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A Study of non-invasive ventilation in acute exacerbation of chronic obstructive pulmonary disease

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Abstract

Setting: -A.J. institute of medical sciences Hospital, Karnataka, India.

Objectives: - To study the efficacy of Non Invasive Ventilation in respiratory failure secondary to acute exacerbation of COPD.

Design: - Prospective Observational study

Methods: -at 95 subjects admitted with acute exacerbation of chronic obstructive pulmonary disease in AJIMS Mangalore who satisfy all inclusion and exclusion criteria. There was no group allocation at admission, patients who received non-invasive ventilation along with pharmacological treatment for acute exacerbation of COPD and assessment was based on clinical improvement by decrease in respiratory rate, heart rate, and improvement in arterial blood gas after initiation of NIV.

Results:-Out of 95 patients 84 (88.42%) patients showed a favorable outcome, with an improvement in pH and PaCO2 and respiratory rate, heart rate, after 1st hour and 4th hour of initiating NIV, corroborating the pivot role of non-invasive ventilation in acute exacerbation of COPD.

Conclusion: - It is concluded that NIV is a promising therapeutic management of acute exacerbations of COPD, its timely institution leads to rapid and profound improvement in blood gas variables that culminates to the reduction of endotracheal intubation in these patients

KEYWORDS: - COPD; Endotracheal intubation; Respiratory Failure;Arterial Blood Gas.

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

INTRODUCTION

The Global Initiative for Obstructive lung disease defines Chronic Obstructive Pulmonary disease (COPD) as, "COPD is a preventable and treatable disease with some significant extra pulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by chronic airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with abnormal inflammatory response of the lungs to noxious particles and gases."[1]

COPD is a major cause of morbidity and mortality and 4th leading cause of death in the world and further increase in its prevalence and mortality can be predicted in coming decades.[2]

The clinical course of COPD is generally one of gradual progressive impairment, which may eventually lead torespiratory failure. Periods of relative clinical stability are interrupted by recurrentexacerbations. An acute worsening of respiratory symptoms is often described asan exacerbation.Acute exacerbation of COPD "Is defined as an event in the natural course of the disease characterized by change in the patient's baseline dyspnea, cough and/or sputum that is beyond normal day to day variation, is acute in onset and warrant a change in regular medication in a patient with underlying COPD".[3]

The pathophysiological pathway of all these features is the inability of the respiratory system to maintain adequate alveolar ventilation in the presence of major abnormalities in respiratory mechanics, which further leads to hypercapnia. This is associated with or secondary to excessive respiratory load, treatment should be directed at reducing the loads imposed on respiratory muscles. The traditional way has been to use endotracheal intubation as a means of access to lower airways to deliver ventilation .A more recent approach called non-invasive ventilation (NIV) has profoundly changed the management and outcome of these patients.[4,5]

Severe exacerbations requiring hospitalizations are responsible for a major chunk of these costs and among these, treatment costs of those who require endotracheal intubation and assisted ventilation with intensive care unit (ICU) admission are largest. Moreover, there are several other hazards of endotracheal intubation itself such as increased risk of infections (commonly called ventilator-associated pneumonia) and tracheal stenosis.

Non-invasive ventilation (NIV) refers to the administration of ventilatory support without using an invasive artificial airway (endotracheal tube or tracheostomy tube). The use of noninvasive ventilation has markedly increased over the past two decades, and noninvasive ventilation has now become an integral tool in the management of both acute and chronic respiratory failure, in both the home setting and in the critical care unit.

Objectives:- to study the efficacy of Non Invasive Ventilation in respiratory failure secondary to acute exacerbation of Chronic Obstructive Pulmonary Disease in our hospital setting.

MATERIALSANDMETHODS

Study design: Prospective Observational study

Study setting: A.J. institute of medical sciences Hospital, Mangalore

Study period: The study was conducted from October 2016 to October 2018

Sample Size: 95 patients

Sampling Methods: Non probable sampling

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

Method of data collection:

A prospective observational study of patients admitted with acute exacerbation of chronic obstructive pulmonary disease in AJIMS Mangalore who satisfy all inclusion and exclusion criteria.

Inclusion criteria:

- Clinically diagnosed case of chronic obstructive pulmonary disease with acute exacerbation.
- Respiratory rate >25 breaths per minute
- Hypercapnia (PaCO2>40mmHg)

Exclusion criteria:

- <18yr old
- Impending or post respiratory arrest
- Impaired consciousness (Glasgow Coma Scale <8)
- Severe uncorrected hypoxia (PaO2<55mmHg)
- Cardiovascular instability
- Copious secretions
- Craniofacial trauma
- Pneumothorax or pneumo-mediastinum
- Acute heart failure or cardiac arrhythmias

Methodology

There was no group allocation at admission, as this was an observational study of patients who received non-invasive ventilation along with pharmacological treatment for acute exacerbation of COPD and assessment was based on clinical improvement by decrease in respiratory rate, heart rate, and improvement in arterial blood gas after initiation of NIV.

- Baseline evaluation including clinical history, and detailed examination was conducted. Patients were subjected to thorough clinical history and examination.
- Brief history of symptoms, personal and past history, treatment history was taken other demographic measure like age, sex, and significant history were noted.
- Thorough clinical examination was done, general physical examination, assessment of conscious levels, along with monitoring of vitals respiratory rate, heart rate, blood pressure, oxygen saturation at admission

All the patients were being treated with pharmacological management, like oxygen supplementation through nasal prongs, nebulization with bronchodilators (inhaled salbutamol, ipratropium,), IV steroids, IV antibiotics were given on case to case basis.

A Bi-level positive airway pressure (BIPAP) ventilator system was used for the study. After explaining details of the procedure and taking **informed written consent** from the nearest kin of the patient NIV was initiated. Each patient was encouraged to use NIV for 14-16 hrs. a day, with discontinuation during eating and drinking.

Patients who deteriorated in terms of gas exchange parameters like rising $PaCO_2$, decreasing pH, worsening levels of consciousness, hemodynamic instability, with fall in blood pressure, increase in heart rate, as well as those with copious secretions, and inability to tolerate face mask were considered for endotracheal intubation and mechanical ventilation.

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

Patients who could tolerate NIV, in terms of stabilization of vitals a decrease in respiratory rate, accessory muscle use, heart rate, improvement in oxygen saturation and improvement in arterial blood gas parameters like decrease in $PaCO_2$ and normalizing pH were continued with non-invasive ventilation along with pharmacologic treatment.

The success of NIV was measured based on primarily the patients who improve on NIV and patients who required endotracheal intubation and mechanical ventilation

Ethical clearance was taken from institutional ethical committee.

Written Informed consent from the nearest kin of the patient NIV was initiated

STATISTICAL METHODS

Student "t" test (two-tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups Inter group analysis) on metric parameters. Chi-square/Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

RESULTS

Mean age was 64.32 $\pm$ 9.21yrs. Majority of the subjects 42.1% belong to 60-69yrs age group, followed by 70-79yrs age group around 25.3%, 24.2% of the subjects in 50-59yrs age group, 40-49yrs age group and 80-89yrs age group had 4.2% each. Majority of the subject 77.9 % were male and female were only 22.1%.

Table 1:- Distribution of subject according to outcome after giving NIV

Outcome	No of subject	Percentage
Recovered	84	88.42
Failed	11	11.58
Total	95	100

For all 95 patients' clinical assessment, monitoring of vitals was done along with arterial blood gas. 84 (88.42%) patients recovered. Patients whose clinical condition deteriorated in terms of increased tachypnea, increased accessory muscle use, altered consciousness, with fall in pH, increase in CO_2 levels in blood were 11(11.58%). These patients deteriorated and required mechanical ventilation. It was considered has failure of NIV.

Table 2:- Comparison of Vitals at various time interval

Blood pressure	On admission	1st hour	4th hour	P value from admission to 1st hour	P value from admission to 4th hour
SBP(mmHg)	145.37±7.742	132.38±10.19	124.06±11.656	<0.001	<0.001
DBP(mmHg)	86.63±6.967	82.40±6.695	81.49±9.01	<0.001	<0.001
Heart rate	119.28±6.97	111.11±6.07	105.16±6.80	<0.001	<0.001
Respiratory rate	30.58±2.33	26.93±2.44	24.28±3.521	<0.001	<0.001

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

SpO_2	81.51±3.37	87.65±2.87	89.12±7.036	<0.001	<0.001

(Table 2)Mean systolic blood pressure at one hour reduced to 132.38 with SD of 10.19 with p value of 0.001 which was statistically significant. Mean systolic blood pressure at four hours was 124.06 with SD of 11.65, which was found to have statistical significance P value <0.001.

Mean diastolic blood pressure at one hour reduced to 82.40 with SD of 6.69 with p value of 0.001 which was statistically significant. Mean diastolic blood pressure at four hours was 81.49 with SD of 9.01, which was found to have statistical significance P value <0.001.

Mean heart rate at first hour reduced to 111.11 with SD of 6.07 with p value of 0.001 which was statistically significant .Mean heart rate at fourth hours was 105.16 with SD of 6.80, which was found to have statistical significance P value <0.001.

Mean respiratory rate at first hour reduced to 26.93 with SD of 2.44 with p value of 0.001 which was statistically significant .Mean respiratory rate at fourth hours was 24.28 with SD of 3.52, which was found to have statistical significance P value <0.001.

Mean oxygen saturation at first hour was 87.65 with SD of 2.87 with p value of 0.001 which was statistically significant .Mean oxygen saturation at fourth hours was 89.12 with SD of 7.036, which was found to have statistical significance P value <0.001.

Table 3:- Comparison of ABG parameters at various time interval

ABG parameters	**On admission**	**1st hour**	**4th hour**	**P value from admission to 1st hour**	**P value from admission to 4th hour**
pH	7.276±0.022	7.325±0.025	7.335±0.074	<0.001	<0.001
$PaCO_2$ (mmHg)	67.22±2.837	58.49±3.179	54.78±4.430	<0.001	<0.001
PaO_2 (mmHg)	70.48±4.829	81.71±8.354	87.84±12.205	<0.001	<0.001
HCO3(mEq/L)	21.53±0.75	22.36±0.70	22.34±1.81	<0.001	<0.001

(Table 3)Mean pH on admission was 7.276 with SD 0.02, at 1st hour after initiation of NIV it was 7.325 with SD 0.025, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 7.335 with SD of 0.074, there was statistical significance difference found between these values

Mean $PaCO_2$ at admission was 67.22 with SD of 2.837, at 1st hour after initiation of NIV it was 58.49 with SD 3.179, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 54.78 with SD of 4.430, there was statistical significance difference found between these values, corroborating the role of NIV in decreasing PCO_2. Mean PaO_2 at admission was 70.48 with SD of 4.829, at 1st hour after initiation of NIV it was 81.71 with SD 8.354, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 87.84 with SD of 12.205 there was statistical significance difference found between these values

ISSN:0975-3583,0976-2833 VOL11,ISSUE04,2020

Mean HCO3 at admission was 21.53 with SD of 0.75, at 1st hour after initiation of NIV it was 22.36 with SD 0.70, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 22.34 with SD of 1.81 there was statistical significance difference found between these values

DISCUSSION

Non-invasive positive pressure ventilation (NIV) has been suggested as an alternative treatment option for patients admitted to hospital with hypercapnic respiratory failure secondary to acute exacerbation of COPD .The present study was conducted to study the efficacy of Non Invasive Ventilation in respiratory failure secondary to acute exacerbation of Chronic Obstructive Pulmonary Disease in our hospital setting.

In this study Majority of the subject 77.9 % were male and female were only 22.1% which was contradict to the study done by PK Plant et al [7]in which incidence of female 55% was high when compare to male 45%. In study by G.C Khilnani et al [8]there were 31 males and 9 females ratio which was similar to our study.

In our study Mean age was 64.32 $\pm$ 9.21yrs. Whereas in a study conducted by PK Plant [7] which was one of the largest randomized control trials had mean age of 69 years SD of 7. Recent, Brochard et al [9] mean age was 71 years with SD 9.

Recent, Indian RCT study by G. C. Khilnani et al [8]on NIV in COPD in very high $PaCO_2$, had mean age 55.25 years SD 10.09.

In our study Out of 95 patients, Comorbidity was analyzed out of which 50 (52.6%) patients had hypertension, 31 (32.7%) of them had diabetes, 5(5.3%) had past history of IHD and 6(6.3%) had past history of Koch's. Only 15 (15.8%) did not had any comorbid condition. Study done G Hillas et al [10]had mention the similar comorbid condition pattern.

In a Indian study done by G. C. Khilnani et al [8], they studied role of NIV in AECOPD with high $PaCO_2$, patients characteristics included pneumonia, pulmonary Koch's, hypertension, bronchiectasis, these variables had no statistical significance in NIPV and the control group.

In study done by Ambrosino et al [12], he correlated Heart rate(beats per minute) (bpm) in group in which baseline heart rate was 108 (bpm) (SD23) which reduced to 102(bpm) (SD14) on NIV, and in group 2 it was 146(bpm) (SD17) and on NIV it was138(bpm) (SD34),which had statistical significance.

In our study, On admission heart rate was recorded, Heart rate was measured in (Beats per minute), Mean Heart rate was 119.28 with SD of 6.97 on admission.Vitals after one hour and four hours of initiating non-invasive ventilation was recorded Mean heart rate at first hour reduced to 111.11 with SD of 6.07 with p value of 0.001 which was statistically significant .Mean heart rate at fourth hours was 105.16 with SD of 6.80, which was found to have statistical significance P value <0.001.

In study by P. K. Plant et al [7] fall in respiratory rate between admission and 4 hours was associated with success (OR 0.92 per breaths/min, 95% CI 0.84 to 0.99, p=0.04).

In our study on admission respiratory rate was recorded, respiratory rate was measured in (Breaths per minute), Mean respiratory rate was 30.58 with SD of 2.33 on admission. Vitals after one hour and four hours of initiating non-invasive ventilation,

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Mean respiratory rate at first hour reduced to 26.93 with SD of 2.44 with p value of 0.001 which was statistically significant .Mean respiratory rate at fourth hours was 24.28 with SD of 3.52, which was found to have statistical significance P value <0.001.

In studies done by Brochard et al [9], celikel et al [6] There was significant improvement in pH with NIV compared to UMC. Overall result significantly favours NPPV.

In our study Mean pH on admission was 7.276 with SD 0.02, at 1st hour after initiation of NIV it was 7.325 with SD 0.025, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 7.335 with SD of 0.074, there was statistical significance difference found between these values

In studies done Brochard et al [9], celikel et al [6] The result was significantly in favour of NIV however it contained significant statistical heterogeneity. Neither the use of random effects model or previously defined criteria resolved the heterogeneity. A step by- step elimination of each study from the meta-analysis done by Lightowler JV et al[11] revealed that the inclusion of studies were the cause of the heterogeneity. The result significantly favoured NIV in improving one hour $PaCO_2$.

In our study Mean $PaCO_2$ at admission was 67.22 with SD of 2.837, at 1st hour after initiation of NIV it was 58.49 with SD 3.179, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 54.78 with SD of 4.430, there was statistical significance difference found between these values, corroborating the role of NIV in decreasing PCO_2

In our study Mean PaO_2 at admission was 70.48 with SD of 4.829, at 1st hour after initiation of NIV it was 81.71 with SD 8.354, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 87.84 with SD of 12.205 there was statistical significance difference found between these values

In our study Mean HCO3 at admission was 21.53 with SD of 0.75, at 1st hour after initiation of NIV it was 22.36 with SD 0.70, there was statistical significance difference found between these values. At 4th hour after initiation of NIV it was 22.34 with SD of 1.81 there was statistical significance difference found between these values

Meta-analysis done by Lightowler JV et al[11]showed that PaO2 improved significantly with NPPV compared to UMC, unfortunately the overall result was heterogeneous.

As ours was an observational study, primary outcome assessed was risk of intubation, of the 95 patients 84 (88.42%) patients showed a favourable outcomecorroborating the pivot role of non-invasive ventilation in acute exacerbation of COPD.

CONCLUSION

Our study concludes that NIV is a promising therapeutic management of acute exacerbations of COPD, its timely institution leads to rapid and profound improvement in blood gas variables that culminates to the reduction of endotracheal intubation in these patients.

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DECLARATIONS

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