ED).

## METHODS

We enrolled 11 patients with acute respiratory failure due to acute exacerbation of fibrotic ILD diagnosed by clinical, physiological, and high-

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resolution computed tomography criteria. This study was conducted in the ED of a university hospital between December 2016 and October 2017. The primary outcome was the proportion of patients who required endotracheal intubation despite HFNC therapy, and secondary outcomes were arterial blood gases, Borg scale, and improvement in vital signs. The study was approved by the Institutional Ethics Committee of our hospital and patients consented to participate.

All patients were treated with HFNC after failure of conventional therapy, defined as arterial oxygen saturation ( $\text{SaO}_2$ ) < 90% with non-rebreathing mask and/or NIV or if conventional therapy was not tolerated.

HFNC was delivered using an Optiflow nasal interface and circuit connected to a heated humidifier (MR730; Fisher & Paykel Healthcare, Auckland, New Zealand) with flow generated through a mechanical ventilator with oxygen therapy software (EVITA XL, Dräger, Lübeck, Germany). This system delivers oxygen at a maximum flow of 50 L/min. Data were collected before and 2 hours after HFNC and included respiratory rate (RR), heart rate (HR), arterial oxygen saturation by pulse oximetry ( $\text{SpO}_2$ ), arterial blood gases as arterial partial pressure of oxygen ( $\text{PaO}_2$ ), arterial partial pressure of carbon dioxide ( $\text{PaCO}_2$ ), ratio of  $\text{PaO}_2$  to the fraction of inspired oxygen ( $\text{FiO}_2$ ), and subjective dyspnea (Borg scale, 0 = no dyspnea to 10 = maximum dyspnea).

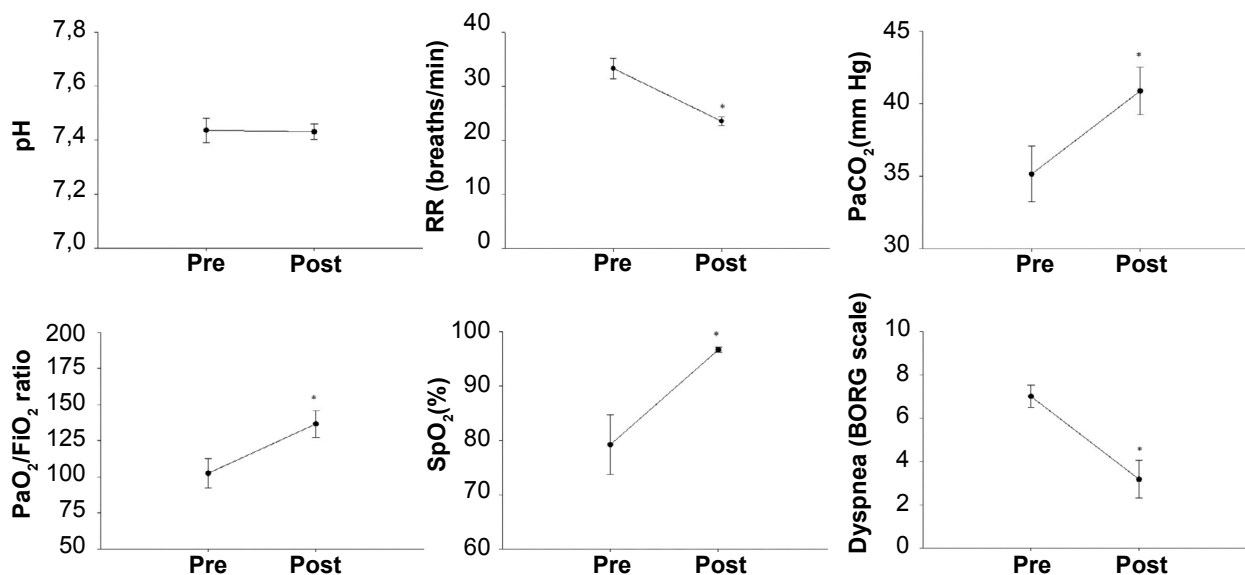
Need for intubation was defined as  $\text{RR} > 40$  breaths/min, signs of high respiratory muscle workload, and  $\text{SpO}_2 < 90\%$  with  $\text{FiO}_2 1.0$ .

HFNC was started in all patients with the flow set at 50 L/min and  $\text{FiO}_2$  to maintain  $\text{SpO}_2 > 90\%$  and according to the patient's comfort and vital signs. Weaning started after improvement of the patient's initial condition with reduction of  $\text{FiO}_2$  up to 40% and flow in steps of 5 L/min until reaching 15 L/min.

Data are expressed in mean and standard deviation and median and interquartile range (25th-75th percentiles). The Shapiro-Wilk test was used to determine the normality of data distribution of the variables, and those with normal distribution were compared by the t-test. The level of significance was set at  $p \leq 0.05$ .

## RESULTS

Eleven patients (7 women) were included in the study (Table 1). The mean hospital stay was  $17.1 \pm 8.4$  days, and total in-hospital mortality was 54%. Patients' vital signs and arterial blood gases improved (Figure 1). One patient (9.1%) required orotracheal intubation in the ED for increased ventilatory effort and desaturation even after the start of HFNC therapy.



**Figure 1:** Changes in pH (A), RR (B),  $\text{PaCO}_2$  (C),  $\text{PaO}_2/\text{FiO}_2$  ratio (D),  $\text{SpO}_2$  (E) and dyspnea (F) before and after 2 hours high flow nasal cannula (HFNC). Lines represent median  $\pm$  standard error. \* $P < 0.01$  comparing before and after HFNC.  $\text{PCO}_2$ , arterial carbon dioxide pressure;  $\text{PaO}_2$ , arterial oxygen pressure;  $\text{FiO}_2$ , inspired oxygen fraction;  $\text{SpO}_2$ , pulse oximetry; subjective dyspnea scale Borg.

Table 1: Baseline characteristics of patients

Characteristic	Result
Age, mean ± SD (yr)	63 ± 8.6
Women, No. (%)	7 (63.6)
BMI, mean ± SD (kg/m <sup>2</sup> )	27.2 ± 4.1
TLC, % of predicted	59 ± 8.8
FVC, % of predicted	48 ± 9.8
<b>Comorbidities, No. (%)</b>	
Arterial hypertension	3 (27)
Diabetes mellitus	3 (27)
COPD	1 (9)
Asthma	1 (9)
Heart failure	1 (9)
Previous use of home oxygen, No. (%)	2 (18)

SD: standard deviation. BMI: body mass index. TLC: total lung capacity. FVC: forced vital capacity. COPD: chronic obstructive pulmonary disease.

## DISCUSSION

This study showed a low intubation rate in patients with acute exacerbation of fibrotic ILD using HFNC. HFNC also improved PaO<sub>2</sub>/FiO<sub>2</sub> ratio and RR with a corresponding lower sensation of dyspnea. These short-term findings may suggest the use of HFNC as an alternative method in this group of patients in the ED.

The decrease in RR with the use of HFNC leads to a consequent decrease in ventilatory effort. This effect may be related to the low positive expiratory pressure generated by the flow of the therapy and may also be related to the improvement in ventilation-perfusion matching<sup>8,9</sup>.

One study investigating the physiological effects of HFNC in patients with acute hypoxemic respiratory failure reported that HFNC delivered at increasing flow rates linearly improves respiratory drive, end-expiratory lung volume, lung mechanics, and oxygenation, while effort and minute ventilation decrease in an exponential manner<sup>10</sup>. These results contribute to understanding why patients

with acute exacerbation of fibrotic ILD in this study had a reduction in ventilatory effort after 2 hours of HFNC therapy. HFNC may be more suitable for the management of acute respiratory failure due to acute exacerbation of fibrotic ILD in which higher positive end-expiratory pressure and/or ventilatory support is required<sup>3</sup>.

Our study has some limitations. The level of patient comfort in relation to HFNC therapy was not evaluated, and future clinical trials enrolling a larger number of patients need to be developed to confirm our findings. In addition, despite the low rate of orotracheal intubation in the ED, we observed a high in-hospital mortality rate, which may be associated with the severity of disease in our patients.

## CONCLUSION

The present results suggest that HFNC may be an effective alternative in the treatment of acute respiratory failure due to acute exacerbation of fibrotic ILD, especially in the ED.

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