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## Original Research

# Evaluation of Non-Invasive Ventilation in Managing Acute Exacerbations of Chronic Obstructive Pulmonary Disease (COPD)

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**ABSTRACT**

**Background:** Chronic obstructive pulmonary disease (COPD) represents a significant contributor to morbidity and mortality, especially in developing nations such as India. Acute exacerbations of chronic obstructive pulmonary disease (COPD) continue to be a prevalent factor contributing to intensive care unit admissions globally, while respiratory failure persists as a frequent and life-threatening complication of these acute exacerbations. In individuals experiencing respiratory failure, both invasive and non-invasive ventilation (NIV) may be employed. Numerous studies have demonstrated that non-invasive ventilation (NIV) is efficacious in the management of these patients, offering an advantage over invasive ventilation, which may be linked to complications arising from endotracheal intubation.

**Aims and Objectives:** To evaluate the efficacy of non-invasive ventilation (NIV) in individuals presenting with type 2 respiratory failure. Additionally, to determine the necessary duration of NIV for achieving clinical improvement, with the ultimate goal of normalizing arterial pH.

**Materials and Methods:** This research was an observational and retrospective investigation executed in the Department of Pulmonary Medicine at Rama Medical College, Hospital & Research Centre, Kanpur, U.P. The study spanned a period of two years, from March 2022 to February 2024. One hundred twenty-nine individuals experiencing acute exacerbation of chronic obstructive airway disease were incorporated into this study according to established inclusion and exclusion criteria. The electronic record of all patients who received non-invasive ventilation (NIV) for acute exacerbations of chronic respiratory illness was examined. The data analysis encompassed the comparison of arterial blood gas pH with the utilization of non-invasive ventilation (NIV). The enhancement in pH levels was associated with the implementation of non-invasive ventilation. Additional comorbidities were incorporated into the dataset and analyzed for correlations with pH values.

**Results:** Out of 129 cases, 69 were females (53.5%) and 60 were males (46.5%), with a male-to-female ratio of 1:1.15. The 51–60 age group had the most cases at 30.2%, followed by 41–50 at 26.3%. The lowest cases were in the >70 years group (6.2%). Overall mean age was 49.8 years. Middle-aged adults were the majority of cases, with slightly more in females. Hypertension is the most common comorbidity at 11.6%. Patient examination showed dyspnea as the main symptom in all 129 cases (100%). Additional complaints were cough 121 (93.7%), expectoration 109 (84.4%), and fever 105 (81.3%). Out of 129 cases, 13 (9. 9%) had Grade I dyspnea, 56 (43.4%) had Grade II, 44 (34.1%) had Grade III, and 19 (14.7%) had Grade IV. The dyspnea stages were classified per GOLD guidelines. Most study participants were GOLD Stage II 38 (29.4%), then Stage III 37 (28.6%), Stage IV 32 (24.8%), and Stage I 23 (17.8%).

**Conclusion:** Non-invasive ventilation is a secure and efficacious method for the management of patients experiencing acute exacerbations of chronic obstructive pulmonary disease.

**Key words:** Chronic Obstructive Airway Disease, Respiratory Failure, Non-Invasive Ventilation

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## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) represents a progressive chronic condition marked by a gradual reduction in respiratory function, exercise tolerance, and overall health status [1]. The rising levels of environmental pollution and tobacco consumption are linked to a heightened incidence of chronic obstructive airway disease [2]. Periodically, individuals with COPD experience exacerbations of symptoms that differ in severity and occurrence throughout the progression of the illness. These exacerbations are significant not only due to their immediate effects on an individual's quality of life but also due to their enduring impacts on health status, morbidity, and mortality. Indeed, the frequency of exacerbations constitutes one of the most critical determinants of health-related quality of life in these patients [3]. COPD exacerbations represent a significant contributor to hospital admissions and readmissions, as well as the strain imposed on healthcare resources.[4] This considerable variation in mortality is attributable to a multitude of factors, including baseline lung function, the etiology of the acute exacerbation, the severity of the illness, the patient's nutritional status, and the necessity for mechanical ventilation. The ventilation of individuals with Chronic Obstructive Pulmonary Disease (COPD) frequently presents challenges, as the condition may lack a reversible aspect. Moreover, the quantification and management of dynamic hyperinflation at the bedside present considerable challenges. Over time, it is evolving into a significant health issue as an increasing number of patients with obstructive diseases are seeking surgical interventions for diverse motivations. Non-invasive ventilation (NIV) represents an evidence-based intervention for individuals experiencing acute respiratory failure resulting from an exacerbation of Chronic Obstructive Pulmonary Disease (COPD). For COPD patients suffering from acute hypercapnic respiratory failure, NIV enhances gas exchange, diminishes the effort of breathing, and decreases both the duration of hospital stays and mortality rates. Moreover, in comparison to invasive ventilation, non-invasive ventilation (NIV) results in a reduced incidence of complications, including ventilator-associated infections [3]. These results have led to the formulation of guideline recommendations regarding the application of non-invasive ventilation (NIV) in acute respiratory failure arising from exacerbations of chronic obstructive pulmonary disease (COPD) [5]. One of the significant advancements in the treatment of AECOPD patients over the last few decades has been the utilization of non-invasive ventilation (NIV) for acute hypercapnic respiratory failure. The utilization of non-invasive ventilation (NIV) effectively alleviates the burden on respiratory muscles and diminishes the exertion associated with the work of breathing. Furthermore, NIV decreases the incidence of intubation, overall mortality linked to respiratory failure, and the prevalence of complications stemming from invasive mechanical ventilation [7]. Drawing on evidence from research conducted in the Asia Pacific region and Western nations, non-invasive ventilation (NIV) is currently endorsed by clinical guidelines as the primary treatment for acute Type 2 respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease (AECOPD) [8]. Medical interventions aim to optimize lung function and mitigate the underlying causes of exacerbations, whereas ventilatory support can decrease the burden on respiratory muscles, thereby alleviating dyspnea and reducing respiratory rate, while also enhancing arterial oxygenation, pH and $PaCO_2$ [9]. Certain complications associated with invasive ventilation are linked to the intubation or tracheostomy procedure; or to ventilation itself, including ventilator-associated pneumonia and various other nosocomial infections. Non-invasive techniques of mechanical ventilation (NIV) have the potential to mitigate a majority of the complications associated with invasive ventilation, while simultaneously maintaining a comparable level of effectiveness [10]. The international consensus conference regarding NIV for acute respiratory failure articulated that "the integration of NIV with conventional medical management of patients experiencing ARF may mitigate the necessity for intubation and diminish the incidence of complications and mortality among individuals with hypercapnic respiratory failure [11]. The diminution of complications associated with endotracheal intubation and the transition from invasive mechanical ventilation constitutes the primary determinant influencing mortality. Furthermore, non-invasive ventilation (NIV) can be implemented prior to intubation during the progression of respiratory failure and may be administered beyond the confines of the intensive care unit (ICU) [12]. To ascertain the advantages of non-invasive ventilation (NIV) in individuals with acute exacerbation of chronic obstructive pulmonary disease (AE-COPD), we performed a retrospective and observational investigation evaluating the efficacy of NIV in patients presenting with Type 2 respiratory failure, with the primary endpoint being the normalization of arterial pH and the duration of NIV necessary for clinical enhancement.

## AIMS AND OBJECTIVES

To evaluate the efficacy of non-invasive ventilation (NIV) in individuals presenting with type 2 respiratory failure. Additionally, to determine the necessary duration of NIV for achieving clinical improvement, with the ultimate goal of normalizing arterial pH.

## MATERIALS AND METHODS

This investigation constituted a retrospective and observational study carried out within the Department of Pulmonary Medicine at Rama Medical College,

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Hospital & Research Centre, Kanpur, U.P. The study was conducted over a period of two years. Forty-four patients experiencing acute exacerbation of chronic obstructive pulmonary disease were selected for inclusion in this study based on a set of predetermined inclusion and exclusion criteria. The research protocol received approval from the Institutional Ethics Committee. Data pertaining to patients admitted to our hospital for acute exacerbation of chronic obstructive airway disease and managed with non-invasive ventilation (NIV) were thoroughly examined, and patients were selected for inclusion in this study according to predetermined criteria. Demographic characteristics of the patients, including age, gender, and body mass index, were obtained from their respective case files. The existence of additional systemic diseases, including diabetes mellitus and hypertension, along with other comorbid conditions, was meticulously documented. All patients were administered NIV via a non-invasive ventilator VPAP. The duration for which the patient was hospitalized was documented, along with the blood gas parameters measured at the respective times. All clinical information and investigative reports, including complete blood counts, hepatic and renal function tests, as well as blood gas analysis reports, were examined and documented. Additionally, Acute Physiology and Chronic Health Evaluation II scores, as reported on case documentation, were also recorded [13]. The severity of dyspnea and the stage of the disease were ascertained using the New York Heart Association classification and the Global Initiative for Chronic Obstructive Lung Disease (GOLD) staging, respectively [14]. The data were analyzed by comparing arterial blood gas pH values with the administration of Non-Invasive Ventilation (NIV). The enhancement in pH values was correlated with the utilization of NIV [15] Furthermore, other comorbidities were incorporated into the data and correlated with pH levels. Patients who ultimately necessitated invasive ventilation due to lack of clinical improvement or exacerbation of acidosis were excluded from the study, even if they received invasive ventilation for a brief period. All gathered data were initially inputted into a Microsoft Excel spreadsheet and subsequently transferred to SPSS software version 17 for analytical purposes. Qualitative data were exhibited in the form of frequencies and percentages. Quantitative data were displayed as means and standard deviations. A p-value less than 0.05 was considered statistically significant.

**Inclusion criteria**

The subsequent criteria were incorporated into the research: Patients hospitalized for acute exacerbation of chronic pulmonary airway disease managed with non-invasive ventilation (NIV). Individuals experiencing Type 2 respiratory failure. pH less than 7.35 and PaCO2 exceeding 45 mm Hg. Individuals older than 20 years.

**Exclusion criteria**

The subsequent criteria were incorporated into the research: Patients hospitalized for acute exacerbation of chronic pulmonary airway disease managed with non-invasive ventilation (NIV). Individuals experiencing Type 2 respiratory failure. pH less than 7.35 and PaCO2 exceeding 45 mm Hg. Individuals older than 20 years.

## RESULTS

Among the total 129 cases, females accounted for 69 cases (53.5%) while males constituted 60 cases (46.5%), resulting in a male-to-female ratio of 1:1.15 (Chart No.1). The highest proportion of cases was observed in the 51–60 years age group, comprising 30.2% of the total, followed by the 41–50 years group (26.3%). In contrast, the lowest number of cases was recorded in the >70 years group (6.2%). Age distribution among females and males was relatively similar across groups, though females slightly outnumbered males in each category. The mean age for females was 50.7 years (SD±13.1), for males 48.8 years (SD±13.3), and the overall mean age was 49.8 years (SD±12.2). These findings indicate that middle-aged adults, particularly those between 41 to 60 years, represented the majority of cases, with a slightly higher prevalence among females. [Table 1].

**Table No.1: Age and Gender wise distribution of cases**

| Age group (Year) | Gender | | Total n (%) |
|---|---|---|---|
| | Female, n (%) | Male, n (%) | |
| 21-30 | 6 (4.6%) | 7 (5.4%) | 13 (10.0%) |
| 31-40 | 8 (6.2%) | 9 (6.9%) | 17 (13.1%) |
| 41-50 | 19 (14.7%) | 15 (11.6%) | 34 (26.3%) |
| 51-60 | 21 (16.2%) | 18 (13.9%) | 39 (30.2%) |
| 61-70 | 10 (7.7%) | 8 (6.2%) | 18(13.9%) |
| >70 | 5 (3.8%) | 3 (2.3%) | 8 (6.2%) |
| **Total** | **69 (53.5%)** | **60 (46.5%)** | **129 (100%)** |
| **Mean age (SD)** | **50.7 (±13.1)** | **48.8 (±13.3)** | **49.8 (±12.2)** |
| **Male: Female ratio 1:1.15** | | | |

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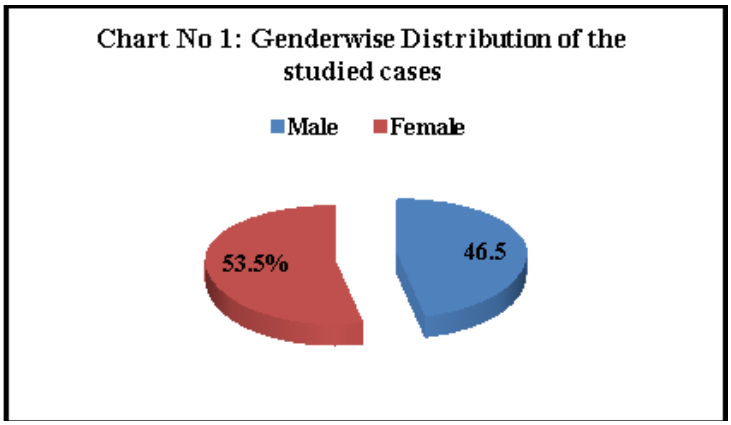
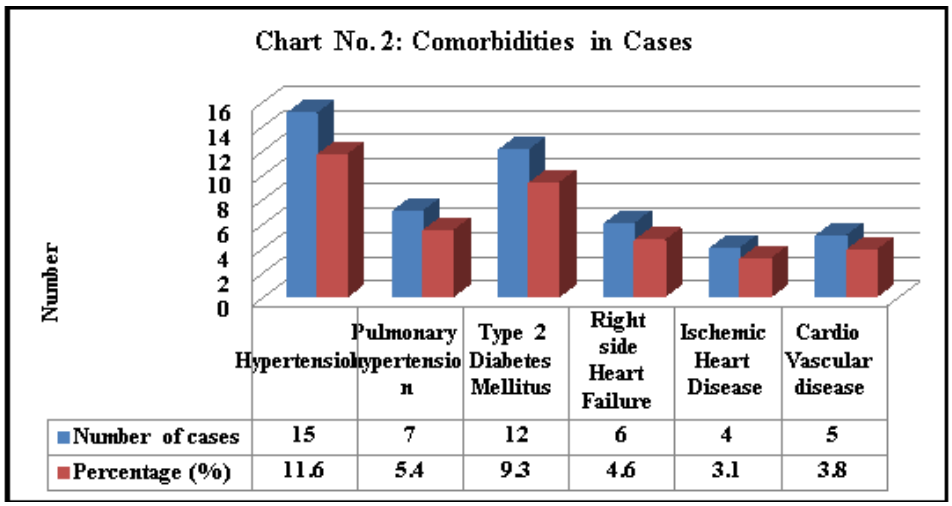



Hypertension emerges in this study as the most common comorbidity, with 15 cases accounting for 11.6% of the total cases, followed closely by Type 2 Diabetes Mellitus with 12 cases accounting for 9.3% of total cases. Pulmonary hypertension is the third most common, resulted in 7 cases (5.4%). Other comorbidities like right-sided heart failure (6 cases, 4.6%), cardiovascular disease (5 cases, 3.8%), and ischemic heart disease (4 cases, 3.1%) were relatively less prevalent. The chart No. 2 highlights a significant decline in the number of cases after the two leading conditions, emphasizing that hypertension and Type 2 Diabetes Mellitus contribute to the majority of the comorbid burden in the studied group. Overall, while a range of comorbidities are present, only a few are notably frequent, suggesting a concentration of risk factors around hypertension and diabetes among the cases analyzed.




The examination of patients according to their presenting complaints revealed that the predominant symptom in the investigated cases was dyspnea, observed in all 129 individuals (100%). The additional presenting complaints encompassed cough 121 (93.7%), expectoration 109 (84.4%), and fever 105 (81.3%). The assessment of dyspnea severity was conducted using the New York Heart Association classification. Among the 129 cases examined, 13 individuals (9.9%) exhibited Grade I dyspnea, while 56 (43.4%), 44 (34.1%), and 19 (14.7%) patients presented with Grade II, Grade III, and Grade IV dyspnea, respectively. The classification of dyspnea stages was determined in accordance with the guidelines provided by the Global Initiative for Chronic Obstructive Lung Disease (GOLD). The majority of the study participants were classified as GOLD Stage II 38 (29.4%), followed by GOLD Stage III 37 (28.6%), GOLD Stage IV 32 (24.8%), and GOLD Stage I 23 (17.8%). [Table 2].

**Table No. 2: Comorbidities, stage of the disease, and severity of dyspnea**

| Patient characteristics | Number of cases | Percentage (%) |
|---|---|---|
| Breathlessness | 129 | 100 |
| Cough | 121 | 93.7 |
| Expectoration | 109 | 84.4 |
| Fever | 105 | 81.3 |
| Dyspnea Grade I | 13 | 9.9 |

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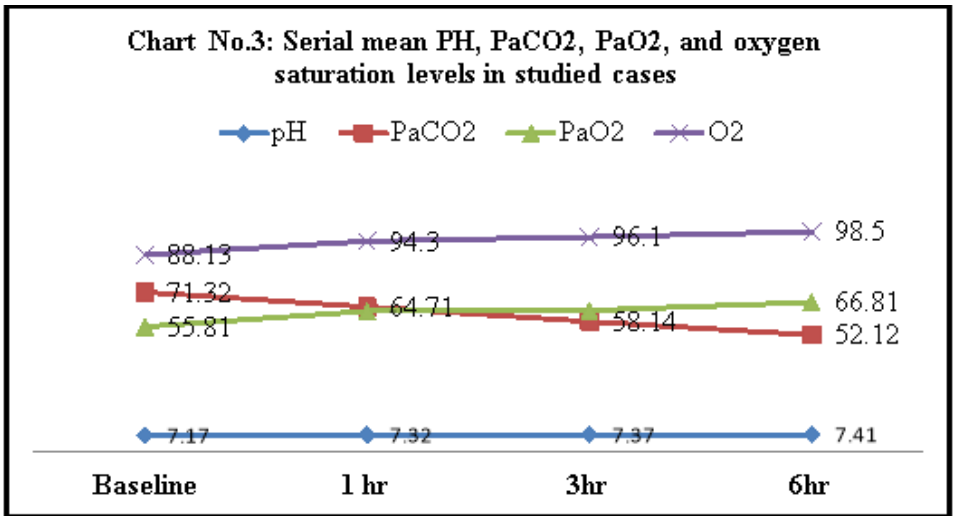
| | | |
|---|---|---|
| Dyspnea Grade II | 56 | 43.4 |
| Dyspnea Grade III | 44 | 34.1 |
| Dyspnea Grade IV | 19 | 14.7 |
| GOLD Stage I | 23 | 17.8 |
| GOLD Stage II | 38 | 29.4 |
| GOLD Stage III | 37 | 28.6 |
| GOLD Stage IV | 32 | 24.8 |
| GOLD: Global Initiative for Chronic Obstructive Lung Disease | | |

The blood gas analysis was conducted at the time of admission, as well as 1, 3, and 6 hours following the initiation of non-invasive ventilation (NIV). Subsequently, arterial blood gas analysis was conducted every six hours until the continuation of non-invasive ventilation (NIV). In all instances, the parameters of pH, PaCO2, PaO2, and O2 saturation were recorded. There was an enhancement in pH, PaCO2, and PaO2, as well as oxygen saturation levels, across all cases. [Chart No. 3].




**DISCUSSION**

In our investigation, a predominance of female individuals was observed among patients necessitating non-invasive ventilation for chronic obstructive pulmonary disease. Sayami et al.[16] executed a research investigation involving individuals with chronic obstructive airway disease, comprising 50 COPD patients aged 30 years and older. The authors observed a distinct female predominance, indicated by a M: F ratio of 1:1.38. In contrast, other researchers such as Agusti et al. [17] and Magitta et al. [18] have documented a male predominance in instances of chronic obstructive airway disease. The disparity in gender distribution may correlate with the heightened

exposure of women to wood smoke for culinary practices in developing nations. The examination of patients according to the presence of risk factors indicated that exposure to wood smoke, primarily for cooking purposes, was noted in 20 (45.45%) individuals within the study population, while 15 (34.09%) patients were identified as active smokers. Sharma et al. conducted a study involving 110 patients diagnosed with COPD. The authors indicated that among the cases examined, 16 patients (17.6%) had never smoked, while 16.3% had ceased tobacco smoking. Furthermore, 18 individuals (19.8%) were exposed to wood smoke. Eight patients (8.8%) were diagnosed with tuberculosis, 5 (4.5%) reported symptoms of asthma, and 2 (1.8%) presented with bronchiectasis. Additionally, 13 patients (11.8%) had diabetes mellitus, 62 (56.3%) exhibited hypertension, and 14 (12.7%) had cor pulmonale. Wood smoke exposure accounted for 20% of cases in our investigation, and the results of our study exhibited notable similarities to those of the research conducted by Sharma et al. [19] An examination of the cases according to their presenting complaints revealed that dyspnea was the most frequently encountered symptom, observed in all 44 patients (100%). The additional presenting symptoms encompassed cough (95.45%), expectoration (84.09%), and fever (81.81%). Song et al. executed a study involving 21 patients experiencing acute exacerbation of asthma. The authors observed that breathlessness and cough were the predominant presenting complaints among patients experiencing acute exacerbations. The researchers additionally documented complications arising from cough, including chest pain, aphonia, and psychosocial issues linked to severe coughing. Comparable results were also documented by researchers such as Kim et al. [21] and Hyland et al. [22]. In this investigation, non-invasive ventilation (NIV) proved effective in 97.7% of the study cohort.

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Padhi et al. carried out an investigation to assess the efficacy and safety of non-invasive positive pressure ventilation (NIPPV) in the context of acute exacerbation of chronic obstructive pulmonary disease (AECOPD). The researchers determined that the average duration of NIPPV administration was 18.3±9.2 hours. The mean length of ICU stay was 2.8±2.1 days, while the average duration of hospitalization was 4.1±1.9 days. A favorable outcome was noted in 43 (86%) patients. The rate of successful outcomes in our study was elevated (97.7%) relative to that reported by Padhi et al.[23]. This could be attributed to the observation that the average age of patients in the study by Padhi et al. was greater than the mean age of cases in our research. Comparable success rates were additionally documented by researchers such as, Brochard et al. [24], and Patel et al. [25].

**Limitation of the Study**

The primary constraint of this research was the comparatively limited number of cases. A study involving a larger cohort of cases would further validate the findings of this research.

## CONCLUSION

Non-invasive ventilation constitutes a secure and efficacious method for the management of individuals experiencing acute exacerbations of chronic obstructive airway disease, demonstrating efficacy in most patients, as evidenced by improvements in arterial pH. It further possesses a notable advantage by mitigating complications related to endotracheal intubation.

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