

Study of use of non-invasive ventilation in patients of acute exacerbation of chronic obstructive pulmonary disease



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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is one of the common causes of morbidity as well as mortality particularly in developing countries including India. Acute exacerbations of COPD remain one of the common causes of intensive care unit admissions worldwide and respiratory failure remains one of the common life-threatening complications of such an acute exacerbation. In patients with respiratory failure invasive as well as non-invasive ventilation (NIV) may be used. Many studies have shown that NIV is effective in managing these patients with an advantage over invasive ventilation which may associated with complications associated with endotracheal intubation. **Aims and Objectives:** (i) To assess the effectiveness of NIV in patients coming with type 2 respiratory failure. (ii) To find out the duration of NIV required for clinical improvement with the end point being normalization of arterial pH. **Materials and Methods:** This was an observational and retrospective study conducted in the Department of Pulmonary Medicine Seth GS Medical College and KEM Hospital, Mumbai. The duration of study was 2 years. Forty-four patients of acute exacerbation of chronic obstructive airway disease were included in this study on the basis of a predefined inclusion and exclusion criteria. The computerized record of all the patients who had been given NIV for acute exacerbations of chronic airway disease was analyzed. The data analysis included comparing the arterial blood gas pH and the use of NIV. The improvement in the pH value was correlated with the use of NIV. Other comorbidities were included in the data and correlated with the pH values. **Results:** In our study, the most of the patients belonged to the age group of 51–60 years (31.8%) followed by 41–50 years (29.5%) and 61–70 years (20.5%). Improvement in pH was observed in 42 out of 43 studied cases. It was observed that the average number of hours of NIV per patient was 10–15 h (20.5%) followed by 16–20 h (15.9%) of the study population. **Conclusion:** NIV is safe and effective form of managing patients of acute exacerbation of chronic obstructive airway disease.

Key words: Chronic obstructive airway disease; Non-invasive ventilation; Outcome; Respiratory failure

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive chronic disease characterized by an inexorable decline in respiratory function, exercise capacity, and health status.¹ Increasing environmental pollution as well as tobacco usage is associated with increased frequency of chronic obstructive airway disease.² Intermittently,

there are exacerbations of COPD symptoms which vary in severity and frequency during the course of patient's illness. These exacerbations are important not only because of their short-term impact on an individual's quality of life but also because of their long-term effects on health status, morbidity, and mortality. Indeed frequency of exacerbations is one of the most important determinants of health-related quality of life

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in these patients.³ COPD exacerbations are a significant cause of hospital admissions and readmissions and the burden placed on health resources.⁴ In-hospital mortality of acute exacerbation of COPD (AECOPD) can vary from 6% to 42%.⁵ Various factors such as baseline lung function, cause of acute exacerbation, severity of illness, nutritional status of the patient, and need for mechanical ventilation are responsible for such a wide range of mortality. Ventilating a COPD patient is often difficult because the disease may not have a reversible component. Further, quantification and management of dynamic hyperinflation at bedside are very difficult. In due course of time, it is becoming a major health problem as a greater number of patients with obstructive disease are presenting for surgeries for various other reasons.⁶

One of the major breakthroughs in treating AECOPD patients in the past few decades is the application of non-invasive ventilation (NIV) for acute hypercapnic respiratory failure. Use of NIV effectively unloads the respiratory muscles and reduces the effort on the work of breathing. NIV reduces intubation rate, overall mortality due to respiratory failure, and rates of invasive mechanical ventilation-related complications.⁷ Based on the evidence from studies in the Asia Pacific region and Western countries, NIV is now recommended by clinical guidelines as first-line treatment for acute Type 2 respiratory failure due to AECOPD.⁸ While medical treatment works to maximize lung function and reverse the precipitating cause of the exacerbations, ventilatory support can lower the level of respiratory muscles load, thus reducing dyspnea and respiratory rate, and improving arterial oxygenation, PaCO₂, and pH.⁹

Some complications of invasive ventilation are related to the intubation or tracheostomy procedure; or to ventilation such as ventilator-associated pneumonia and other nosocomial infections. Non-invasive methods of mechanical ventilation (NIV) may avoid most of the complications related to the invasive ventilation, ensuring at the same time a similar degree of efficacy.¹⁰ The international consensus conference on NIV for acute respiratory failure stated that “the addition of NIV to standard medical treatment of patients with ARF may prevent the need for intubation and reduce the rate of complications and mortality in patients with hypercapnic respiratory failure.”¹¹ The reduction of complications related to the endotracheal intubation and to the weaning from the invasive mechanical ventilation is the main factor affecting mortality.¹¹ Moreover, NIV can be applied earlier than intubation in the course of ventilatory failure and can be administered outside of the intensive care unit (ICU).¹²

To evaluate the benefits of NIV in patients with AECOPD, we conducted this retrospective and observational study assessing the effectiveness of NIV in patients coming with Type 2 respiratory failure and the duration of NIV required for clinical improvement with the end point being normalization of arterial pH.

Aims and objectives

(i) To assess the effectiveness of NIV in patients coming with type 2 respiratory failure. (ii) To find out the duration of NIV required for clinical improvement with the end point being normalization of arterial pH.

MATERIALS AND METHODS

This was a retrospective and observational study conducted in the Department of Pulmonary Medicine Seth GS Medical College and KEM Hospital, Mumbai. The duration of study was 2 years. Forty-four patients of acute exacerbation of chronic obstructive airway disease were included in this study on the basis of a predefined inclusion and exclusion criteria. Institutional Ethical Committee duly approved the study.

Records of patients admitted to our hospital for acute exacerbation of chronic obstructive airway disease and treated by NIV were analyzed in detail and patients were included in this study on the basis of a predefined inclusion and exclusion criteria. Demographic details of the patients such as age, gender, and body mass index were retrieved from case papers. Presence of other systemic illnesses such as diabetes mellitus or hypertension as well as other comorbid conditions was noted down. All patients received NIV by Non-invasive ventilator VPAP. The number of hours for which the patient was admitted was recorded along with the blood gas parameters at the corresponding times. All the clinical details and investigation reports such as complete blood count, hepatic, and renal functions tests as well as blood gas analysis reports were analyzed and recorded. Acute Physiology and Chronic Health Evaluation II scores as mentioned on case papers were also recorded.¹³ Severity of dyspnea and stage of the disease were determined by New York Heart Association and Global Initiative for Chronic Obstructive Lung Disease (GOLD) staging, respectively.^{14,15} The data were analyzed comparing the arterial blood gas pH and the use of NIV given. The improvement in the pH value was correlated with the use of NIV. Other comorbidities were included in the data and correlated with the pH values. Some patients who ultimately required invasive ventilation because they were not improving clinically or there was worsening of acidosis were excluded from the study even if invasive ventilation was given for short period of time.

All the collected data were entered in Microsoft Excel sheet and then transferred to SPSS software version 17 for analysis. Qualitative data were presented as frequency and percentages. Quantitative data were presented as mean and standard deviation. $P < 0.05$ was taken as statistically significant.

Inclusion criteria

The following criteria were included in the study:

1. Patients admitted for acute exacerbation of chronic pulmonary airway disease treated by NIV
2. Patients having Type 2 respiratory failure
3. $pH < 7.35$ and $PaCO_2$ more than 45 mm of Hg
4. Age above 18 years.

Exclusion criteria

The following criteria were excluded from the study:

- Patients < 18 years of age
- Incomplete record available
- Patients with severe comorbid conditions likely to affect the outcome.

RESULTS

Our study consisted of total 44 patients. Out of these 44 patients, there were 26 (59.1%) females and 18 (39.9%) males with a M: F ratio of 1:1.22 (Figure 1). The mean age of patients in studied cases was found to be 43.55 ± 11.86 years. Majority of the cases were between the age group of 51–60 years (Table 1).

Wood-smoke exposure, mostly for cooking purpose, was observed in 20 (45.45%) patients of study population whereas 15 (34.09%) patients were active smokers. The analysis of the patients on the basis of comorbidities showed that the most common comorbidity was found to be hypertension (15.91%) followed by diabetes mellitus Type 2 (11.36%), pulmonary hypertension (9.09%), right-sided heart failure (6.82%), ischemic heart disease (4.55%), and cerebrovascular disease (4.55%) (Figure 2).

The analysis of the patients on the basis of presenting complaints showed that the most common presenting complaint in studied cases was breathlessness which was seen in all 44 patients (100%). The other presenting complaints included cough (95.45%), expectoration (84.09%), and fever (81.81%). The analysis of severity of dyspnea was done by New York heart association classification. Out of 44 studied cases, 19 (43.1%) patients had Grade II dyspnea. Grade III, Grade IV, and Grade I dyspnea was seen in 15 (34.09%), 6 (13.63%), and 4 (9.09%) patients, respectively. The stage of dyspnea was classified according to the GOLD. Most of the study population

had GOLD Stage II (29.54%) followed by GOLD Stage III (27.27%), GOLD Stage IV (25.0%), and GOLD Stage I (18.18%) (Table 2).

The blood gas analysis was done at the time of admission, 1, 3 hours, and 6 hours after starting NIV. Thereafter, arterial blood gas analysis was done every 6 hourly till NIV was continued. In all cases pH , $PaCO_2$, PaO_2 , and O_2 saturation parameters were noted. There was improvement in pH , $PaCO_2$, and PaO_2 as well as oxygen saturation levels of all the cases. The most of the study population had 10–15 h duration of NIV (20.5%) followed by 16–20 h (15.9%), 26–30 h (15.9%), and < 10 h (13.6%). NIV was successful in 97.7% (43/44) of study population. Improvement in pH was observed in 42 out of 43 successful cases and zero out of one failure cases, and the difference was statistically significant. (Chi-square test, $P = 0.001$). Only one patient did not improve and ultimately required endotracheal intubation and invasive ventilation (Figure 3).

DISCUSSION

In our study, there was a female preponderance in the cases of patients requiring NIV for COPD. Sayami et al., conducted a study of patients with chronic obstructive airway disease consisting of 50 COPD patients above the age of 30 years.¹⁶ The authors found

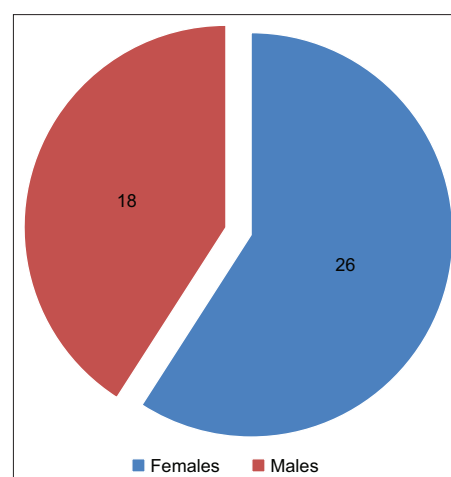


Figure 1: Gender distribution of the studied cases

Table 1: Mean age of the studied cases

Age group in years	No. of cases	Percentage
18–30	5	11.36
31–40	8	18.18
41–50	13	29.55
51–60	14	31.82
Above 60	4	9.09
Total	44	100.00
Mean Age	43.55 ± 11.86 years	

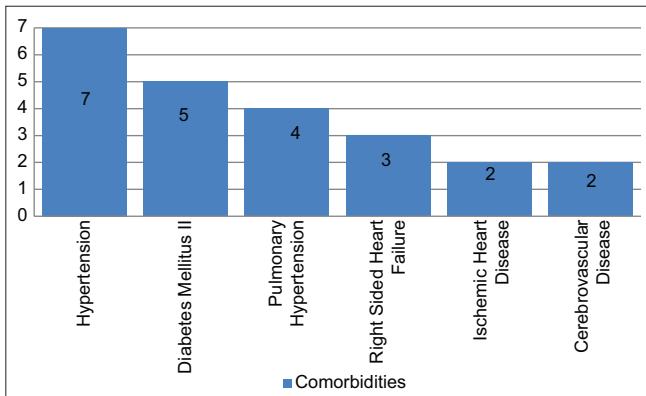


Figure 2: Comorbidities in studied cases

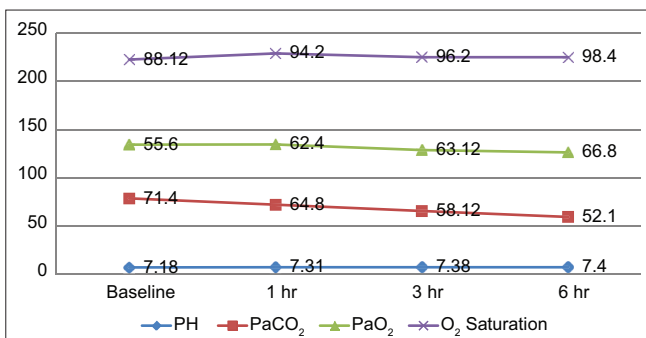


Figure 3: Serial mean PH, PaCO₂, PaO₂, and oxygen saturation levels in studied cases

Table 2: Comorbidities, severity of dyspnea, and stage of the disease

Patient characteristics	No of patients	Percentage
Presenting Complaint		
Breathlessness	44	100.00
Cough	42	95.45
Expectoration	37	84.09
Fever	36	81.82
Severity of dyspnea (NYHA classification)		
Grade II	19	43.18
Grade III	15	34.09
Grade IV	6	13.64
Grade I	4	9.09
Stage of disease (GOLD Stage)		
Stage I	8	18.18
Stage II	13	29.55
Stage III	12	27.27
Stage IV	11	25.00%

GOLD: Global Initiative for Chronic Obstructive Lung Disease

that there was a clear female preponderance with a M: F ratio of 1:1.38. Whereas other authors such as Magitta et al.,¹⁷ and Agusti et al.,¹⁸ reported a male preponderance in cases of chronic obstructive airway disease. The difference in gender distribution may be associated with increased exposure of women to wood smoke for the purpose of cooking in developing countries.

The analysis of patients on the basis of presence of risk factors showed that Wood-smoke exposure, mostly for cooking purpose, was observed in 20 (45.45%) patients of study population followed, 15 (34.09%) patients were active smokers. Sharma et al., conducted a study of 110 patients with COPD.¹⁹ The authors reported that out of studied cases, 16 (17.6%) patients never smoked, while 16.3% had quit tobacco smoking. Eighteen (19.8%) were exposed to wood smoke. Eight (8.8%) patients had tuberculosis, 5 (4.5%) complained of asthma symptoms, and 2 (1.8%) had bronchiectasis, Thirteen (11.8%) diabetes mellitus, 62 (56.3%) hypertension, and 14 (12.7%) cor pulmonale. Wood smoke exposure was responsible for 20% of cases in our study also and the findings of our study were found to be similar to the study conducted by Sharma et al.¹⁹

The analysis of the cases on the basis of presenting complaints showed that breathlessness was the most common presenting complaint which was seen in all 44 patients (100%). The other presenting complaints included cough (95.45%), expectoration (84.09%), and fever (81.81%). Song et al., conducted a study of 21 patients having acute exacerbation of asthma.²⁰ The authors found that breathlessness and cough were the most common presenting complaints of the patients presenting with acute exacerbation. The authors also reported complications secondary to cough such as chest pain, inability to talk, and psychosocial problems associated with severe coughing. Similar findings were also reported by the authors such as Hyland et al.,²¹ and Kim et al.²²

In the present study, NIV was successful in 97.7% of study population. Padhi et al., conducted a study to determine the effectiveness and safety of non-invasive positive pressure ventilation (NIPPV) in AECOPD.²³ The authors found that the mean duration of NIPPV was 18.3±9.2 h. The average duration of ICU stay was 2.8±2.1 days whereas the mean duration of hospital stay was 4.1±1.9 days. Successful outcome was observed in 43 (86%) patients. The successful outcome in our study was higher (97.7%) in our study as compared to the study done by Padhi et al.²³ This may be due to the fact that the mean age of patients in the study conducted by Padhi et al., was higher than the mean age of cases in our study. Similar success rates were also reported by the authors such as Patel et al.,²⁴ and Brochard et al.²⁵

Limitation of the study

The limitation of this study was a relatively small number of cases. A study consisting of larger cohort of cases would further substantiate the results of this study.

CONCLUSION

Non-invasive ventilation is safe as well as effective form of managing patients of acute exacerbation of chronic obstructive airway disease and was found to be effective in majority of the patients as evidenced by improvement in arterial pH. It also is having a distinct advantage of avoiding complications associated with endotracheal intubation.

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Authors Contribution:

VJ- Concept and design of the study, interpreted the results, prepared first draft of manuscript and critical revision of the manuscript; **NB-** Statistically analyzed and interpreted, reviewed the literature, and manuscript preparation; **SD-** Design of the study, statistically analyzed and interpreted, preparation of manuscript, and revision of the manuscript; and **AAU-** Concept and coordination of the overall study.

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