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Efficacy of High Flow Nasal Cannula Versus Noninvasive Ventilation in Acute Exacerbation of COPD

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ABSTRACT

Introduction: COPD is a familiar treatable disorder, Despite the availability of various treatment options, there is limited local evidence to guide the most effective and accessible treatment strategies in resource-constrained settings, Non-Invasive Ventilation (NIV) has been widely used as the standard of care for managing AECOPD; however, recent advancements, such as High-Flow Nasal Cannula (HFNC), offer a promising alternative. **Materials & Methods:** There were 200 patients with acute exacerbations of COPD, both male and female, ranging in age from 20 to 70. Individuals suffering from systemic illnesses such as chronic liver disease, heart failure, renal failure, hematological disorders, bronchiectasis, pneumonia, life-threatening hypoxemia, agitation, confusion, bowel obstruction, vomiting, upper gastrointestinal surgery, hemodynamic instability requiring pressors or inotropes, trauma, facial burns, or recent upper airway or facial surgery were not included. Group A received non-invasive ventilation (NIV). Group B received high flow nasal oxygen treatment. The following parameters were used to determine the frequency of treatment success: pH >7.35, a decrease in $PaCO_2$ of >15–20% with SaO_2 (with or without oxygen) of >90%, and a decrease in respiratory rate of >20% compared with spontaneous breathing. All patients were monitored for 24 hours. **Results:** The study's age range was 20 to 70 years old, with a mean age of 57.79 ± 4.93 years. Patients in group A were 57.69 ± 5.01 years old on average, while those in the group B were 57.84 ± 4.91 years old. Out of 200 patients, 132 (66.0%) were males and 68 (34.0%) were females with male to female ratio of 1.9:1. At the end of 24 hours of treatment, 73 patients (73.0%) in group A (noninvasive ventilation) and 89 patients (89.0%) in group B (nasal high-flow oxygen) showed successful with 0.0039 significant p-value. **Conclusion:** This study demonstrated the efficacy of nasal high-flow oxygen is better than noninvasive ventilation in acute exacerbation of COPD.

INTRODUCTION

As the fourth leading cause of death worldwide, chronic obstructive pulmonary disease (COPD) has a negative impact on patient health, hospitalization, and mortality rates.[1] The hospital mortality rate ranged from 28 to 30%, especially for patients with COPD receiving invasive mechanical ventilation. For patients with COPD who suffer from severe hypercapnic respiratory failure, invasive ventilation may be necessary to preserve their lives.[2] In cases of acute exacerbation of COPD, the global plan for the diagnosis, management, and prevention of COPD recommends non-invasive ventilation (NIV) as a weaning-facilitating technique. Without increasing the risk of re-intubation or weaning failure, it lowers hospital mortality and the incidence of pneumonia linked to ventilator use.[3] Studies have shown that it improves gas exchange, reduces respiratory effort, and increases survival.[4]

One high-concentration oxygen method that consistently produces a FiO_2 as high as 100% is the high-flow nasal cannula (HFNC). Patients with severe symptoms who require high-concentration oxygen are more likely to benefit from HFNC than those who need low oxygen flow rates.[5] Therefore, individuals with severe acute respiratory failure who are at high risk of intubation are more likely to receive HFNC. Although HFNC has a well-established role in treating hypoxaemic respiratory failure, there are no specific studies supporting its use in patients with COPD.[6-8] In one trial, the non-invasive ventilation group experienced 16% treatment failure, while the high flow nasal cannula group experienced 27%.[9] In another study[10], the rate of reintubation was 13% with NIV and 27% with high-flow nasal oxygen alone. NIV significantly decreased reintubation rates compared to high-flow nasal oxygen alone after 72 hours and until ICU discharge: 9% (6/64) with high-flow nasal oxygen alone versus 6% (5/86) with NIV, although ICU mortality did not change between groups.[10]

COPD is a familiar treatable disorder, Despite the availability of various treatment options, there is limited local evidence to guide the most effective and accessible treatment strategies in resource-constrained settings, Non-Invasive Ventilation (NIV) has been widely used as the standard of care for managing AECOPD; however, recent advancements, such as High-Flow Nasal Cannula (HFNC), offer a promising alternative. So, this study will be helpful to evaluate the efficacy of HFNC versus NIV in the management of AECOPD and identify the superior treatment strategy to improve patient outcomes, reduce mortality rates, and provide an evidence-based approach for clinicians. There is also no local data on the comparison of these two treatment modalities.

MATERIALS AND METHODS

Following ethical review committee approval, this Randomized control trial was conducted at the Department of Pulmonology, Bahawal Victoria Hospital, Bahawalpur from 12th March 2025 to 11th June 2025. By using WHO sample size calculator for 2 proportions Efficacy of high-flow nasal cannula = 73.0%, Efficacy of non-invasive ventilation = 87.0%[10] Power of study = 80 %, Level of significance = 5%, Sample size = 200 (100 in each group). Patients having age range between 20-70 years of both genders with acute exacerbation of COPD (presence of at least two of the following findings; fever (>98.6 °F or >37 °C), worsening of dyspnea (breathing rate >20/min), increase intensity of cough >3 days, increase sputum volume and increase sputum purulence >3 days, post bronchodilator FEV1 <50% on spirometery were included. Individuals suffering from systemic conditions such as chronic liver disease, heart failure, renal failure, hematological disorders, life-threatening hypoxemia, bronchiectasis, pneumonia, agitation, confusion, bowel obstruction, vomiting, upper gastrointestinal surgery, pneumothorax, trauma, face burns, recent upper airway or facial surgery, and hemodynamic instability requiring pressors or inotropes were not included.

Patients fulfilling the inclusion criteria were enrolled and informed consent was taken from them. All the patients were divided into two groups by using computer generated random number table. While blinding the intervention to the treating team is not feasible due to the nature of the study, outcome assessors and data analysts remained blinded to group allocation to reduce observer and assessment bias. Both groups were followed a standardized treatment protocol, and baseline characteristics such as age, gender, duration of COPD, smoking status, residence (rural/urban), and biomass fuel exposure were recorded to identify and account for potential confounding factors.

According to the British Thoracic Society/Intensive Care Society ventilatory management guideline, non-invasive ventilation (NIV) should be started in Group A with the following initial parameters: inspiratory time of 0.8–1.2 s, expiratory positive airway pressure of 3 cmH2O, inspiratory positive airway pressure of 15 cmH2O, and inspiratory to expiratory ratio of 1:2 to 1:3. To keep arterial oxygen saturation, as determined by pulse oximetry (SpO2), between 88 and 92%, the inspiratory oxygen fraction (FIO2) should be modified. High flow nasal oxygen therapy was administered to Group B, with the initial flow setting being 50–60 L·min−1, the temperature being 37°C, and the FIO2 being regulated to keep the SpO2 between 88 and 92 percent. Every patient received treatment, and they were monitored for 24 hours. Improvement in these parameters—pH > 7.35, a drop in PaCO2 of >15–20% with SaO2 (with or without oxygen) of >90%, and a decrease in respiratory rate of >20% as compared to spontaneous breathing—were used to determine the frequency of success. A reduction in these parameters from the time of admission to the 24-hour mark was deemed successful. All of these parameters were evaluated after 24 hours. Otherwise, it was considered failure) was noted. All the information was collected on proforma. To further reduce bias, objective tools such as pulse oximetry were used to measure outcomes like oxygen saturation, treatment success and mortality. Additionally, confounding variables, including comorbidities, severity of exacerbation, prior hospitalizations, and medication history, were identified and statistically adjusted during data analysis using multivariate regression models. By implementing these measures, the study aims to minimize confounding variables and biases, producing robust and reliable results.

All the data was entered in SPSS V-25. Age and duration of COPD were presented as mean and SD or median (IQR). Frequency and percentage were calculated for gender, residence (rural/urban), smoker (yes/no), occupation (domestic/office/field), biomass fuel exposure (yes/no) and success (yes/no). Chi square/fisher exact test was used to compare success in two groups. Effect modifiers like age, gender, duration of COPD, residence (rural/urban), smoker (yes/no), occupation (domestic/office/field) and biomass fuel exposure (yes/no) were controlled by stratification. Post-stratification Chi square/fisher exact test was applied. P-value ≤ 0.05 was taken as significant.

RESULTS

The study's age range was 20 to 70 years old, with a mean age of 57.79 ± 4.93 years. Patients in group A were 57.69 ± 5.01 years old on average, while those in the group B were 57.84 ± 4.91 years old. Out of 200 patients, 132 (66.0%) were males and 68 (34.0%) were females with male to female ratio of 1.9:1. The mean duration of COPD was 6.61 ± 1.97 years. Table I displays the distribution of patients by different variables.

At the end of 24 hours of treatment, 73 patients (73.0%) in group A (noninvasive ventilation) and 89 patients (89.0%) in group B (nasal high-flow oxygen) showed successful with 0.0039 significant p-value. (Table II).

Stratification of success with respect to age, gender, duration of COPD, residence, smoker, occupation and biomass fuel exposure is shown in Table III.

Table I

Distribution of different variables (n=200).

		Group A (n=100)	Group B (n=100)
		Number (%)	Number (%)
Age (years)	20-45	36 (36.0%)	38 (38.0%)

	46-70	64 (64.0%)	62 (62.0%)
Gender	Male	67 (67.0%)	65 (65.0%)
	Female	33 (33.0%)	35 (35.0%)
Duration (years)	≤3	42 (42.0%)	48 (48.0%)
	>3	58 (58.0%)	52 (52.0%)
Residence	Rural	59 (59.0%)	61 (61.0%)
	Urban	41 (41.0%)	39 (39.0%)
Smoker	Yes	72 (72.0%)	74 (74.0%)
	No	28 (28.0%)	26 (26.0%)
Biomass fuel exposure	Yes	48 (48.0%)	45 (45.0%)
	No	52 (52.0%)	55 (55.0%)
Occupation	**Office**	24 (24.0%)	21 (21.0%)
	Field	46 (46.0%)	45 (45.0%)
	Domestic	30 (30.0%)	34 (34.0%)

Table II

Comparison of success (n=200).

	Group A (n=100)		Group B (n=100)		P-value
	Yes	No	Yes	No	
Success	73 (73.0%)	27 (27.0%)	89 (89.0%)	11 (11.0%)	0.0039

Table III

Stratification of success with respect to age, gender, duration of COPD, residence, smoker, occupation and biomass fuel exposure.

		Group A (n=100)		Group B (n=100)		P-value
		Success		Success		
		Yes	No	Yes	No	
Age (years)	20-45	27 (75.0%)	09 (25.0%)	31 (81.58%)	07 (18.42%)	0.492
	46-70	46 (71.88%)	18 (28.12%)	58 (93.55%)	04 (6.45%)	0.001
Gender	Male	41 (61.19%)	26 (38.81%)	58 (89.23%)	07 (10.77%)	0.0002
	Female	32 (96.97%)	01 (3.03%)	31 (88.57%)	04 (11.43%)	0.185
Duration (years)	≤3	33 (78.57%)	09 (21.43%)	42 (87.50%)	06 (12.50%)	0.257
	>3	40 (68.97%)	18 (31.03%)	47 (90.38%)	05 (9.62%)	0.006
Residence	Rural	45 (76.27%)	14 (23.73%)	55 (90.16%)	06 (9.84%)	0.041
	Urban	28 (68.29%)	13 (31.71%)	34 (87.18%)	05 (12.82%)	0.043
Smoker	Yes	53 (73.61%)	19 (26.39%)	67 (90.54%)	07 (9.46%)	0.007
	No	20 (71.43%)	08 (28.57%)	22 (84.62%)	04 (15.38%)	0.244
Biomass fuel exposure	Yes	29 (60.42%)	19 (39.58%)	39 (86.67%)	06 (13.33%)	0.004
	No	44 (84.62%)	08 (15.38%)	50 (90.91%)	05 (9.09%)	0.319
Occupation	Office	16 (66.67%)	08 (33.33%)	18 (85.71%)	03 (14.29%)	0.138
	Field	35 (76.09%)	11 (23.91%)	40 (88.89%)	05 (11.11%)	0.109
	Domestic	22 (73.33%)	08 (26.67%)	31 (91.18%)	03 (8.82%)	0.059

DISCUSSION

The current study was a randomized controlled one that aimed to compare the high flow nasal cannula versus noninvasive ventilation in acute exacerbation of COPD. The mean age of studied patients was 57.79 ± 4.93 years; 66.0% of them were males while 34.0% were females. In order to compare the efficacy of HFNC therapy to NIV in treating severe AECOPD with moderate hypercapnic acute respiratory failure (ARF), Lee et al.[11] carried out a comparable observational trial. They reported that the median age was 73 (66.5-79) years, 57 patients out of 92 (64.8%) were males. This was also true for study[12] where the mean age was 71.8±8.2 and (65.9%) of patients were males, and McKinstry et al., study where mean age was 68 ±9.0 years and 11(45.8%) were females.[13] Varmaghani et al in 2019 declared that the prevalence of COPD had risen from 5.28% in the < 50 years group to 21.38% in the ≥ 60 years group. Prevalence of COPD was also higher among men. This difference could be due to the fact that smoking is more common among men.[14] In terms of smoking status, the group that had never smoked had the lowest prevalence (7.20%), while the group that currently smoked had the highest prevalence (18.36%).[14] Research suggests that nonsmokers have a far higher prevalence of COPD than previously believed. Ten to twenty percent of COPD patients have never smoked. According to a recent, extensive Canadian study, about 30% of Canadians with COPD are nonsmokers.[15] The discovery of COPD cases in nonsmokers indicates that, in addition to tobacco use, other risk factors for the disease could include genetic predisposition, reduced lung development, respiratory infections, and environmental exposures, such as occupational exposures and indoor and outdoor air pollution.[16]

At the end of 24 hours of treatment, 73 patients (73.0%) in group A (noninvasive ventilation) and 89 patients (89.0%) in group B (nasal high-flow oxygen) showed successful with 0.0039 significant p-value. In order to demonstrate the difference in clinical outcomes between HFNC and NIV in the AECOPD patients, a meta-analysis comprising seven RCTs with a total of 481 patients found no significant differences in PaCO2, PaO2, and SpO2 between the HFNC and NIV groups.[17] In one trial, the non-invasive ventilation group experienced 16% treatment failure, while the high flow nasal cannula group experienced 27%.[9] The rate of reintubation was 13% with NIV and 27% with high-flow nasal oxygen alone in a different study[10]. In the intensive care unit, mortality did not differ between groups: 6% (5/86) with NIV vs. 9% (6/64) with high-flow nasal oxygen alone, despite the fact that reintubation rates were significantly lower with NIV than with high-flow nasal oxygen alone after 72 hours and until ICU departure.[10]

According to a systematic analysis comparing the effects of HFNC and continuous oxygen therapy (COT) and NIV on the risks of intubation and death for patients with AECOPD, HFNC reduced respiratory rate and diaphragm movement during respiratory distress more than COT did. As a result, alveolar ventilation decreases and PaCO2 rises, suggesting that HFNC reduced respiratory effort and aided in diaphragm recovery.[18] In the current study, there was significant difference in the outcome after therapy where 89% of those cases treated with HFNC improved versus 73% of cases exposed to NIV.

In his meta-analysis, Fahey et al.[19] recommended HFNC over NIV for adjusting PaCO2, pH, and PaO2, as well as death rates and intubation risk, however these results were not statistically significant. Although, once more, this conclusion was not statistically significant, it was discovered that the HFNC group shifted to the opposite intervention more frequently. Tan et al[20], on the other hand, favored NIV over HFNC because they discovered that the HFNC group had greater treatment failure rates, which they defined as the rate of endotracheal intubation. When it came to lowering PaCO2 48 hours after beginning respiratory treatment, NIV outperformed HFNC.

Due to treatment intolerance, the NIV group's failure rate (29%) was significantly greater than the HFNC group's (4%) in the Doshi et al.[21] trial. Ten patients (22.7%) in the HFNC group and twelve patients (28.6%) in the NIV group experienced treatment failure in Tan's et al. study[22]. Additionally, there was no statistically significant difference in the cumulative failure rates between the two groups. Although there was a one-day difference in the length of the ICU stay favoring HFNC in one RCT, Huang et al.[23] systematic review and meta-analysis revealed no significant difference in the length of hospitalization between patients with HFNC and NIV. However, other RCTS did not reveal any significant differences.

Xu C et al[24] declared that patients with hypercapnia can tolerate HFNC, and they felt more comfortable than NIV and COT, and that using HFNC caused a lower incidence of complications, compared with NIV. It has been identified that NIV needs a tight mask, which usually leads to discomfort for some patients and elevating the risk of treatment failure. The current study reported no statistically significant correlation between (duration of hospital stay, support time & ICU admission time) & vital signs (systolic BP, diastolic BP, RR, pulse, temperature, and SaO2) or ABG of assessed patients using NIV or HFNC device, except for PH in NIV group and pO2 in HFNC group that were significantly correlated positively with all durations.

CONCLUSION

This study demonstrated the efficacy of nasal high-flow oxygen is better than noninvasive ventilation in acute exacerbation of COPD. So, we recommend that nasal high-flow oxygen should be used routinely in acute exacerbation of COPD in order to improve patient outcomes and reduce mortality rates.

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