Original Article

# A Study of non invasive positive pressure ventilation for acute exacerbation of chronic obstructive pulmonary diseases: Its efficacy and safety

Gunadhar Padhi[1*], Aklesh Tandekar[2], Nitin Rathod[3]

[1,2]Consultant Intensivist, [3]Director, Department of Critical Care Medicine, Nanavati Superspeciality Hospital, S V Road Villeparle(West)
**Email:** gunadharpadhi@yahoo.co.in

## Abstract

**Aims and objectives:** To determine the effectiveness and safety of non-invasive positive pressure ventilation (NIPPV) in acute exacerbation of chronic obstructive pulmonary disease. **Materials and method:** Fifty patients with acute exacerbation of chronic obstructive pulmonary disease leading to hypoxemia and respiratory acidosis with pH < 7.35 and PaCO2 > 45 mm of Hg admitted to the intensive care unit (ICU) were eligible for inclusion in the study. Noninvasive ventilation was administered with the use of portable non-invasive ventilator VPAP II. Data for heart rate, respiratory rate, arterial blood gases (pH, PaO2, PaCO2) at baseline, one and six hours was recorded. The primary outcome was the need for endotracheal intubation during the intensive care unit (ICU) stay. **Results:** The mean age of study patients was 52.6±14.2years. The male:female ration was 2.13:1. The mean BMI was 22.3± 3.7 with APACHE II of 19.3±2.9. It was seen that after one hour there was significant improvement in respiratory rate and heart rate, pH, PaCO2 levels, PaO2 levels and O2 saturation parameters in patients successfully managed with NIPPV. After six hours also there was significant improvement in the clinical and arterial blood gas parameters as compared to baseline parameters. When the levels of parameters after six hour were compared with levels after one hour it was observed that the improvement in respiratory rate, heart rate, pH and O2 saturation was statistically significant. However the difference in PaO2 and PaCO2 levels was not statistically significant. The mean duration of NIPPV was 18.3± 9.2hrs. The average duration of ICU stay was 2.8±2.1days whereas the mean duration of hospital stay was 4.1±1.9days. Successful Outcome was observed in 43 (86%) patients. **Conclusion:** In patients with exacerbation of chronic obstructive pulmonary diseases, non invasive positive pressure ventilation leads to rapid improvement in blood gas parameters and reduces the need for ETI. Thus it is effective and safe for use in patients of chronic obstructive pulmonary diseases with acute exacerbation.

**Key words:** chronic obstructive pulmonary diseases, NIPPV, acute exacerbation.

[*]**Address for Correspondence:**
Dr. Gunadhar Padhi, Consultant Intensivist, Department of Critical Care Medicine, Nanavati Superspeciality Hospital, S V Road Villeparle(West), Mumbai, Maharashtra, INDIA.
**Email:** gunadharpadhi@yahoo.co.in

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## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a major health problem and leading cause of morbidity and mortality worldwide.[1] Moreover the burden of the disease is expected to rise in future. World Health Organization has predicted that by 2020, COPD will be the 5th most prevalent disease worldwide (currently ranked 12th) and will be among the three leading causes of death.[2] Acute exacerbations of COPD (AECOPD) are largely responsible for the morbidity and mortality associated with the disease. In fact, Andersson and colleagues have estimated that almost 35-45% of the total per capita health-care costs account for COPD exacerbations.[3]

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Patients with chronic obstructive pulmonary disease (COPD) are prone to respiratory failure, often resulting in admission to hospital. Between a fifth and a third of patients admitted with hypercapnic respiratory failure secondary to acute exacerbation of COPD will die in hospital, despite mechanical ventilation.[4-8]

The frequency of hypercapnic respiratory failure in patients with AECOPD varies from 16-35% with overall mortality of 35-43%.[9,10] Ventilatory support via endotracheal intubation (ETI) is the standard mode of therapy, for such patients. However, endotracheal intubation is associated with several complications including nosocomial pneumonia, injury to upper airways causing ulceration, hemorrhage and long term complication like tracheal stenosis. Moreover, patients with COPD are prone to ventilator dependence and may have repeated weaning failures leading to requirement of tracheostomy.[11-14] It is obvious that avoiding endotracheal intubation in patients with AECOPD is the key to improving their in-hospital outcomes. To this end, NIPPV has been claimed to be a safe and effective alternative in patients with AECOPD.

In the early 1990s, noninvasive ventilation (NIV) emerged as a potential useful addition in the management of patients with ventilatory failure due to an acute exacerbation of chronic obstructive pulmonary disease (COPD). That it was an effective alternative to standard medical therapy and oxygen[6,15], and indeed to endotracheal intubation and mechanical ventilation[16], was confirmed in a number of randomized controlled trials (RCTs), systematic reviews, and meta-analyses[17].

A reduction in infectious complications was a consistent finding, and in some studies this translated into reduced ICU and hospital lengths of stay. Cost is one barrier to the implementation of any new treatment in medicine. However, NIV was more cost effective than standard therapy[18] and the savings were even greater when performed outside the ICU[19]. In enthusiastic units, as confidence and skill grows, outcomes improve and NIV can be used in sicker patients and lower-dependency settings. Despite this overwhelming evidence that NIV is more effective than standard therapy and can be provided at lower cost, the technique has been underutilized.

## MATERIALS AND METHOD

The present prospective observational study was conducted in the intensive care unit (ICU) of the study institute. After receiving the clearance by the Institute Ethics Committee and written consent from all patients or the next of kin the study was initiated. Patients with acute exacerbation of chronic obstructive pulmonary disease leading to hypoxemia and respiratory acidosis with pH < 7.35 and PaCO2 > 45 mm of Hg admitted to the intensive care unit (ICU) were eligible for inclusion in the study. Fifty cases of chronic obstructive pulmonary disease with acute exacerbations that met the above mentioned criteria and were enrolled in the study.

Noninvasive ventilation was administered with the use of portable non-invasive ventilator VPAP II (ResMed, Sydney, Australia). After explaining the details of the process of the NIPPV institution, patient was propped up to a 45° angle. NIPPV was initiated by the investigators (GCK and NS) in all the cases. Patients were usually initiated on an inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) of 8 cm of H2O and 4 cm of H2O respectively. Subsequent adjustments were carried out according to the need of the patient and the results of blood gas analysis. The protocol was to augment IPAP and EPAP by 2 cm H2O every 5-10 min, patient's comfort and arterial oxygen saturation permitting. All patients were given oxygen at 3-4 l/min during ventilation to maintain oxygen saturation above 90%. After starting treatment each patient was monitored closely for initial one hour. Patient's discomfort and intolerance to mask was looked for. Clinical status such as use of accessory muscles of respiration, increase or decrease of dyspnoea, appearance or disappearance of cyanosis, heart rate, respiratory rate and blood pressure were monitored. Level of consciousness was also closely monitored. At admission, the demographic details of patient were recorded which included age, sex, body mass index and presence of associated co-morbid illnesses if any. The disease severity was calculated using Acute Physiology and Chronic Health Evaluation (APACHE) II scores. We prospectively collected the data for heart rate, respiratory rate, arterial blood gases (pH, PaO2, PaCO2) at baseline, one and six hours. The primary outcome was NIPPV failure, defined as the need for endotracheal intubation during the ICU stay due to inability to improve or stabilize gas exchange or dyspnea in one hour or failure to improve mental status within 60 minutes of initiating NIPPV in patients who were lethargic from CO2 retention or agitated from hypoxemia. Ultimately, clinical judgment was applied in the decision to intubate any patient. The total time spent on NIV, the ICU and the hospital length of stay was also recorded. The collected data was entered in Microsoft excel 2010 and Statistical analysis was performed using the statistical package SPSS (version 10). Results are presented in a descriptive fashion as number (percentage) or means (standard deviation).

## RESULTS

**Table 1:** Baseline characteristics of study patients

| Baseline characteristics | Mean± SD |
|---|---|
| Age | 52.6±14.2 |
| Sex (m/f) | 34/16 |
| BMI | 22.3± 3.7 |
| Co morbidities (%) | 38 (76%) |
| APACHE II | 19.3±2.9 |
| Respiratory rate (breaths/min) | 33.9±5.7 |
| Heart rate (beats/min) | 118±14.73 |
| pH | 7.2±0.09 |
| PaO2 | 62.34±15.32 |
| PaCO2 (mm Hg) | 83.29±16.72 |
| O2 saturation (%) | 89.42±5.14 |

It was observed that the mean age of study patients was 52.6±14.2years. the male : female ration was 2.13:1. The mean BMI was 22.3± 3.7 with APACHE II of 19.3±2.9.

**Table 2:** Effect on clinical and arterial blood gas parameters during the ICU course

| Parameter | 0 hour | 1 hour | 6 hour |
|---|---|---|---|
| RR | 33.9±5.7 | 30.21 ±4.9* | 28.1±3.5#$ |
| HR | 118.7±14.73 | 107.2±12.6* | 101.9±10.2#$ |
| pH | 7.2±0.09 | 7.29±0.12 * | 7.34±0.07#$ |
| PaO2 | 59.34±15.32 | 64.9±12.2* | 66.3±11.6# |
| PaCO2 | 83.29±16.72 | 63.6±15.3* | 57.5±16.4# |
| O2 saturation (%) | 89.42±5.14 | 93.34 ± 5.32* | 95.49±5.23#$ |

*Statistically significant difference between 0 hr and 1hr
#Statistically significant difference between 0 hr and 6hr
$Statistically significant difference between 1 hr and 6hr

The Serial clinical and arterial blood gas parameters were assessed after one hour and six hour during the ICU admission.It was seen that after one hour there was significant improvement in respiratory rate and heart rate, pH, PaCO2 levels, PaO2 levels and O2 saturation parameters in patients successfully managed with NIPPV. After six hours also there was significant improvement in the clinical and arterial blood gas parameters as compared to baseline parameters. When the levels of parameters after six hour were compared with levels after one hour it was observed that the improvement in respiratory rate, heart rate, pH and O2 saturation was statistically significant. However the difference in PaO2 and PaCO2 levels was not statistically significant.

**Table 3:** Outcome of NIPPV

| Variable | Mean± SD |
|---|---|
| Duration of NIPPV | 18.3± 9.2 |
| Successful Outcome (%) | 43 (86%) |
| Duration of ICU stay | 2.8±2.1 |
| Duration of hospital stay | 4.1±1.9 |

The mean duration of NIPPV was 18.3± 9.2hrs. The average duration of ICU stay was 2.8±2.1days whereas the mean duration of hospital stay was 4.1±1.9days. Successful Outcome was observed in 43 (86%) patients.

## DISCUSSION

The present study was conducted with the objectives to determine the effectiveness and safety of non-invasive positive pressure ventilation (NIPPV) in acute exacerbation of chronic obstructive pulmonary disease. For the purpose of study we enrolled 50 cases of chronic obstructive pulmonary disease with acute exacerbation. It was observed that the mean age of study patients was 52.6±14.2years. The male: female ration was 2.13:1. The mean BMI was 22.3±3.7 with APACHE II of 19.3±2.9. The Serial clinical and arterial blood gas parameters were assessed after one hour and six hour during the ICU admission. It was seen that after one hour there was significant improvement in respiratory rate and heart rate, pH, PaCO2 levels, PaO2 levels and O2 saturation parameters in patients successfully managed with NIPPV. The findings were comparable with finding observed by Ritesh Agarwal[20] and Gopi C. Khilnani[21]. Acidosis is an important prognostic factor for survival after respiratory failure in COPD, and thus early correction of acidosis is an essential goal of treatment.[8] In the present study it was observed that NPPV significantly improves pH, PaCO2, and respiratory rate within the first hour. The improvement in pH was associated with the fall in PaCO2 which indicates an improvement in respiratory failure. After six hours also there was significant improvement in the clinical and arterial blood gas parameters as compared to baseline parameters. When the levels of parameters after six hour were compared with levels after one hour it was observed that the improvement in respiratory rate, heart rate, pH and O2 saturation was statistically significant. However the difference in PaO2 and PaCO2 levels was not statistically significant. Singh *et al*[22], showed that NIPPV use was associated with significant improvement in clinical and ABG parameters in patients with ARF. George *et al*[23], demonstrated benefits of NIPPV in avoiding the need for invasive mechanical ventilation in patients presenting with ARF of diverse etiology. The mean duration of NIPPV was 18.3± 9.2 hrs. The average duration of ICU stay was 2.8±2.1days whereas the mean duration of hospital stay was 4.1±1.9days. Successful Outcome was observed in 43 (86%) patients. In remaining 7 patients no improvement was observed on NIPPV and ETI was required. There was reduction in the need of ETI and the consequent complications including the increased hospital stay are the obvious effects of NIPPV. Thus the NIPPV can be used safely as compared to ETI. Although NPPV reduces the need for intubation, in some patients NPPV will fail, and it is essential that a decision be made with the patient on what should be done in this eventuality. Patients for whom NPPV eventually fails, despite initial tolerance and effectiveness of the treatment, need to be distinguished

from patients who cannot tolerate it at all. An uncontrolled study of these "late failures" suggests a poor outcome regardless of whether the patient is intubated or continues to receive NPPV.[5,24]

## CONCLUSION

In patients with exacerbation of chronic obstructive pulmonary diseases, non invasive positive pressure ventilation leads to rapid improvement in blood gas parameters and reduces the need for ETI. Thus it is effective and safe for use in patients of chronic obstructive pulmonary diseases with acute exacerbation.

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