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Original research article

Significance of Clinical and Arterial Blood Gas Analysis in Assessing The Success of Non-Invasive Ventilation In Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease In Tertiary Health Care Centre

[1] Dr Pantham Sunitha,[2] Dr.J.Sowmya,[3] Dr.P.Radhika,[4] Dr.Najeeb. T,[5] Dr.Sravan kumar

[1]Associate Professor. Department of Pulmonary Medicine, Kakatiya Medical college.Warangal.

[2]Assistant Professor, Department of Pulmonary Medicine, Kakatiya Medical college.Warangal.

[3]Assistant Professor, Department of Pulmonary Medicine, Kakatiya Medical college.Warangal.

[4]Post graduate. Department of Pulmonary Medicine, Kakatiya Medical college.Warangal.

[5] Professor and HOD. Department of Pulmonary Medicine, Kakatiya Medical college.Warangal.

CORRESPONDING AUTHOR:

Dr. Pantham Sunitha(dr.sunithapantham@gmail.com)

ABSTRACT:

BACKGROUND: Non-invasive ventilation (NIV) reduces the rate of endotracheal intubation and overall mortality in severe acute exacerbation of COPD (AECOPD) with respiratory failure. However, poor patient selection and ineffective NIV administration lead to higher mortality. We aimed to identify factors that predict the outcome of NIV in AECOPD.

METHODOLOGY: We have conducted prospective observational study in the Department of Pulmonary Medicine Government Chest diseases and TB hospital, Hanmakonda, Telangana. between November 2020 to July 2022. Patients who were admitted with AECOPD with increased work of breathing and PaCO2 >45mm Hg were included in this study. COPD was diagnosed with history, clinical examination, chest X-ray PA View and previous spirometry. Blood gas analysis was done to assess PaCO2, PaO2 and PH before and after NIV administration after clinical improvement.

RESULTS: Total 40 patients were included in this study of which 12.5% were female and 87.5% were male patients. Out of 40 patients, 37 patients improved with NIV treatment and remaining 3 failed to improve. Duration of NIV treatment depends upon following factors like sputum consistency, current history smoking, respiratory rate at the time of admission, presence of comorbidities (corpulmonale,diabetes) high PaCO2 levels and low PH levels.

KEYWORDS :AECOPD, NIV, Arterial Blood Gas Analysis.

INTRODUCTION:

Chronic obstructive pulmonary disease (COPD) is a form of chronic airway disease that develops mostly due to chronic exposure to noxious stimuli of which the most common is smoking [1] . The following are valid points about COPD:

I. Complex mechanisms are involved in airflow obstruction, which leads to increased airway resistance.

II. COPD can affect airway, lung parenchyma, pulmonary vasculature and the lesion can correlate to change in pulmonary function tests and clinical appearance.

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III. COPD is ranked third in worldwide case mortality rate and the disease is both treatable and preventable [1].

IV. Incidence of COPD is increasing year by year and many people die prematurely due to the disease or its complication.

V. A unique programme to fight against COPD was developed in 1998. This was known as global initiative for chronic obstructive lung disease with a cooperation of NIH, World health organization and National Heart, Lung, Blood institute. Main aim of this initiative is to increase awareness about global burden of COPD, preventive measures involved and management of COPD.

According to WHO estimation in 2019, there were about 64 million people affected by COPD worldwide [2]. In the year 2019, case fatalities due to COPD accounts for about more than 3.23 million people, which is approximately around 5% of all death globally that year. Almost 90 % of deaths occurred in low- and middle-income group countries. Without any intervention to cut down the risk factors related to COPD; total death may increase by more than 30% the next 10 years. Exacerbation of COPD is defined as "a sustained worsening of the patient's condition, from stable state and beyond normal day-to-day variations, that is acute in onset and necessitates a change in regular medication in a patient with underlying COPD". Acute exacerbation of COPD is due to either viral infection of upper respiratory tract or infection of the conducting airways like tracheobronchitis. The aim of treatment in COPD patients with acute exacerbation is to reduce current exacerbation and also to prevent the development of further exacerbations. Medications used during acute exacerbation includes short acting beta2 adrenergic agonists with or without anti cholinergic drugs. COPD exacerbation can be prevented by simple measures like cessation of smoking, vaccination against influenza and pneumococcus, knowledge about how to use inhaled medication and treatment with long-acting drugs such as adrenergic drugs with or anti-cholinergic and beta2 without inhaled form of corticosteroids. These measures reduce the number of acute exacerbations and hospitalization.

According to GOLD guidelines, indication for non-invasive mechanical ventilation in acute exacerbation of COPD includes [1]:

1. Respiratory acidosis (arterial pH < 7.35 and / or PaCO2 >6.0 kPa, 45 mmHg).
2. Severe dyspnoea with clinical signs characterized by fatigue of respiratory muscles, maximized work of breathing or both such as increased activity of accessory muscles, abdominal paradox, or intercostal muscle indrawing.

Guidelines for respiratory failure management in acute exacerbation of COPD are mainly based on arterial blood gas analysis. Failure and success of Non-invasive ventilation depends upon arterial pH. Among hospitalized patients with COPD majority suffer from increased work of breathing and a few percentages of patients were admitted with acidosis requiring mechanical ventilation. When NIV is applied to this group of patients suffering from increased work of breathing, we can reduce the duration of NIV and also prevent progression of this stage to severe acidosis.

The key interest in our study is relating the outcome of NIV therapy with respect to association between Respiratory rate, Electrocardiogram, Comorbidities, though previous others studies related the outcome NIV therapy with respect to arterial pH and PaCO2.

Another important interest in this study is to compare the association of sputum consistency and smoking duration with NIV therapy.

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AIMS AND OBJECTIVES:

Aim: Role of clinical and arterial blood gas analysis for predicting outcome of non-invasive ventilation in patients with acute exacerbation of chronic obstructive pulmonary disease.

Objective: 1. To evaluate the influence of parameters like respiratory rate, sputum consistency, ECG,chest X ray, arterial blood gas analysis (pH, paCo2) and comorbidities on NIV therapy outcome in these selected group of patients.

2.To know the correlation between type II respiratory failure patients with increased respiratory rate and work of breathing and NIV outcome (NIV success or failure) in a selected group of patients admitted in our hospital.

PATIENTS AND METHODS :

The Study was conducted in the Department of Pulmonary Medicine Government Chest diseases and TB hospital, Hanmakonda, Telangana.

Study period: The study was conducted over a period of 18 months from January 2021 to June 2022.

Study design: Prospective observational study.

Statistical analysis: By using Epi info7 software.

INCLUSION CRITERIA:

1. COPD patients with acute exacerbation with PaCO2 > 45 mmHg, pH (>7.25) with increased work of breathing.
2. Age >18 years.

EXCLUSION CRITERIA:

1. Diagnosis of asthma, sleep apnoea syndrome or respiratory failure not due to COPD.
2. Patient with acidosis (arterial pH < 7.25).
3. Patients with shock with a systolic blood pressure of < 90 mmHg despite fluid challenge or need for vasopressor agents.
4. Altered conscious state (GCS < 8).
5. Copious respiratory secretions that could not be cleared easily by the patients.
6. RTPCR confirmed COVID 19 patients.
7. Recent myocardial infarction, unstable angina.
8. Recent facial trauma.
9. Upper abdominal surgery

METHODOLOGY:

1. Patients admitted with acute exacerbation of COPD with increased work of breathing and abnormal pH (7.25-7.35) where included in this study. COPD was diagnosed with clinical examination, history, chest x ray finding, previous Spirometry.
2. Thorough history about smoking, pack years, occupation, duration of symptoms,history of exacerbation, wheeze history, clinical examination like measurement of respiratory rate, heart rate, blood pressure, work of breathing, accessory muscle activity & pulse oximetry for oxygen saturation.
3. Taking Chest x ray PA view to look for COPD changes, cardiomegaly, Parenchymal infiltration, and pneumothorax. ECG for Corpulmonale changes & to rule out ischemia.
4. 1 to 2 ml of blood for haemoglobin estimation is collected to rule out anaemia and polycythemia.
5. Patient should be placed in a comfortable position and collect 2 ml of arterial blood from radial artery for blood gas analysis to assess PaCO2 level, PaO2, and pH.

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6. Procedure explained to the patient about administration of Non-invasive ventilation, whenever possible attendees should are included in the discussion.
7. Assess patients heart rate, respiratory rate, blood pressure, sensorium, oxygen saturation, work of breathing and accessory muscle activity.
8. Optimum medical therapy given to all patients with acute exacerbation before initiating NIV which includes:
    i. Controlled oxygen delivered to the patient to maintain arterial saturation between 88–92%.
    ii. Administration of nebulized salbutamol in a dose of 2.5–5 mg mixed with distilled water followed by nebulized ipratropium 500 µg given.
    iii. Injection Hydrocortisone 100mg IV and antibiotic therapy if indicated.
    iv. NIV should be administered in patients with respiratory failure in spite of optimum medical management for more than 1 hour.

Before starting our study we ensured that the instruments are in working condition, proper motivation was given to patients to alleviate their anxiety, nurses were given adequate training, tolerance of patient to mask ventilation was ensured, and possibility of air leakage in system circuit was checked.

To improve psychological support, relatives of the patients were allowed to stay with them and assist them whenever they needed any help. This is considered important to gain patient confidence and motivate them in pursuing therapy.

i. The patient was placed in a comfortable position like either sitting or semi recumbent position in bed. Patient was connected to non-invasive ventilation, spontaneous –timed mode with low pressure setting of inspiratory pressure of 10 cm H2O, and expiratory pressure of 4 cm H2O ramp of 10 minutes, rate depends upon patient's respiratory rate.
ii. Low pressure settings will improve the patient's compliance.
iii. Oxygen is connected through side port of non-invasive ventilator tube if patient saturation is less than 88%- 92%.
iv. Interface is selected depending upon patient's comfort. During acute exacerbation compliance is important for outcome. A clinical assessment of correct fitting of mask over the Oronasal region and degree of leakage of air (particularly on to the corneas) should be checked then and there.
v. Once patient tolerates previous NIV settings, inspiratory pressure increased by approximately 5cm of H2O every 20 minutes, until upper limit of target pressure (20 cm H2O) is reached.
vi. Reassess all the parameters after 1 hour to decide about tolerability of the patient and response to treatment.
vii. Patient is monitored every 2 hours for first 12 hours and then every 4 hours for next 36 hours. Monitoring is important to decide about treatment escalation to intubation.
viii. Bronchodilators administered preferably when patient is not connected to NIV machine, because delivery of both nebulized solutions and oxygen is affected by NIV pressure settings. If this is not possible then nebulizer can be connected between the expiration port and face mask.
ix. As per BTS guidelines even if patients work of breathing is improved and respiratory rate becomes normal in a few hours, NIV therapy is continued for a minimum duration of 6 hours in order to prevent relapse.
x. Patient who is still having increased work of breathing in 4 hours but improvement from baseline will continue NIV as much as possible in first day with break for food, and nebulization.
xi. If Patient shows response, NIV is continued on second day during night time only.
xii. If patients condition is worsened (cardiac arrest or respiratory arrest, worsening of hypercapnia, loss of consciousness) from baseline, then mechanical ventilation was established.

DATA RECORDING:

Before administering NIV following parameters were recorded:

1. Age and sex of the patient
2. Childhood symptom
3. Seasonal exacerbation

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4. Atopy
5. Sputum consistency (mucoid / mucopurulent)
6. Family history
7. Smoking index, current smoker (yes / no)
8. Sensorium

On examination:

1. Vital parameter like heart rate, respiratory rate,blood pressure, spo2, were recorded
2. Work of breathing.
3. Wheeze on auscultation.
4. Electrocardiogram, chest x ray, arterial blood gas analysis.

After administration of NIV the following data were recorded:

1. Duration of NIV
2. ABG analysis
3. Outcome:
    - Improvement defined as normalization of respiratory rate, no respiratory distress, normal heart rate, normal saturation, and work of breathing.
    - Failure is defined as patient's intolerance to non-invasive ventilation, requiring mechanical ventilation for survival and death during non-invasive ventilation.
4. Duration of hospital stay.

OBESERVATIONS AND RESULTS:

Total number of 40 patients were included in this study of which 12.5% were female and 87.5% were males. None of the study group members had history of Atopy.

Childhood symptoms were absent in all patients. None of study group members had family history. None of the study group members had history of Seasonal exacerbation.

In the current study, 80% patients had a mucoid Sputum production, 20% patients' sputum were mucopurulent.

Current smoking history is present in 2.5 % of study population; current smoking history has influence on NIV duration and outcome of treatment.

Among the study population, the predominant comorbidity is hypertension with Corpulmonale (3 cases,7.5%) followed by diabetes (1 cases,2.5%).

All members of the study population had wheeze on auscultation.

COMPARISON OF VARIOUS PARAMETERS:

- Mean age ofenrolment in this study is 62.9 (S.D +10.2), minimum age of the patient is 39, maximum age is 85.
- Mean pack years for males was found to be 20, females included in our study were non-smokers.
- They had exposure to second hand smoking and Volume biomass fumes making them vulnerable to COPD.
- Mean respiratory rate was 32.3bpm (S.D + 5.1), minimum rate was is 26bpm and maximum was 52bpm.
- Mean heart rate was 103.1/min (S.D + 11.0), minimum rate was is 88 /min and maximum was136/min.
- Mean PRE NIV-PCO2 was 63.1(S. D + 9.5),minimum PCO2 was is 47 and maximum was 77.3.
- Mean END NIV-PCO2 was 43.5(S. D + 15.0) , minimum PCO2 was is 31.2 and maximum was
- 101.5.
- Mean PRE NIV-PH was 7.311(S.D + 0.1) , minimum PH was is 7.260 and maximum was7.349.
- Mean END NIV-PH was 7.40(S. D + 0.1) minimum PH was is 7.192 and maximum was 7.491.
- Mean duration of symptoms for male was17.2(S.D +5.4).
- The mean duration of NIV was 23.7 hours (S.D + 14.7).

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- Mean duration of hospital stay was 10.1 days (S.D + 5.5).

RESULTS AND OUTCOMES:

DISTRIBUTION OF NIV OUTCOME AMONG PATIENTS:

- Total number of 40 patients was enrolled in this study of which females were 10% and males 90%. Mean age of enrolment in this study is 62.9 (S.D + 10.2).
- We record our finding that of 40 patients, 36 patients got improved with NIV treatment and remaining 4 patients failed to improve.

GENDER WISE DISTRIBUTION VERSUS NIV OUTCOME

- Correlation of gender with the NIV outcome is not statistically significant.

SPUTUM PRODUCTION VERSUS NIV OUTCOME

- While assessing consistency of sputum, 8 out of 40 patients had mucopurulent sputum and the remaining had mucoid sputum. We found that consistency of that Sputum had not much impact on the outcome of study i.e. improvement of symptoms or failure of treatment. But we found that consistency of sputum do have impact on duration of NIV. Patients with mucopurulent sputum had longer duration of NIV than patients with mucoid sputum.

COMORBIDITY VS NIV OUTCOME

- Comorbidity is correlated with the NIV outcome and the correlation is statistically significant

VARIOUS PARAMETERS VERSUS NIV OUTCOME (Table 01)

- Respiratory rate, PRE NIV-PCO2, END NIVPCO2, PRE NIV-PH, END NIVPH, Duration of NIV and Duration of hospital stay are correlated with the NIV outcome and the correlation is statistically significant.
- However the correlation of Age, Duration of symptoms, Pack years, Heart rate with the NIV outcome is not statistically significant.

CONCLUSION:

The addition of NIV to standard therapy benefits more to patients with AECOPD with significant reduction of hospital mortality, rate of endotracheal intubation, incidence of complication and longer hospital stay compared to standard therapy alone. Failure can be predicted by the presence of more comorbidities, signs of severe exacerbation, high BMI, rapid respiratory rate at admission and severe acidosis before NIV treatment.

AUTHORS CONTRIBUTION

Conceptualization: Prof and HOD- Dr. Sravan kumar

Design of study and supervision of study: Dr. P. Sunitha.

Data collection,research and analysis: Dr.J.Sowmya, Dr. P.Radhika.

Interpretation of data, editing: Dr.Najeeb .T.

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CONFLICT OF INTEREST: None.

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	Minimum	Maximum	Mean	SD
Age	39	85	62.9	10.2
Duration of symptoms in days	7	30	17.2	5.4
Pack years	0	38	20.3	15.7
Heart rate	88	136	103.1	11.0
DBP	70	90	77.5	6.3
SBP	110.00	140.00	123.5	8.6
Respiratory rate	26	52	32.3	5.1
PRE NIV-PACO	47.0	77.3	63.1	9.5
END NIV-PACO	31.2	101.5	43.5	15.0
PRE NIV-PH	7.260	7.349	7.311	0.1
END NIV-PH	7.192	7.491	7.4	0.1
Hb%	9.6	13.6	11.5	1.0
Duration of NIV	6	60	23.7	14.7
WBC	4700	13200	9000.0	1941.1

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Duration of hospital stay	4	28	10.1	5.5

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