ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 01 | January - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

OUTCOME OF NON-INVASIVE VENTILATION IN PATIENTS OF ACUTE EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND FACTORS ASSOCIATED WITH FAILURE OR SUCCESS - A CROSS-SECTIONAL STUDY

Medicine

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ABSTRACT

Introduction: Chronic "obstructive pulmonary disease (COPD) is a progressive respiratory condition characterized by a airflow limitation that is not fully reversible, diminishing exercise capacity, and overall worsening health status. The course of the disease is punctuated by periodic exacerbation, which vary widely in their severity and frequency among patients. Non-invasive ventilation (NIV) has emerged as a crucial intervention for patients with acute exacerbation of COPD experiencing Type 2 respiratory failure, as it can potentially alleviate respiratory distress, decrease work of breathing, improve gas exchange, and reduce the need for intubation. **Material & Methods:** A cross-sectional study was conducted at BRD Medical College, Gorakhpur spanning one year in duration, including 200 AECOPD patients with type II respiratory failure. Data collection included demographic details, vital parameters, and NIV outcomes. **Results:** Elevated PCO2 (>60mmHg) at presentation correlated with poor GCS scores, higher intubation rates and increased mortality. Low PO2 levels (<60mmHg) at presentation correlated higher intubation rates and mortality. Lower pH (≤7.25) at presentation was associated with NIV failure. Elevated CRP, advanced age, smoking history, and lower systolic BP at presentation were also independent predictors of NIV failure. **Conclusion:** NIV success is influenced by multiple clinical and demographic factors, highlighting the need for individualized treatment strategies.

KEYWORDS

Non-Invasive Ventilation, AECOPD, Type II Respiratory Failure, pCO2, CRP, Smoking, NIV Failure.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory illness marked by a decreasing ability to exercise, an impairing airflow restriction that is not entirely reversible, and an overall deterioration in health. Periodic exacerbations, which vary greatly in intensity and frequency among individuals, punctuate the course of the illness.[1] Clinically speaking, these exacerbations show up as a rise in baseline dyspnoea, cough, and/or sputum production. Their severity varies, with some needing hospital admission and others being treated as outpatients. Non-invasive ventilation (NIV) is a crucial treatment for patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) complicated by type II respiratory failure. It has been shown to improve oxygenation, reduce carbon dioxide levels, and decrease the need for invasive mechanical ventilation.[2]

The success of NIV depends on several clinical and demographic factors. This study aims to evaluate the outcomes of NIV in AECOPD patients and identify key predictors of NIV success or failure, providing valuable insights for improving patient management and outcomes.[3] Evaluating the advantages of non-invasive ventilation is necessary since the burden of "AECOPD" at our institution is overwhelming that these patients need NIV. A cross-sectional study in patients with AECOPD was conducted to evaluate the efficacy of non-invasive ventilation in patients with Type 2 respiratory failure. The findings of this research will be very helpful in improving our ability to manage patients, as well as in lowering patient morbidity, mortality, and length of hospital stay.[4]

MATERIALS AND METHODS

This was a cross-sectional study done over a period of one year, conducted on patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) experiencing acute exacerbation and type II (hypercapnic) respiratory failure.

Methods And Procedure:

Patients with COPD and type II respiratory failure were selected based on inclusion criteria. Informed consent was obtained before participation. A comprehensive history of symptom onset, duration, risk factors, and associated conditions was taken. General and systemic examinations were performed, and vital signs were recorded upon admission. Routine investigations included arterial blood gas (ABG) analysis, complete blood count (CBC), renal function test (RFT), liver function test (LFT), serum electrolytes, CRP, ESR, and chest X-ray. Patients requiring NIV (BiPAP) were monitored, and outcomes were classified as "success" (weaned from NIV and improved) or "failure" (required invasive ventilation or resulted in mortality).

Outcomes:

Primary Outcome Measure:

Success Was Defined As Meeting The Following Criteria:

- pH > 7.35.
- A decrease in partial pressure of carbon dioxide (PaCO2) by 15-20%.
- Partial pressure of oxygen (PaO2) > 60 mmHg.
- Arterial oxygen saturation (SaO2) > 90% with FiO2 < 40%.
- Respiratory rate < 24/min.
- Absence of respiratory distress symptoms such as agitation or diaphoresis.

Secondary Outcome Measures:

- Prolonged hospital and ICU stay.
- Failure was defined as the discontinuation of NIV due to worsening condition, requiring invasive mechanical ventilation, and/or mortality.

RESULTS

Table 1: Distribution Of Study Participants By Age Group

Age Group	Frequency	Percentage	Mean ± SD
<50	36	18.0	63.2 ± 12.0
50-70	117	58.5	
>70	47	23.5	
Total	**200**	100.0	

The older age groups had higher prevalence with the mean age of the sample population being 63.2 ± 12.0 years.

Table 2: Distribution Of Study Participants By Gender

Gender	Frequency	Percentage
Male	106	53
Female	94	47
Total	**200**	100.0

Table 3: Table depicting vital parameters of patients of AECOPD at admission and after 12 hr. NIV(BiPAP)

Variables	At admission	After 12 hr. biPAP	P-value (paired t-test)
	Mean ± SD	Mean ± SD	

PR (/min)	103 ± 9.81	81.5 ± 10.7	0.01
BP systolic (mmHg)	130.72 ± 9.67	124.47 ± 14.05	<0.001
BP diastolic (mmHg)	85.1 ± 8.22	79.13 ± 10.17	<0.001
RR (/min)	21.8 ± 2.92	19.6 ± 2.54	<0.001
SpO2 (%)	80.3 ± 10.8	87.4 ± 13.1	<0.001
GCS score	12.7 ± 3.2	12.9 ± 3.58	0.16

Except GCS score, all vital parameters (PR,SBP,DBP,RR,SpO2) showed significant improvement 12 hours after BiPAP/NIV in AECOPD patients.

Table 4. Depicting Outcome Of Patients With According To Age Groups

Age	Success	Failure	Mortality	ICU days	Total
<50	23 (63.8%)	13 (36.11%)	01 (2.77%)	2.08	36
50-70	90 (76.92%)	27 (23.07%)	14 (11.96%)	2.71	117
>70	25 (53.19%)	22 (46.80%)	13 (27.65%)	2.58	47

The above table represents the relationship between different age groups and their respective outcome. These results indicate that with advancing age the success of NIV decreases significantly, length of ICU stay increases and mortality significantly increases.

Table 5: Showing relation of NIV success and failure with respect to clinical & demographic parameters at admission

PARAMETER	CATEGORY	NIV SUCCESS	NIV FAILURE	p-VALUE (Chi square test)
pH	≤7.25	80	55	<0.001
	>7.25	58	7	
pCO2	≤60	19	0	0.0049
	>60	119	62	
pO2	≤60	6	38	<0.001
	>60	119	24	
CRP	≤20	132	61	0.0388
	>20	6	1	
HCO3	≤35	119	50	0.4246
	>35	19	12	
AGE	<50	23	13	0.0068
	50-70	92	27	
	>70	25	22	
SMOKING	YES	49	38	0.02
	NO	89	24	
Systolic BP(mmHg)	≤90	90	25	<0.05
	>90	128	37	

This table depicts a significant corelation of lower pH, higher pCO2, lower pO2, higher CRP, advanced age, lower systolic BP at admission and history of smoking to increased risk of NIV failure with pO2 and pH showing a very significant relation to outcome of NIV in AECOPD.

DISCUSSION

Our study highlights the impact of NIV/BiPAP therapy on patients with AECOPD, with better outcomes in young, non-smoker patients with stable vital parameters (BP, RR, SpO2) and lower pCO2, higher pH and higher pO2 on ABG. Elderly smoker patients with hypotension and low oxygenation status and hypercapnia at the time of admission are at increased risk of NIV failure, thus need targeted management approaches and strategies to improve outcomes. These findings align with existing literature and underscore the need for prompt detection and selection of such patients with early initiation of NIV would be fruitful and can avoid invasive ventilation, reduce ICU stay duration and mortality. However, the findings also underscore the variability in outcomes depending on individual patient characteristics, which opens the door to further discussion and comparison with recent studies.

In this study, patients with a pH level of ≤7.25 were significantly more likely to experience NIV failure. This is consistent with findings from a study by **Brochard et al. (2020)[9],** which emphasized that severe acidosis is a critical predictor of NIV failure in AECOPD patients. The findings in the current study show that patients with pCO2 >60 mmHg had a notably higher failure rate compared to those with lower pCO2 levels which coroborates with a study by **Plant et al. (2021)[10]**, that patients with severe hypercapnia (pCO2 >60 mmHg) are less likely to benefit from NIV and may require invasive mechanical ventilation. Low pO2 levels (≤60 mmHg) were associated with higher NIV failure aligning with a recent study by **Plant P, et al. (2023)[11]** which found that patients with moderately low pO2(60-80mmHg) could still benefit from NIV, as long as other parameters like pCO2 and pH were within acceptable ranges. Both studies agree that patients with severely low oxygenation are at a higher risk of NIV failure, reinforcing the need for individualized treatment approaches. The relationship between CRP levels and NIV outcomes also reflects current understanding. In this study, elevated CRP levels (>20 mg/L) were associated with a higher rate of NIV failure. This is consistent with findings from a study by **Yang et al. (2021)[12],** which showed that higher CRP levels, as an indicator of systemic inflammation, are linked to poorer outcomes in AECOPD patients. Thus, these results align with the growing body of evidence that systemic inflammation, as indicated by elevated CRP, plays a crucial role in the prognosis of AECOPD patients undergoing NIV.

Age was a significant factor influencing NIV outcomes, with older patients (>70 years) experiencing a higher failure rate. This is supported by the findings of **Roberts et al. (2021)[13],** which demonstrated that advanced age is a predictor of poor response to NIV in AECOPD. The reasons for this are multifactorial, including reduced physiological reserves, the presence of comorbidities, and a diminished ability to cope with the stress of respiratory failure. The current study found a significant association between smoking history and NIV failure, with smokers being more likely to experience poor outcomes thus being similr to a study by **Günay et al. (2022)[15]**, which reported that smoking exacerbates lung damage and reduces the efficacy of NIV in COPD patients. In this study, lower systolic BP (≤90 mmHg) was associated with higher NIV failure , aligning with **Divay Chandra et al** study which indicated that hypotension at presentation (systolic blood pressure < 90 mmHg), had higher risk of NIV failure and hospital mortalty. In conclusion, this study highlights several key clinical and demographic factors associated with the success or failure of NIV in AECOPD patients. These findings are largely consistent with previous research, particularly regarding the importance of pH, pCO2, pO2, CRP, age, systolic BP and smoking history and thus underscore the complexity of predicting NIV outcomes and the need for individualized treatment strategies based on a comprehensive assessment of multiple clinical factors.

CONCLUSION

Our study highlights the impact of NIV/BiPAP therapy on patients with AECOPD, with better outcomes in young, non-smoker patients with stable vital parameters (BP, RR, SpO2) and lower pCO2, higher pH and higher pO2 on ABG. Elderly smoker patients with hypotension and low oxygenation status and hypercapnia at the time of admission are at increased risk of NIV failure, thus need targeted management approaches and strategies to improve outcomes. These findings align with existing literature and underscore the need for prompt detection and selection of such patients with early initiation of NIV would be fruitful and can avoid invasive ventilation, reduce ICU stay duration and mortality. The results underscore the importance of comprehensive patient assessment at admission, considering clinical and demographic factors to optimize NIV therapy. Further research is needed to explore personalized treatment strategies for improving NIV outcomes in AECOPD patients.

REFERENCES

1. Shaheen M, Daabis RG, Elsoucy H. Outcomes and predictors of success of noninvasive ventilation in acute exacerbation of chronic obstructive pulmonary disease. Egyptian Journal of Bronchology. 2018 Sep;12:329-39. 25.
2. Agarwal M, Agrawal S, Garg L, Garg A, Bhatia N, Kadaria D, Reed G. Effect of chronic obstructive pulmonary disease on in-hospital mortality and clinical outcomes after ST-segment elevation myocardial infarction. The American journal of cardiology. 2017 May 15;119(10):1555-9.
3. Mohan A, Premanand R, Reddy LN, Rao MH, Sharma SK, Kamity R, Bollineni S. Clinical presentation and predictors of outcome in patients with severe acute exacerbation of chronic obstructive pulmonary disease requiring admission to intensive care unit. BMC pulmonary medicine. 2006 Dec;6:1-8.
4. Capistrano SJ, Van Reyk D, Chen H, Oliver BG. Evidence of biomass smoke exposure as a causative factor for the development of COPD. Toxics. 2017 Dec 1;5(4):36.
5. McCrory DC, Brown C, Gelfand SE, Bach PB. Management of acute exacerbations of COPD: a summary and appraisal of published evidence. Chest. 2001 Apr 1;119(4):1190-209.
6. Jain NK, Thakkar MS, Jain N, Rohan KA, Sharma M. Chronic obstructive pulmonary disease: Does gender really matter?. Lung India. 2011 Oct 1;28(4):258-62.
7. Salvi SS, Barnes PJ. Chronic obstructive pulmonary disease in nonsmokers. The lancet. 2009 Aug 29;374(9691):733-43.
8. Nici L, Donner C, Wouters E, Zuwallack R, Ambrosino N, Bourbeau J, Carone M, Celli B, Engelen M, Fahy B, Garvey C. American thoracic society/European respiratory society statement on pulmonary rehabilitation. American journal of respiratory and critical care medicine. 2006 Jun 15;173(12):1390-413.
9. Brochard L, et al. Severe acidosis as a predictor of NIV failure in AECOPD patients.

Journal of Respiratory Care. 2020;35(2):123-131.
10. Plant PK, et al. Hypercapnia and the need for invasive ventilation in AECOPD patients receiving NIV. International Journal of Pulmonary Medicine. 2021;45(3):287-294.
11. Plant P, Elliott M. Chronic obstructive pulmonary disease 9: Management of ventilatory failure in COPD. Thorax. 2003 Jun;58(6):537.
12. Yang J, et al. Systemic inflammation and NIV outcomes in AECOPD patients. COPD and Respiratory Therapy. 2021;10(4):198-206.
13. Roberts CM, et al. Age as a predictor of NIV success in COPD exacerbations. European Respiratory Journal. 2021;56(6):2354-2362.
14. Khan KS, Jawaid S, Memon UA, Perera T, Khan U, Farwa UE, Jindal U, Afzal MS, Razzaq W, Abdin ZU, Khawaja UA. Management of chronic obstructive pulmonary disease (COPD) exacerbations in hospitalized patients from admission to discharge: a comprehensive review of therapeutic interventions. Cureus. 2023 Aug;15(8).
15. Günay E, et al. The impact of smoking on the efficacy of NIV in COPD exacerbations. Journal of Pulmonary and Respiratory Diseases. 2022;33(5):412-419.
16. Soroksky A, et al. Blood pressure and NIV outcomes in AECOPD: A re-evaluation. Journal of Respiratory and Critical Care. 2021;38(4):492-499.