# PREDICTORS OF OUTCOME OF NONINVASIVE VENTILATION IN SEVERE COPD EXACERBATION

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# PREDICTORS OF OUTCOME OF NONINVASIVE VENTILATION IN SEVERE COPD EXACERBATION


## ABSTRACT

**Background:** Chronic obstructive pulmonary disease (COPD) is a major cause of morbidity and mortality worldwide. Acute exacerbation of COPD (AECOPD) often leads to respiratory failure requiring ventilatory support. Non-invasive ventilation (NIV) has emerged as an effective treatment strategy, but factors predicting its outcome remain inadequately understood. This study aimed to identify factors that predict NIV outcomes in patients with AECOPD and explore determinants of NIV settings and duration.

**Methodology:** A hospital-based prospective cohort study was conducted at the Department of Respiratory Medicine, Jaipur National University Hospital, Rajasthan, India. Sixty patients with AECOPD requiring NIV were enrolled. Clinical parameters, arterial blood gas (ABG) analyses and ventilator settings were recorded at baseline and at multiple intervals during treatment. Outcomes were categorized as "success" (clinical stability allowing ward transfer) or "failure" (worsening respiratory parameters requiring intubation or resulting in death).

**Results:** Of the 60 patients, 43 (71.7%) responded successfully to NIV. Baseline demographic and clinical characteristics were comparable between success and failure groups. However, significant improvements in pH ($p=0.013$), $PaCO_2$ ($p=0.007$) and $PaO_2$ ($p=0.018$) were observed in the success group after just 2 hours of NIV therapy with continued improvement in subsequent measurements. The mean duration of NIV treatment was significantly longer in the success group (2.69±3.80 days) compared to the failure group (0.92±1.41 days, $p=0.018$). Commonly observed complications included dryness of oral and nasal mucosa (30%), eye irritation (20%) and skin abrasion (13.3%).

**Conclusion:** Early improvement in arterial blood gas parameters, particularly pH, $PaCO_2$ and $PaO_2$ within the first 2 hours of NIV initiation, strongly predicts successful outcomes in AECOPD patients. Regular monitoring of these parameters may help identify patients who would benefit from continued NIV support versus those requiring escalation to invasive ventilation.



**Keywords:** Chronic obstructive pulmonary disease, Non-invasive ventilation, Acute exacerbation, Respiratory failure, Arterial blood gases, Predictors of outcome


## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is the third most common cause of death worldwide, causing 3 million deaths and 63.5 million disability-adjusted life years (DALY) lost globally in 2016, leading to substantial morbidity.[1] One common complication of COPD is acute exacerbation (AECOPD), which can lead to hospitalization and significant expenses for the healthcare system and society, alongside higher rates of morbidity and mortality.[2] People with COPD, especially those with more severe disease, are more likely to experience exacerbations, which often lead to hospitalization. Breathing becomes extremely challenging for patients experiencing a severe episode of COPD. This may result in acute hypercapnic respiratory failure (AHRF), which frequently necessitates immediate hospital-based medical attention. Acute respiratory acidosis brought on by protracted hypercapnia (high carbon dioxide levels) is a typical feature of severe AECOPDs. Despite the adoption of mechanical ventilator support techniques, between one-third and one-fifth of COPD patients admitted to hospitals with AHRF pass away while still in the hospital.[3-8]

The respiratory muscles work near their maximum capacity in severe COPD and hyperinflation puts them at a mechanical disadvantage.[9,10] Ventilatory failure may result from increased elastic and resistive stresses on the respiratory muscles during acute exacerbations. Ventilatory failure spirals downward as a result of the ensuing tissue acidosis, which further compromises ventilatory muscle performance.[11] Conventional therapy aims to treat the underlying cause of the aggravation while facilitating appropriate oxygenation using bronchodilators, corticosteroids, antibiotics and controlled

oxygen. Invasive mechanical ventilation has historically been used for patients who do not respond to standard treatment, involving sedation, intubation, mechanical ventilator attachment and transfer to an intensive care unit (ICU). This approach has been linked to successful reversal of hypercapnic acidemia in some patients but carries serious risks including damage to tissue structures, oxygen toxicity, volutrauma, tracheal stenosis, vocal cord dysfunction and ventilator-associated infections.[12-14] High morbidity and difficulty weaning off ventilatory assistance are also linked to invasive mechanical ventilation in COPD patients.[15,16] For AHRF secondary to AECOPD, non-invasive ventilation (NIV) has emerged as an alternate therapeutic approach.[4,12,17,18] NIV provides ventilatory support through a flow generator attached to a full face or nasal mask without requiring sedation or intubation. NIV offers several advantages over invasive ventilation, including the ability to be used for brief periods, absence of sedation, preservation of the patient's capacity to eat, drink and speak and a lower incidence of nosocomial pneumonia.[19-21]

NIV improves ventilation by supplying pressure-supported airflow to relieve tired ventilatory muscles, facilitating the normalization or improvement of lung volumes and mechanics to reverse academia.[22] Randomized controlled trials and case reports have validated the use of NIV in AHRF due to AECOPD.[4,22,23] Despite this, failure rates ranging from 9% to 50% have been documented and NIV is not always more effective than standard treatment.[24,25] This is concerning because ineffective NIV may delay necessary intubation, potentially leading to worse outcomes.[26,27] The aim of this study is to identify factors that predict the outcome of Non-Invasive Ventilation in acute exacerbations of chronic obstructive pulmonary disease and to investigate factors that influence NIV settings and duration.

## METHODOLOGY

The study employed a hospital-based prospective cohort design, conducted over a period of one year at the Department of Respiratory Medicine, Jaipur National University Hospital, located in Jaipur, Rajasthan. Ethical approval was granted by the Institutional Review Board for Ethical Clearance at Jaipur National University Hospital. All participants, or their attendants, were thoroughly informed about the study's procedures and its objectives. Written informed consent was obtained from all consenting individuals and patient confidentiality was strictly maintained throughout the research. The study did not alter the standard treatment protocols for the participants, nor did it impose any additional financial burdens on them.

The sample size for the study was determined based on a 95% confidence level, assuming a failure rate of 24% after non-invasive ventilation (NIV) for acute exacerbation of chronic obstructive pulmonary disease (AECOPD), as cited by Mostafa Shaheen et al.[28] With an absolute error of 10%, the required sample size was calculated to be 70, using the formula $n = Z\alpha^2\ p\ q\ /\ d^2$, where $Z\alpha$ is 1.96, p is the failure rate (0.24), q is the complement of p (0.76) and d is the absolute error (0.1).

The inclusion criteria for the study included individuals experiencing acute exacerbation of COPD with type 2 respiratory failure, those with a prior COPD diagnosis per the GOLD 2023 guidelines and patients who were admitted to the ICU, hospital, or casualty and were older than 18 years. Participants had to provide written informed consent. The exclusion criteria eliminated patients with severe upper gastrointestinal hemorrhage, hemodynamic instability, cardiac or respiratory arrest, facial surgery or trauma interfering with mask fitting, pneumonia, cerebrovascular accidents or those requiring immediate intubation, among other conditions. After applying these criteria, the study population consisted of 60 patients.

A cohort of 60 patients who met the inclusion and exclusion criteria was enrolled. COPD was diagnosed through clinical history, physical examination, pulmonary function tests and imaging such as chest radiography. Prior to starting NIV, all patients received standard medical therapy for 45-60 minutes. NIV settings varied with patients being ventilated using either pressure support ventilation (PSV) or pressure-controlled ventilation (PCV) through a full face mask or, in some cases, a helmet. The inspiratory pressure was adjusted according to the patient's tolerance, targeting an expired tidal volume of 7-8 mL/kg with external positive end-expiratory pressure (PEEP) not exceeding 6 $cmH_2O$.

ICU ventilators or specialized NIV platforms were used to monitor exhaled tidal volume and $FiO_2$ was adjusted to maintain $SaO_2$ levels above 90%.

The definitions for NIV success and failure were clearly established. Success was defined as achieving a clinical and functional status that allowed the patient to be transferred to the ward, whereas failure was identified by a worsening of arterial blood gas (ABG) tensions, significant dyspnea, or sensory deterioration during mechanical ventilation, or if the patient died in the ICU. For each patient, data was collected, including age, gender, baseline ABG results and measurements taken two hours after NIV initiation, on days one to three and at the time of ICU discharge (for successful cases) or before intubation or death (for failed cases).

The parameters assessed in the study included age, gender, BMI, lung function tests, blood pressure, ABG values, total and differential counts, creatinine clearance and echocardiographic data. Additionally, respiratory rate changes, the need for endotracheal intubation, the duration of NIV during the first 72 hours and the length of hospital stay (LOS) were recorded. The statistical analysis was carried out using SPSS 22.0 for Windows. Means and standard deviations were calculated for each group at various assessment points. One-way ANOVA was applied to analyze the data with a significance threshold set at $p < 0.05$.

## RESULTS

A hospital-based prospective observational study was conducted including 60 established cases of COPD enrolled from the Department of Respiratory Medicine, Jaipur National University Hospital, Jaipur. The demographic and clinical characteristics of the study population are presented in Table 1.

**Table 1: Demographic and Clinical Characteristics of Study Participants**

| Characteristics | Value (N=60) | Percentage (%) |
|---|---|---|
| **Gender** | | |
| Male | 32 | 53.33 |
| Female | 28 | 46.67 |
| **Age** (years), Mean±SD | 65.05±8.71 | - |
| **BMI**, Mean±SD | 24.5±4.28 | - |
| **Symptoms** | | |
| Cough | 55 | 91.67 |
| Sputum | 34 | 56.67 |
| Fever | 22 | 36.67 |
| Chest Pain | 5 | 8.33 |
| Shortness of Breath | 60 | 100 |
| **MMRC Grade of Dyspnea** | | |
| II | 2 | 3.33 |
| III | 30 | 50.00 |
| IV | 28 | 46.67 |
| **Biomass Exposure** | | |
| Yes | 25 | 41.67 |
| No | 35 | 58.33 |
| **Smoking Status** | | |
| Yes | 49 | 81.67 |
| No | 11 | 18.33 |
| **Comorbidities** | | |
| Diabetes Mellitus | 20 | 33.33 |
| Hypertension | 23 | 38.33 |

| | | |
|---|---|---|
| OSA | 7 | 11.67 |
| CAD | 5 | 8.33 |
| Pulmonary Hypertension | 2 | 3.33 |
| **COR Pulmonale** | | |
| Yes | 36 | 60 |
| No | 24 | 40 |

Table 1 summarizes the demographic and clinical profile of patients with AECOPD requiring NIV. The study found a slight male predominance (53.33%) in the gender distribution, which contrasts with the traditionally higher male prevalence in COPD. This could reflect changing epidemiological trends, possibly due to increased smoking among women or exposure to biomass fuels, which was present in 41.67% of the cohort. The mean age of 65.05±8.71 years is typical for COPD exacerbations requiring hospitalization as the disease commonly presents in the sixth and seventh decades of life. The mean BMI of 24.5±4.28 was within the normal range. Dyspnea was the most common symptom reported by all participants (100%), followed by cough (91.67%) with 56.67% of patients having a productive cough, aligning with chronic bronchitis in COPD. Fever was observed in 36.67% of cases, suggesting an infectious trigger, while chest pain was uncommon (8.33%). The majority of patients (50%) had severe breathlessness (MMRC grade III) and 46.67% were in grade IV indicating significant functional limitations.

Tobacco smoking was the primary risk factor, affecting 81.67% of patients with a mean smoking index of 718. Non-smokers (18.33%) were likely affected by other factors, including biomass fuel exposure (41.67%). The comorbidity profile revealed a high prevalence of hypertension (38.33%) and diabetes mellitus (33.33%). Obstructive sleep apnea (11.67%) and coronary artery disease (8.33%) were also present, indicating overlap syndromes and shared risk factors with cardiovascular diseases. Notably, cor pulmonale was present in 60% of patients, signifying advanced pulmonary vascular remodeling and right heart dysfunction. This finding is important as cor pulmonale is associated with poorer COPD outcomes and may influence NIV therapy effectiveness. Most patients (26.7%) had been diagnosed with COPD for 4 years and 35% had experienced a previous exacerbation within the last year indicating either their first severe exacerbation or significant deterioration after a period of relative stability.

**Clinical, Laboratory and Radiological Findings**

The comprehensive evaluation of clinical parameters revealed significant respiratory compromise in the study population. The mean $SPO_2$ at presentation was notably low at 76.05±7.11%, indicating substantial hypoxemia despite supplemental oxygen. This was accompanied by tachypnea with a mean respiratory rate of 31.55±4.91 breaths per minute, reflecting the increased work of breathing characteristic of acute exacerbations. The mean total leukocyte count was 9225.17±1814.50 cells/$mm^3$, suggesting an inflammatory response that often accompanies AECOPD, although not reaching levels typically seen in acute bacterial infections. Cardiovascular assessment through ECG revealed predominant sinus tachycardia in 71.7% of patients, likely a compensatory response to hypoxemia and increased metabolic demands. More concerning were the findings of arrhythmia in 18.3% of patients, which may represent either pre-existing cardiac disease or acute strain on the cardiovascular system. Acute coronary syndrome was identified in 10% of patients, highlighting the significant cardiopulmonary interaction during severe COPD exacerbations and the potential for hypoxemia to precipitate myocardial ischemia.

Radiological evaluation through chest X-rays demonstrated the chronic changes expected in COPD with hyperinflation of the lungs identified in 51.7% of patients (consistent with chronic bronchitis predominant phenotype) and emphysematous changes in 48.3% (consistent with emphysema predominant phenotype). These findings reflect the underlying pathophysiological processes that predispose patients to acute exacerbations. Pulmonary function testing revealed significant airflow limitation that showed measurable improvement during the course of treatment. The mean PEFR at admission was 162.05±47.11 L/min, which improved to 190.53±41.78 L/min at discharge ($p<0.01$).

While this improvement was statistically significant, the discharge values remained substantially below predicted normal values, consistent with the irreversible component of airflow limitation characteristic of COPD.

**NIV Parameters and Outcomes**

The NIV settings employed in this study reflect a therapeutic approach tailored to balance patient comfort with effective ventilatory support. The mean IPAP of 14.25±1.56 cm $H_2O$ provided moderate inspiratory assistance to reduce the work of breathing without causing excessive gastric insufflation or patient discomfort. The mean EPAP of 6.49±1.04 cm $H_2O$ was sufficient to counteract intrinsic PEEP and maintain airway patency during exhalation. The overall success rate of NIV therapy was 71.7% (43 patients) with 28.3% (17 patients) experiencing treatment failure. This success rate is comparable to those reported in similar studies, including those by Brochard L et al. (1995)[5] and Kshatriya RM et al. (2019)[29], which reported success rates of 74%. A notable finding was the significant difference in NIV duration between the success and failure groups (2.69±3.80 days versus 0.92±1.41 days, p=0.018), suggesting that patients who responded positively to NIV were able to tolerate and benefit from longer periods of ventilatory support. The complications associated with NIV therapy were generally mild and manageable. The most common complication was dryness of oral and nasal mucosa (30%), followed by eye irritation (20%) and skin abrasion (13.3%). These interface-related issues are well-recognized challenges in NIV delivery and can often be addressed through mask adjustment, application of protective dressings and appropriate humidification. More concerning complications such as hypotension (6.7%) and abdominal distension (1.7%) were relatively rare. Importantly, 23.3% of patients experienced no complications, suggesting good overall tolerability of the intervention.

**Comparison of Arterial Blood Gas Parameters Between Success and Failure Groups**

**Table 2: Comparison of pH, $PaCO_2$, $PO_2$ and $HCO_3$ Between Success and Failure Groups**

| Parameter | Interval | Success Group (Mean±SD) | Failure Group (Mean±SD) | p-value |
|---|---|---|---|---|
| **pH** | 0 hr | 7.10±0.01 | 7.10±0.02 | 0.10 |
| | 2 hr | 7.18±0.01 | 7.02±0.01 | 0.013* |
| | 24 hr | 7.20±0.02 | 7.01±0.02 | 0.009* |
| | 24-48 hr | 7.25±0.04 | 7.05±0.01 | 0.007* |
| | 48-72 hr | 7.30±0.02 | 7.02±0.02 | 0.005* |
| | 72-96 hr | 7.31±0.03 | 7.03±0.03 | 0.004* |
| **$PaCO_2$** (mmHg) | 0 hr | 71.86±3.51 | 72.54±2.73 | 0.79 |
| | 2 hr | 62.43±2.54 | 71.19±3.12 | 0.007* |
| | 24 hr | 53.05±2.69 | 74.06±2.54 | <0.01* |
| | 24-48 hr | 50.02±2.94 | 75.28±2.91 | <0.01* |
| | 48-72 hr | 45.08±2.01 | 77.55±3.09 | <0.01* |
| | 72-96 hr | 41.23±2.80 | 79.38±2.56 | <0.01* |
| **$PO_2$** (mmHg) | 0 hr | 75.43±3.54 | 74.68±2.89 | 0.62 |
| | 2 hr | 77.81±2.61 | 71.43±3.06 | 0.018* |
| | 24 hr | 80.26±2.76 | 66.05±2.48 | <0.01* |
| | 24-48 hr | 83.19±3.01 | 61.02±2.85 | <0.01* |
| | 48-72 hr | 85.40±2.08 | 59.08±3.03 | <0.01* |
| | 72-96 hr | 86.83±2.87 | 58.23±2.50 | <0.01* |

| | | | | |
|---|---|---|---|---|
| **$HCO_3$** (mmol/L) | 0 hr | 30.21±2.81 | 30.10±2.62 | 0.83 |
| | 2 hr | 31.56±1.88 | 30.78±2.79 | 0.60 |
| | 24 hr | 34.19±2.03 | 32.05±2.21 | 0.07 |
| | 24-48 hr | 35.82±2.28 | 32.69±2.58 | 0.031* |
| | 48-72 hr | 35.54±1.35 | 33.07±2.76 | 0.044* |
| | 72-96 hr | 35.91±2.14 | 33.04±2.23 | 0.048* |

*Statistically significant ($p<0.05$)

Table 2 provides a comprehensive comparison of arterial blood gas parameters between the success and failure groups at multiple time intervals, offering critical insights into physiological response to NIV therapy. At baseline (0 hr), both groups demonstrated comparable severe respiratory acidosis with mean pH values of 7.10, indicating significant decompensation of the acid-base status. Similarly, baseline $PaCO_2$ levels were markedly elevated in both groups (71.86±3.51 vs. 72.54±2.73 mmHg, p=0.79), reflecting severe alveolar hypoventilation. Initial $PO_2$ values were also comparable (75.43±3.54 vs. 74.68±2.89 mmHg, p=0.62), as were $HCO_3$ levels (30.21±2.81 vs. 30.10±2.62 mmol/L, p=0.83), suggesting that the severity of acute respiratory failure at presentation was not predictive of NIV outcome. The divergence in physiological trajectories became evident as early as 2 hours after NIV initiation. The success group demonstrated a significant improvement in pH (7.18±0.01 vs. 7.02±0.01, p=0.013), representing a clear trend toward normalization of acid-base status. This early improvement aligns with findings by Anton A et al. (2000)[30], who identified early pH response as a predictor of NIV success. Concurrently, the success group showed a substantial reduction in $PaCO_2$ levels (62.43±2.54 vs. 71.19±3.12 mmHg, p=0.007), indicating effective alveolar ventilation and $CO_2$ elimination with NIV support. $PO_2$ levels also improved significantly in the success group compared to the failure group at this early time point (77.81±2.61 vs. 71.43±3.06 mmHg, p=0.018).

The physiological disparity between groups became progressively more pronounced over subsequent time intervals. By 24 hours, the success group had achieved a mean pH of 7.20±0.02 compared to 7.01±0.02 in the failure group (p=0.009) with further improvement to near-normal values (7.31±0.05) by 72-96 hours. The failure group, in contrast, remained persistently acidotic. This pattern is consistent with findings by Confalonieri M et al. (2005)[31], who identified persistent acidosis as a marker of NIV failure. Perhaps most striking was the divergent trend in $PaCO_2$ levels. While the success group showed progressive reduction in $PaCO_2$ reaching near-normal values by 72-96 hours (41.23±2.80 mmHg), the failure group demonstrated not only persistence but worsening of hypercapnia (79.38±2.56 mmHg at 72-96 hours, $p<0.01$). This deterioration in the failure group likely reflects progressive fatigue of respiratory muscles, worsening ventilation-perfusion mismatch, or increasing airway resistance despite NIV support - processes that eventually necessitate invasive ventilation or may lead to mortality if left unaddressed. Oxygenation parameters ($PO_2$) showed similar divergence with the success group achieving progressive improvement (reaching 86.83±2.87 mmHg by 72-96 hours), while the failure group experienced deterioration (falling to 58.23±2.50 mmHg, $p<0.01$). This suggests that NIV not only improved ventilation but also oxygenation in responsive patients, likely through recruitment of collapsed alveoli and improvement in ventilation-perfusion matching. The $HCO_3$ response, representing renal compensation, showed a delayed pattern compared to the respiratory parameters. No significant difference was observed at 2 hours or 24 hours. However, by 24-48 hours, the success group demonstrated significantly higher $HCO_3$ levels (35.82±2.28 vs. 32.69±2.58 mmol/L, p=0.031), a difference that persisted through subsequent measurements. This delayed response is physiologically consistent with the slower time course of renal bicarbonate retention compared to the more rapid respiratory compensation facilitated by NIV.

**DISCUSSION**

This study, conducted at the Department of Respiratory Medicine, Jaipur National University Hospital, investigated the determinants of outcome of non-invasive ventilatory assistance in patients experiencing a COPD exacerbation. Sixty patients meeting the inclusion criteria were selected.

Numerous studies have demonstrated the effectiveness of non-invasive ventilatory assistance as therapy option for acute exacerbations of COPD with respiratory failure.[32,33] Early use of NIV in the course of COPD exacerbations with hypercapnic acute respiratory failure can help avoid intubation and its associated complications. The majority of participants in this study were men (53.33%) with the remainder (46.67%) being women. These results were in line with those of Steriade AT et al. (2019)[34], who also noted that 50.56% of patients in their study were male. Similar to the current study, the majority of the subjects in the study by Vaudan S et al. (2015)[35] were men. The subjects' mean BMI in this study was 24.5±4.28. Barbé F et al. (1996)[24] found similar results, reporting that the subjects' mean BMI was 24.9±1.3.

In the present study, 81.67% of subjects had a positive history of smoking with a mean smoking index of 718. This high prevalence of smoking history is consistent with the known strong association between tobacco smoking and COPD development. The most common comorbidities observed in this study were hypertension (38.33%), diabetes mellitus (33.33%), OSA (11.67%) and CAD (8.33%). According to a study by Ongel EA et al. (2014)[36], cardiovascular comorbidities (hypertension, coronary artery disease and arrhythmias) are the most prevalent comorbidities in COPD with incidence rates of 35%, 14% and 13%, respectively. This finding aligns closely with the current study.

Of the 60 patients who participated in the research, 71.7% received successful NIV treatment, avoiding the need for endotracheal intubation, while 28.3% experienced NIV failure. This outcome is nearly in line with a study by Kshatriya RM et al. (2019)[29], which reported a success rate of 74%. Our study's NIV success rate was comparable to that of Singh VK et al. (2006)[37]. Similar to our study, 74% of patients with COPD exacerbations placed on NIV in a multicentric study conducted in Europe between 1990 and 1991 by Brochard L et al. (1995)[5] did not require intubation and invasive ventilation. Plant PK et al. (2000)[32] reported a success rate of 84.7%, which is higher than the current trial, while Ambrosino N et al. (1995)[3] reported a success rate of 78% in the NIV group, which aligns more closely with our findings.

Both the successful and failed groups in the current investigation had the same baseline pH. The successful group's acidosis improved more statistically significantly than the failed group's after two hours of treatment (p=0.013). The successful group's pH improved more statistically significantly than the failure group's during all subsequent intervals. Numerous investigations of acute exacerbations of COPD have demonstrated that acidosis predicts death and is a measure of the degree of decompensation in acute hypercapnic respiratory failure.[37,38] There was no discernible difference between the successful and failure groups' baseline mean $PaCO_2$ values. Following two hours of therapy, the successful group's $PaCO_2$ levels were considerably lower than those of the failure group (p=0.007). Throughout all subsequent intervals, the successful group's $PaCO_2$ values were considerably lower than those of the failure group (p<0.01). The baseline $PO_2$ level did not significantly differ between the successful and failure groups. The successful group's $PO_2$ level improved more statistically significantly than the failed group's after two hours of treatment (p=0.018). Over the course of the subsequent periods, the successful group's $PO_2$ level improved more statistically significantly than the failure group's (p<0.01).

In the current investigation, it was found that patients receiving non-invasive ventilatory support showed a considerable improvement in pH, $PaCO_2$ and $PO_2$. According to several authors, improvements in pH, $PCO_2$ and consciousness level during the first hour or two after NIV initiation are excellent markers of success (166). Similar findings were made in a study by Celikel T et al. (1998)[39], which indicated that baseline values for pH, $PaCO_2$, $PO_2$ and respiratory rate had significantly improved with NIV. In the study by Bott J et al. (1993)[4], the pH increased while the controls decreased and the $PaCO_2$ decreased more in the NIV group. In the comparison of efficacy and mortality, the NIPPV group experienced a decrease in mortality. They therefore concluded that NIPPV significantly increased pH, decreased $PaCO_2$ and dyspnea and decreased mortality in patients with acute ventilatory failure brought on by COPD. According to a study by Kshatriya RM et al. (2019)[29], a favorable outcome was significantly correlated with improvements in baseline ABG parameters like pH, $PCO_2$ and $PO_2$ during or after 24 hours of NIV support. The pH levels of the two groups at the start and end of the trial differed significantly (P values 0.0001 and 0.0001, respectively)

according to Abdelfattah RA et al. (2023)[40] with the success group having higher pH levels, just like in our study.

The poor result of NIV support was significantly influenced by a low pH and a high starting $PCO_2$. This result aligned with the findings of Ambrosino N et al. (1995)[3], who demonstrated that the degree of hypercapnia and acidosis during a non-invasive mechanical ventilation initial trial influences the likelihood of success and is therefore helpful in determining whether or not to continue NIV treatment. A pH of less than 7.25 following an hour of NIV use was associated with a greater likelihood of NIV failure, per Confalonieri M et al. (2005).[31] In line with other studies like Agarwal R et al. (2008)[41] and Anton A et al. (2000)[30], which also recommended that intubation should be considered if NIV does not improve pH and respiratory rate within the first two hours, this suggests that the degree of hypercapnia and the severity of acidemia after one hour of treatment may be predictive factors for the success of NIV in COPD cases.

In the current investigation, there was no discernible difference in the mean $HCO_3$ level between the successful and failure groups at baseline, two hours later and twenty-four hours later. The successful group's mean $HCO_3$ level improved more statistically significantly than the failure group's after 24 to 48 hours of therapy (p=0.031). The successful group's mean $HCO_3$ level improved more statistically significantly than the failure group's at 48–72 and 72–96 hours (p values of 0.044 and 0.048, respectively). This was consistent with findings by Corrêa TD et al. (2015)[42] who found that one indicator that could indicate NIV failure was lower arterial bicarbonate levels. The mean number of NIV days in the present study was 2.69±3.80 in the successful group and 0.92±1.41 in the failure group, indicating a statistically significant difference between the two groups with a p value of 0.018. According to a study by Kshatriya RM et al. (2019)[29], patients in the success group received NIV for an average (SD) of 2.72 (1.19) days. This result is nearly in line with their findings.

## CONCLUSION

Chronic obstructive pulmonary disease (COPD) is a major public health concern among people over 40 and will remain a challenge in the future. Exacerbations of COPD result in significant morbidity and mortality. This study found non-invasive ventilation to be an effective treatment option for COPD exacerbation with respiratory failure, helping prevent a considerable percentage of patients from requiring mechanical breathing and its associated side effects. After two hours of NIV therapy, there was a significant improvement in pH, $PaCO_2$ and $PaO_2$ levels in patients who ultimately had successful outcomes. The overall success rate of NIV in this study was 71.7%, comparable to other studies in the literature. The most reliable predictors of NIV success were early improvements in arterial blood gas parameters, particularly pH, $PaCO_2$ and $PO_2$ within the first 2 hours of NIV initiation. Continued monitoring of these parameters can help clinicians identify patients likely to benefit from continued NIV support versus those who may require escalation to invasive ventilation. NIV can reduce the complications and mortality linked to hypercapnic respiratory failure by reducing the requirement for endotracheal intubation if it is administered early with close monitoring of arterial blood gas parameters to guide ongoing treatment decisions.

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