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Non- Invasive Ventilation Strategies in the Management of Acute Exacerbation of Chronic Obstructive Pulmonary Disease (COPD): A Prospective Study in a Tertiary Care Pulmonology Department

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ABSTRACT

Background: The term "acute exacerbations of chronic obstructive pulmonary disease" (AECOPD) refers to the condition in which a patient's respiratory symptoms and airway function suddenly deteriorate. In addition, mild, moderate, and severe COPD exacerbations can be categorized according to the treatment used to control it. **Purpose:** This study aims to prospectively compare the effectiveness and outcomes of two non-invasive Ventilation strategies namely bi-level positive airway pressure (BiPAP) and continuous positive airway Pressure (CPAP) in the management of exacerbations of COPD within the pulmonology department. **Methods:** Current Prospective study was conducted in pulmonology department (ICU) of Sudha Hospital Erode after getting approval from the Hospital Ethical committee. A specialized data collection form was designed for collecting the Patient details (Demographic data, Severity of COPD, Respiratory rate and BP) and ABG lab reports (PH, PaCO2, PaO2, HCO3). Further patient's breathing ability was assessed by using Dyspnea Brog CR10 scale. **Results:** Non-smokers showed more significant improvement in dyspnea scores compared to smokers in both BIPAP and CPAP groups. However, BIPAP appears to provide slightly better relief in terms of breathlessness than CPAP, especially during physical activity, but there is approximately only 10% difference in the improvement between BIPAP and CPAP. **Conclusion:** Both BIPAP and CPAP resulted in significant improvements in arterial blood gas (ABG) parameters, such as pH, PaCO2, PaO2 and HCO3 with BiPAP showing slightly better results in terms of reducing hypercapnia and enhancing oxygenation. While the differences between BiPAP and CPAP were statistically significant, they were not drastic, indicating that both methods can be effective in managing respiratory distress in COPD exacerbations.

Keywords: Chronic Obstructive Pulmonary Disease (COPD), Acute exacerbations of chronic obstructive pulmonary disease" (AECOPD), Bilevel positive airway pressure (BPAP), Continuous positive airway pressure (CPAP)

INTRODUCTION

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) recently defined COPD as "a common preventable and treatable disease characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patient". Data from the World Health Organization show that chronic obstructive pulmonary disease (COPD) has become an important contributor to the global burden of non-communicable diseases . From 1990 to 2017, the prevalence of COPD showed an overall upward trend with a relative increase of 5.9%. In 2017, the global prevalence rate of COPD was approximately3.92%. COPD is the world's second most common respiratory disease, affecting approximately 174 million individuals in 2015, a 44.2% rise from 1990. In 2015, 3.2 million individuals worldwide died from COPD, representing an 11.6% rise from 1990.

NON-INVASIVE VENTILATION:

Non-invasive positive pressure ventilation uses positive pressure to supply oxygen to the lungs without requiring endotracheal intubation. It is used for both acute and chronic respiratory failure, however in order to guarantee effectiveness and prevent side effects, thorough monitoring and titration are necessary. Respiratory acidosis, severe dyspnea, and chronic hypoxemia in spite of further oxygen therapy are indications for non-invasive ventilation. Positive pressure improves alveolar ventilation in hypercapneic respiratory failure by reducing respiratory effort and enabling a greater tidal volume for a given respiratory effort. Non-invasive ventilation (NIV) should be utilized early in the course of the disease as the first-line strategy for patients experiencing a COPD exacerbation, in addition to standard medical care, according to the results of a meta-analysis.

In comparison to medical therapy alone, the study demonstrated that NIV was linked to a decreased need for endotracheal intubation, a decrease in treatment failure, a decrease in mortality, a decrease in respiratory rate, greater improvements in the pH and PaCO2 levels one hour after treatment, fewer complications, and a shorter duration of treatment.

For COPD patients experiencing acute respiratory failure, NIV is currently the accepted standard of therapy. Measurements of arterial blood gas should be made both prior to and throughout the administration of NIV. When attempting to wean patients off the machine, it is also beneficial.

BI-PAP:

Bilevel positive airway pressure (BPAP) therapy is a pressure-cycling mode of delivery of NIV. Inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) are alternately delivered by the device. The tidal volume is determined by the difference between the two preset pressures. Greater tidal volume results in increased alveolar ventilation when the respiratory rate remains constant. When a patient is unable to regulate their secretions or has facial traumas that make face mask interfaces ineffective, BPAP should not be used.

BPAP settings vary in order to accommodate different respiratory problems. For IPAP, the minimum setting is 8 cm H2O, and for EPAP, it is 4 cm H2O. Whereas EPAP is titrated to a maximum of 10, IPAP is increased by levels of 2 cm H2O to a maximum of 20.

The amount of titration needed to increase the patient's respiratory drive must be decided by caregivers who are present at the patient's bedside. It is important to proceed cautiously because an excessive increase in EPAP could unintentionally reduce the delivered tidal volume.

CPAP:

In individuals who are breathing on their own, continuous positive airway pressure, or CPAP, is a form of positive airway pressure in which airflow is injected into the airways to maintain a constant pressure that keeps the airways open. The pressure in the alveoli above atmospheric pressure at the conclusion of expiration is known as positive end-expiratory pressure, or PEEP. In addition to providing PEEP, continuous positive end-expiratory pressure (CPAP) keeps the set pressure constant during the breathing cycle . The unit of measurement is centimeters of water pressure (cm H2O).

In contrast to bilevel positive airway pressure (BiPAP), which adjusts the pressure given depending on the patient's breathing pattern, continuous positive airway pressure (CPAP) does not. These pressure levels are referred to as expiratory positive airway pressure (EPAP) and inspiratory positive airway pressure (IPAP).

Patients using CPAP must start every breath on their own and are not given any more pressure above the predetermined threshold. By increasing the alveolus's surface area, enhancing V/Q matching, preserving PEEP, and possibly even reducing atelectasis, CPAP treatments also enhance oxygenation .

INVASIVE VENTILATION:

Invasive Ventilation Indications for the use of invasive ventilatory support in patients with acute exacerbation include the inability to tolerate non-invasive ventilation or ventilator failure, severe hemodynamic instability without response to fluids, massive aspiration or persistent vomiting .

This study focus on comparing the effectiveness and outcomes of two non-invasive Ventilation strategies namely bi-level positive airway pressure (BiPAP) and continuous positive airway Pressure (CPAP) in the management of exacerbations of COPD using ABG analysis lab report (PH, PaCO2, PaO2, HCO3) and patient’s breathing ability was assessed by using Dyspnea Brog CR10 scale.

MATERIALS AND METHODS

This prospective observational study was conducted over a six-month period, from January 2024 to June 2024, in Sudha Institute of Medical Science, Erode **(SIMS)**. Ethical clearance was obtained from the Sudha Institute Ethical Committee after submitting a proposal that included the study title, duration, inclusion and exclusion criteria, objectives, and a brief methodology (Approval number: ECR/948/Inst/TN/2018/RR-22). A specialized data collection form was designed for collecting the Patient details (Demographic data, Severity of COPD, Respiratory rate and BP) and ABG lab reports (PH, PaCO2, PaO2, HCO3). Further patient's breathing ability was assessed by using Dyspnea Brog CR10 scale. Statistical analysis was performed using SPSS version 21, and the paired t-test was used to evaluate the data.

RESULT AND DISCUSSION

TABLE 1: Age Wise Distribution

Age (in years)	BIPAP		CPAP	
	Number of participants	**Percentage of participants**	**Number of participants**	**Percentage of participants**
45 – 55	5	15.16	5	15.16
56 – 65	14	42.42	14	42.42
66 - 80	14	42.42	14	42.42
Total number of participants	33	100	33	100
Mean age	63.18		63.63	

Table 1 Shows the Age wise distribution of patients receiving NIV for AECOPD. The majority of participants (56-65 years old and percentage of 42.42%) were in the middle-aged group, followed by the elderly (66-80 years old and percentage of 42.42%) and the younger group (45-55 years old and percentage of 15.16%). A significant proportion of patients receiving NIV for AECOPD were in the middle-aged group. This reflect the increasing prevalence of COPD in this age group.

TABLE 2: Comparison of ABG test parameters between BIPAP and CPAP groups (Before and After 48 hours of NIV)

Parameters	BIPAP			CPAP		
	Baseline	**After 48 hours of NIV**	**P Value**	**Baseline**	**After 48 hours of NIV**	**P Value**
pH Mean pH±SD	7.18 ± 0.04	7.341 ± 0.03	<0.001	7.173 ± 0.40	7.28 ± 1.26	<0.001
PaCO2 Mean PaCO2±SD	73.81 ± 11.5	46.33 ± 7.53		67.47 ± 10.73	49.98 ± 6.63	
PaO2 Mean PaO2±SD	61.03 ± 4.47	89.79 ± 6.96		59.57 ± 4.51	78.76 ± 3.90	
HCO3 Mean HCO3±SD	34.54 ± 1.36	32.54 ± 1.87		35.28 ± 1.62	34.08 ± 1.81	

Table 2 compares arterial blood gas (ABG) parameters between the BIPAP and CPAP groups before and after 48 hours of non-invasive ventilation (NIV). The key parameters include pH, PaCO2 (partial pressure of carbon dioxide), PaO2 (partial pressure of oxygen), and HCO3 (bicarbonate levels) to observe the effectiveness of NIV mode.

TABLE 3: Comparison of Mean ABG test parameters between BIPAP and CPAP groups in smoking patients

Parameters	BIPAP (Smokers)	CPAP (Smokers)
pH Mean pH±SD	7.17 ± 0.045	7.178 ± 0.048
PaCO2 Mean PaCO2±SD	71.83 ± 10.98	65.56 ± 10.67
PaO2 Mean PaO2±SD	61.97 ± 5.21	59.36 ± 5.17
HCO3 Mean HCO3±SD	34.75 ± 1.44	35.37 ± 1.81

Table 3 provides a comparison of Mean arterial blood gas (ABG) parameters between BIPAP and CPAP groups in smoking patients, focusing on four key parameters: pH, PaCO2, PaO2, and HCO3. Both groups show similar trends, but certain differences in the ABG values are noteworthy.

TABLE 4: Comparison of Improvement in Dyspnea Assessment score between Smoking and Non-smoking patients among the study groups

Groups		Dyspnea Assessment score				Interpretation
		Before NIV		After 48 hours of NIV		
		At rest	During physical activity	At rest	During physical activity	
BIPAP	Smokers	6.1 ± 0.38	6.6 ± 1.19	4.6 ± 0.68	5.3 ± 0.85	Slight improvement
	Non-Smokers	4.8 ± 1.32	5.4 ± 0.63	2.8 ± 1.06	3.6 ± 0.54	Moderate improvement
	P Value (BIPAP vs CPAP)	<0.001				
CPAP	Smokers	5.2 ± 1.66	6 ± 1.19	4.2 ± 1.36	4.8 ± 0.99	Low improvement
	Non-Smokers	4.1 ± 1.23	5 ± 0.48	3.3 ± 1.0	3.9 ± 0.4	Slight improvement
	P Value (BIPAP vs CPAP)	<0.001				

Table 4 The Dyspnea Assessment Score was measured using the Borg CR10 scale in both smokers and non-smokers, comparing the effectiveness of BIPAP and CPAP over 48 hours of non-invasive ventilation (NIV). This scale is a numerical rating that assesses the severity of breathlessness, with scores ranging from 0 (no breathlessness) to 10 (maximum breathlessness). The statistical analysis was performed using a **paired t-test**, and the results showed a significant improvement in both groups with a **p-value of <0.001**, indicating the observed changes were **statistically significant**.

CONCLUSION

The study effectively highlights the use of Non-invasive ventilation, particularly BIPAP and CPAP, in managing acute exacerbations of COPD.

In conclusion, Both BIPAP and CPAP resulted in significant improvements in arterial blood gas (ABG) parameters, such as pH, PaCO2, PaO2 and HCO3 with BiPAP showing slightly better results in terms of reducing hypercapnia and enhancing oxygenation. While the differences between BiPAP and CPAP were statistically significant, they were not drastic, indicating that both methods can be effective in managing respiratory distress in COPD exacerbations. Smoking status had a considerable impact on the outcomes, with non-smokers showing more significant improvements than smokers in both groups. Overall, the findings suggest that BiPAP had a slight advantage over CPAP in managing acute exacerbations of COPD, but the overall percentage difference in improvement of ABG parameters between BiPAP and CPAP is approximately 10-15% only.

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