

## Original Research Article

# Effectiveness of non-invasive positive pressure ventilation for acute exacerbation of chronic obstructive pulmonary disease

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## ABSTRACT

**Background:** In patients with acute exacerbations of COPD, endotracheal intubation and complications associated with mechanical ventilation may be evaded using non-invasive ventilation. The aim of the study was to analyse the effectiveness of NPPV for hypercapnic respiratory failure secondary to acute exacerbation of COPD in India.

**Methods:** In this prospective study, 63 cases of hypercapnic respiratory failure secondary to acute exacerbation of COPD admitted in the intensive care unit during 2011-13 formed the study population. Standard therapy was initiated in all the patients. Patients who failed to improve with standard therapy alone were given a trial of non invasive ventilation. Non invasively ventilated patients, showing significantly improvement in their clinical status and arterial blood gas parameters were discharged. Patients who failed to show significant improvement with NPPV were given invasive ventilation.

**Results:** Standard therapy was initiated in 63 patients on admission but 25 patients failed to improve with standard therapy alone. Out of the total 25 patients non invasively ventilated, 22 patients showed significantly improvement. Significant improvement in the Mean pH, Mean paCO<sub>2</sub> and Mean paHCO<sub>3</sub> in both standard therapy and non invasive ventilation group. Success rate was found to be highest (88%) in standard therapy + noninvasive ventilation treatment modality group.

**Conclusions:** NIV is an effective tool in hypercapnic respiratory failure secondary to acute exacerbation of COPD and its early initiation would improve the clinical status and respiratory acidosis.

**Keywords:** Noninvasive ventilation, Pulmonary disease, Chronic obstructive

## INTRODUCTION

Patients with chronic obstructive pulmonary disease (COPD) often get admitted to hospital for management of respiratory failure needing endotracheal intubation and mechanical ventilation. These procedures are associated with high morbidity, and it may be difficult to wean these patients from ventilation.<sup>1,2</sup> Noninvasive ventilation

(NIV) is an alternative approach that was developed to avoid these complications in patients with acute respiratory failure.<sup>3</sup> It is often used for acute exacerbations of COPD, because such exacerbations may be rapidly reversed and because the hypercapnic ventilatory failure that occurs in patients with this disorder seems to respond well to NIV.<sup>4,5</sup>

In non-invasive positive pressure ventilation (NPPV) the patient receives air or a mixture of air and oxygen from a flow generator through a full facial or nasal mask, and thus the unloading of fatigued ventilatory muscles enhances ventilation. NIV reduces the rates of intubation and mortality in patients with severe acute exacerbation of COPD.<sup>6</sup> There is consensus on the fact that NPPV should be considered early in the course of respiratory failure and before severe acidosis ensues and to avoid the need for endotracheal intubation and reduce mortality in patients with COPD but there is supporting evidence to substantiate the fact.<sup>7</sup>

According to best of our knowledge, subject experts in Southeast Asian population have not delineated potential effectiveness of NIV in terms of improvement in their clinical status and arterial blood gas parameters. Such data are particularly important in view of the practical and technical difficulties that may be encountered with this form of therapy. Therefore the present study was planned to analyse and ascertain the effectiveness of NPPV for hypercapnic respiratory failure secondary to acute exacerbation of COPD in India.

## METHODS

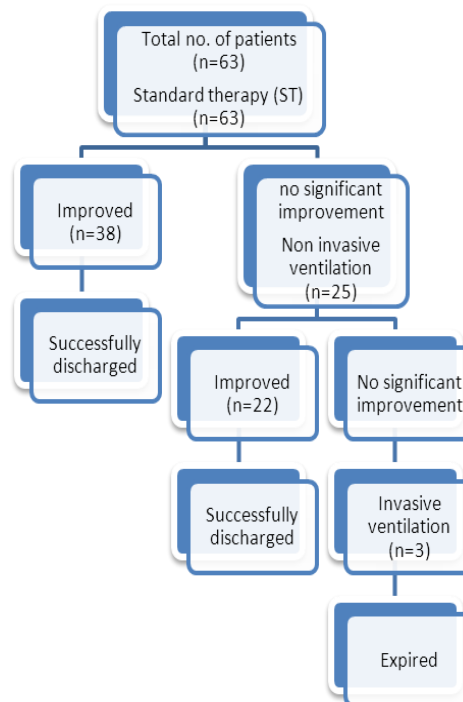
The present prospective study was planned and executed by the Department of Department of General Medicine, Dr. D.Y. Patil Hospital and Research Institute, Kolhapur for a period of 2 years i.e. during May 2011 to April 2013. All cases of hypercapnic respiratory failure secondary to acute exacerbation of COPD admitted in the intensive care unit during the study period formed the study population. A total of 63 such patients were enrolled.

On admission clinical parameters of study subjects viz heart rate, blood pressure, respiratory rate, base line ECG, arterial blood gas analysis were captured. Standard therapy as per API guidelines (bronchodilators, corticosteroids, antibiotics and controlled oxygen) was initiated in all the 63 patients on admission. At the end of 1 hour arterial blood gas analysis was repeated.

Patients showing significant improvement and requiring no further intervention, were discharged. Patients who failed to improve with standard therapy alone fitted in the inclusion criteria for NIV. These patients were given a trial of NIV using NPPV with full face mask (GE versa med/ivent 201). Indications for non-invasive positive pressure ventilation were RR >25/min, Use of accessory muscles of respiration, PaCO<sub>2</sub> >45mmHg with pH <7.35 and Proper mask fit.

Non-invasively ventilated patients, showing significantly improvement in their clinical status and arterial blood gas parameters were discharged. In these patients Arterial blood gas analysis was repeated after 4 hours of NIV that is 5 hours after admission. There was decrease in dyspnea and improvement of respiratory acidosis. Patients who

failed to show significant improvement with NPPV were given invasive ventilation.



**Figure 1: Study protocol.**

For the purpose of this study, success rate was defined as patients not needing invasive mechanical ventilation in the non-invasive ventilation group and not requiring non-invasive ventilation or invasive ventilation in the standard therapy group.

The study adhered to the tenets of the Declaration of Helsinki for research in humans. Informed consent was obtained from study subjects after discussing advantages and risks. Permission of Institutional ethics committee (IEC) was sought before the commencement of the study. All the questionnaires along with other relevant data were manually checked and were then coded for computer entry. After compilation of the collected data, analysis was done using Statistical Package for Social Sciences (SPSS), version 20 (IBM, Chicago, USA). The results were expressed using appropriate statistical methods. Chi-square and t-test were used to test level of significance. A two-tailed  $p < 0.05$  was considered statistically significant.

## RESULTS

Standard therapy was initiated in 63 patients on admission. At the end of 1 hour arterial blood gas analysis was repeated. 38 patients showed significant improvement and required no further intervention, whereas remaining 25 patients failed to improve with standard therapy alone. 38 patients who showed significant improvement with standard therapy alone were subsequently discharged successfully. 25 patients

who failed to improve with standard therapy alone fitted in the inclusion criteria for non invasive ventilation. These patients were given a trial of non invasive ventilation.

Out of the total 25 patients non invasively ventilated, 22 patients showed significantly improvement. Arterial blood gas analysis was repeated after 4 hours of non invasive ventilation that is 5 hours after admission. There was decrease in dyspnea and improvement of respiratory acidosis. These patients showed further improvement in

their clinical status and arterial blood gas parameters and were discharge successfully subsequently. Out of the total 25 patients non-invasively ventilated, 3 patients failed to show any improvement in dyspnea and other clinical parameters.

The mean pH, paCO<sub>2</sub> and HCO<sub>3</sub> can be compared on admission and after 5 hours in the study subjects receiving standard therapy, standard therapy + noninvasive ventilation and patients who required invasive ventilation (Table 1).

**Table 1: Comparison of arterial blood gas parameters among three treatment modalities.**

Parameters	ST (38)	ST+NIV (22)	ST+NIV+IV (3)
<b>Mean pH</b>			
pH	7.33±0.028	7.25±0.036	7.17±0.06
pH [after 5hr]	7.40±0.034	7.3±0.019	7.23±0.026
P-Value	P<0.001*	P<0.001*	(P=0.17)NS
<b>Mean paCO<sub>2</sub></b>			
paCO <sub>2</sub>	47.36±2.89	54.90±4.13	55.33±4.61
paCO <sub>2</sub> [after 5 hr]	40.71±2.75	49.63±2.87	50.66±3.05
P-Value	P<0.001*	P<0.001*	(P=0.11) NS
<b>Mean HCO<sub>3</sub></b>			
HCO <sub>3</sub>	27.42±1.78	30.5±5.10	24.66±3.05
HCO <sub>3</sub> [after 5 hr]	24.60±1.98	26.5±2.82	27.33±2.30
P-Value	P<0.001*	P<0.001*	(P=0.057) NS

ST- Standard therapy, NIV- noninvasive ventilation, IV- invasive ventilation; \*Significant p value.

**Table 2: Comparison of success rate of three treatment modalities.**

Success rate	ST	ST+NIV	ST+NIV+IV
	57.14%	88%	0%
(n)	63	25	3
P value	P=0.0072*		

ST- Standard therapy, NIV- noninvasive ventilation, IV- invasive ventilation; \*Significant p value.

Success rate was found to be highest (88%) in standard therapy + noninvasive ventilation treatment modality group (Table 2).

## DISCUSSION

63 patients of acute exacerbation of COPD fitting in the inclusion criteria were included in this study and the effectiveness of non invasive positive pressure ventilation in their management was studied.

We observed significant improvement in the pH in both standard therapy and non invasive ventilation group. Similar finding is reported in a randomised controlled parallel trial conducted in La Sapienza University Hospital by Conti et al.<sup>8</sup> The mean pH on admission was 7.2 (SD 0.05) in both standard therapy and non invasive ventilation group. Another study by Celikel et al observed that the mean pH on admission in standard therapy group was 7.28 (SD 0.02) and after 6 hours of treatment the mean pH was 7.29 (SD 0.08), whereas in

non invasive ventilation group the baseline pH was 7.27 (SD 0.07) and after 6 hours was 7.36 (SD 0.09).<sup>9</sup> Agarwal et al conducted a trial in respiratory ICU from northern India and reported that mean pH in non invasive ventilation group on admission was 7.27 (SD 0.07) and after 4 hours was 7.378 (SD 0.07).<sup>10</sup>

In our study we observed a significant improvement in the levels of pCO<sub>2</sub> in standard therapy and standard therapy + non invasive ventilation group. Another study by Celikel et al observed that the mean pCO<sub>2</sub> on admission in standard therapy group was 66.6 (SD 10.6) and in non invasive ventilation group was 68.8 (SD 15.2).<sup>9</sup> After 6 hours of treatment pCO<sub>2</sub> was 63.1 (SD 11.9) and 62.0 (SD 16.9) in standard therapy and non invasive ventilation group respectively. In a study conducted by Agarwal et al in 2008 reported that the mean pCO<sub>2</sub> in non invasive ventilation group on admission was 73.1 (SD 24.3) and after 4 hours of treatment was 53.6 (SD 14.9).<sup>10</sup>

In the only study with negative findings, Barbe et al observed that NPPV failed to lower intubation or mortality rate or hospital stay in consecutive patients admitted to the hospital with COPD exacerbations, but it is notable that no intubations or mortalities occurred in the control group.<sup>11</sup>

In our investigation success rate was found to be highest (88%) in standard therapy + noninvasive ventilation treatment modality group. In a study conducted by Celikel et al observed that success rate for non invasive ventilation group was 93.4% whereas for standard therapy group was 60% which is comparable to our study.<sup>9</sup>

Kramer et al observed that NPPV reduced the rate of endotracheal intubation to 9% from 67% among controls in a subgroup of COPD patients.<sup>12</sup> He also showed more rapid improvement in respiratory rate and blood gas values in the NPPV group. Lightowler et al (in a Cochrane systematic review) and Keenan et al demonstrated that NPPV is effective for moderate-to-severe COPD exacerbations.<sup>13,14</sup> Both found significantly lower mortality rate (relative risk 0.41, risk reduction 10%) and less need for intubation (relative risk 0.42, risk reduction 28%). Lightowler et al found significantly greater improvements in PaCO<sub>2</sub> NPPV-treated patients than in controls.<sup>13</sup>

This study has several strengths. First, we made a serious attempt to capture evidence on effectiveness of NPPV for hypercapnic respiratory failure secondary to acute exacerbation of COPD, relatively an underexplored entity. It will add to existing literature. Second, we used robust methodology including inclusion and exclusion criteria and standard API guidelines. Thirdly, investigators himself captured all the data. It creates uniformity in data gathering. Finally, our study is unique for studying the Southeast Asian population.

The study has some limitations as well. First, one may consider sample size of 63 subjects as a limitation of this study. Second, findings emerging out of this study may not be generalized as confining such estimates to a single centre limits the generalizability of the findings to other regions. Thirdly, effectiveness of NPPV was not compared with acute exacerbation of COPD patients with Co morbid conditions such as diabetes, hypertension and ischemic heart disease.

## CONCLUSION

On the basis of empirical evidences of the current study it can be summarized that NIV is an effective tool in hypercapnic respiratory failure secondary to acute exacerbation of COPD and its early initiation would improve the clinical status and respiratory acidosis.

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