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PREDICTORS FOR MECHANICAL VENTILATION IN ACUTE EXACERBATION OF COPD WITH RESPIRATORY FAILURE

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ABSTRACT

The COPD is the sixth leading cause of mortality in the world and the third most common cause of hospitalization in Indian Scenario. According to Gold (1985) COPD- is characterized by airflow limitation that is not fully reversible. Approximately 85% of patients with COPD suffered from chronic bronchitis, and 15% suffering from emphysema. Due to paucity of literature effective programme has not been implemented at national level .In this context of the research gap, the present study aims to identify the predictors and need of mechanical ventilation among patients with acute exacerbation of COPD with respiratory failure and device a new scoring system based on the observations. Recruited patients presenting the chief complaints at casualty with acute exacerbation of COPD Respiratory failure was enrolled underlying with COPD. The parameters were compared between patients needing mechanical ventilation and those managed on modified medical therapy. Statistical analysis was done by using SPSS version 19univariate analysis was done for testing the hypothesis. The study included a total of 100 patients. Of the 100 patients 73 (73%) were males and 27 females. 56 patients required mechanical ventilation. Of the 56 patients 15 needed intubation and 41 were managed on NPPV. Age >70 years, P_{CO2} >60 mm Hg, respiratory >30 bpm, heart rate >115 bpm were significant factors in patients requiring mechanical ventilation. Patients with more number of acute physiological derangements had higher incidence of mechanical ventilation rates. Patients with chronic organ failure, acute kidney injury and reduced GCS are the patients for invasive mechanical ventilation. The score could be validated appropriately by randomized controlled trials (RCT) for wider range of clinical settings.

KEYWORDS: *AECOPD, Respiratory Failure, Mechanical Ventilation, NIV*

INTRODUCTION

The COPD is the sixth leading cause of death in the world and the third most common cause of hospitalization[1]. According to the U.S. National Heart, Lung, and Blood Institute and the World Health Organization's Global Initiative for Chronic Obstructive Lung Disease (GOLD), COPD is characterized by airflow limitation that is not fully reversible[2]. The airflow obstruction is generally progressive and associated with an abnormal inflammatory response to noxious particles or gases. Approximately 85% of patients with COPD suffer from chronic bronchitis, and 15% suffer primarily from emphysema[2]. Chronic bronchitis[2] is the presence of chronic productive cough for 3 months in each of 2 successive years, where other causes of chronic cough have been excluded. Emphysema results from progressive destruction of bronchioles and alveoli and limitation of elastic recoil. Chronic bronchitis is defined in clinical terms, and emphysema is defined in terms of anatomic pathology which limits the clinical utility of the definitions. In contrast, the GOLD definition encompasses chronic bronchitis, emphysema, bronchiectasis, and, to a lesser extent, asthma and it is more flexible by acknowledging that most patients have a combination of the different stages of the disease. The COPD is a disease of

adults (>40 years) with a prevalence of 9-10%. In India the prevalence was 3.3 to 20.9% with a male preponderance. Primary cause of COPD is smoking. Other causes include indoor pollution, passive smoking and use bio-mass fuels. Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) describe the phenomenon of sudden worsening in airway function and respiratory symptoms in patients with COPD. Exacerbations of chronic obstructive pulmonary disease (COPD) cause hospital admissions, morbidity, and mortality, and strongly influence quality of life. About half of COPD exacerbations are caused or triggered primarily by bacterial and viral infections (colds, especially from rhinovirus), but air pollution can contribute to the herald an exacerbation[3]. Respiratory failure from airflow obstruction is a direct consequence of acute airway narrowing and critical increases in airway resistance. These lead to two important mechanical changes. First, the increased pressures required for airflow may overload respiratory muscles, producing a ''ventilatory pump failure'' with spontaneous minute ventilation inadequate for gas exchange (hypercapnic respiratory failure)[6]. The main rationale of the study is to evaluating the predictors for mechanical ventilation in acute exacerbation of COPD with respiratory failure. All studies have found some independent predictors of mechanical ventilation like first day p_aco_2, first day P^H etc.[7,8,9,10]. There are multiple scoring systems in acute and critical settings to assess severity of disease[11, 12]. There is no specific score to predict the need for mechanical ventilation in acute exacerbation of COPD with respiratory failure. The current study is aimed to fill the lacuna by proposing a clinical scoring system for the prediction of mechanical ventilation in acute exacerbation of COPD.

MATERIALS AND METHODS

This is a prospective study undertaken over a period of 1 year from December 2013 to December 2014. Patients who were already diagnosed as COPD have been recruited for the study. Spirometry is not done in the emergency department at the time of presentation because most of our patients are too unstable to complete spirometry as is the experience of Risom MB et al. Exacerbation of COPD was diagnosed on the basis of worsening of at least one of these respiratory symptoms, i.e., dyspnea, cough and/ or sputum production, leading to change in medical therapy. Respiratory failure is diagnosed by doing an arterial blood gas analysis which showed hypoxemia, hypercapnia or both. Informed consent was obtained from the patients or the next of kin. Clinical symptomatology, demographic profile, biochemical parameters including renal functions, and acid base parameters at the time of admission are recorded in each recruited case of COPD exacerbation. Findings on clinical examination including heart rate, respiratory rate and mean blood pressure were recorded simultaneously. Acid-base abnormalities were analyzed by recording the arterial blood gas analysis and serum electrolytes. The parameters selected were based on the APACHE 2 Score. Various parameters were compared between patients who required mechanical ventilation with those managed with modified medical therapy. Inclusion criteria**; a**ll patients admitted with a primary admitting diagnoses of acute exacerbation of COPD are eligible for inclusion. Exclusion criteria; Patients with underlying COPD admitted with another primary admitting diagnosis (e.g., Accidents, Stroke, and Acute Myocardial Infarction) were excluded from the study. Similarly, patients with acute respiratory failure secondary to causes other than COPD were also excluded. The patients were managed by a physician team. The management strategy was decided by the treating physician, and it was individualized for each patient according to the patient′s severity of presentation. All patients received regular nebulization therapy with salbutamol, ipratropium bromide and intravenous steroids and also received antibiotics empirically decided. Spontaneously breathing patients were administered controlled oxygen therapy (2-3 L/min). Endotracheal intubation was performed for standard indications like respiratory arrest, deteriorating level of consciousness, exhaustion, progressive hypoxemia, hypercapnia and decreasing pH despite maximal level of medical care. NIV was used as the initial strategy wherever it was feasible. It was employed for

indications as per standard recommendations. Analysis was done using the statistical software "SPSS version 19.0". Descriptive analysis consisted of mean with standard deviation and range for various parameters. Correlation coefficients were calculated for variables which appeared to be predictors of mechanical ventilation. Student t-test was used to check the statistical significance.

RESULTS

The study included a total of 100 patients with respiratory failure secondary to acute exacerbation of COPD. Of the 100 patients 73 (73%) were male patients and 27 were females. 56 (56%) patients required mechanical ventilation (invasive or Non-invasive). All the hundred patients had worsening of dyspnea as the major complaint. 94 patients had accompanying cough. Only 67 patients had change in sputum production both quantity and quality. Totally 18 patients had chronic organ dysfunction and 10 patients had acute kidney injury. Of the 18 patients who had chronic organ dysfunction 17 patients needed mechanical ventilation. A Pearson correlation of 0.215 was found between chronic organ failure and invasive mechanical ventilation. Of the 56 patients who required mechanical ventilation 15 (26.8%) patients required endotracheal intubation and 41 (73.2%) can be managed on NPPV alone. The main indicator for invasive mechanical ventilation was found to be reduced GCS scores. The main predictors of mechanical ventilation were first day P_aco_2, first day pH, heart rate, respiratory rate, GCS.A weak correlation of 0.010 was found between mechanical ventilation and age with mean age of 70.17±12.31 in ventilatory group and 61±8.1 in non-ventilatory group.

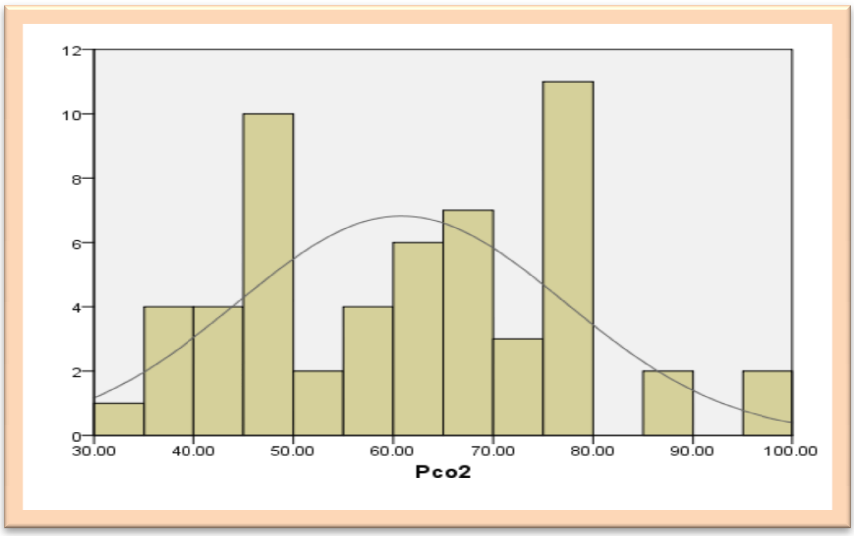

Figure 1: $P_a co_2$ Trends in Mechanically Ventilated Patients

Independent predictors of mechanical ventilation include age of the patient, higher P_aco_2 levels at presentation, pH, heart rate, respiratory rate, total WBC count, GCS. The parameters have been compared between the two groups in table.

Table 1: Indicators of Need for Hospitalization in Acute Exacerbation of Chronic Obstructive Pulmonary Disease

Sl	Parameters	CI-95%	P-Value
1	Older age	0.96-0.98	0.00**
2	Severe underlying chronic obstructive pulmonary disease/already receiving long term oxygen therapy	0.85-0.89	0.00**

3	Marked increase in breathlessness	0.93-0.97	0.00**
4	Poor or deteriorating general condition with little activity	0.96-0.97	0.01**
5	Cyanosis or worsening peripheral edema	0.86-0.91	0.02**
6	Impaired level of consciousness or confusion	0.88-0.97	0.03**
7	Difficulty in coping at home	0.92-0.99	0.06*
8	Significant comorbidities (particularly arrhythmias, heart failure, and insulin-dependent diabetes)	0.93-0.95	0.00**
9	Failure to respond to initial medical treatment	0.86-0.90	0.03**
10	Oxygen saturation< 90%	0.93-0.98	0.01**

**, Significant at 1% level (p<0.01)

Table 2: Comparison between Ventilatory and Non-Ventilatory Group

Parameter	Ventilatory Group	Non-Ventilatory Group	P-Value
$Paco_2$	60.80±16.38	48.36±10.28	0.00**
PH	7.30±0.08	7.37±0.08	0.01**
Heart rate	115±18.73	103.11±13.47	0.03**
Respiratory rate	30.80±5.90	25.68±3.44	0.08**
WBC count	12.51±5.15	10.56±3.10	0.00**
GCS	14.46±1.09	15±0.96	0.00**

**, Significant at 1% level (p<0.01)

DISCUSSIONS

Current study has found higher age of the patient as an independent predictor of mechanical ventilation. The average age of ventilatory group is 70.18±12.31 vs. 61±8.90 in ventilatory group. The p value is 0.0001 indicating extreme statistical significance. The impact of age might be due to longer duration of disease which causes more frequent exacerbations and progression of disease[13]. In the current study 51(51%) patients presented with only hypercarbic failure, 35 patients had combined hypoxic and hypercarbic failure and 14 patients had only hypoxic failure. Overall 86% patients had type 2 respiratory failure and only 14% patients had type 1 respiratory failure. This correlates with well proven fact that COPD patients will have type 2 respiratory failures. The average first day $PaCO_2$ was 60.80±16.38 in ventilatory group vs. 48±10.25 in non-ventilatory group with a Pearson correlation coefficient of 0.338 indicating a significant positive correlation. The p value of 0.0001 has been noted indicating extreme statistical significance. Of the 56 patients 41 were managed on non-invasive positive pressure ventilation. 15 patients required more invasive mechanical ventilation by endotracheal intubation. Many studies have proved that non-invasive ventilation decreases length of hospital stay, morbidity and mortality in COPD patients with type respiratory failure but not in other causes of type 2 respiratory failures[14, 15, 16]. The main indications for intubation included reduced GCS, patient intolerance to NIV, and failure of NIV and also organ dysfunctions. Reduced GCS is also a contraindication for non-invasive ventilation because of risk of aspiration[7]. The patients requiring mechanical ventilation had a pH of 7.30±0.08 vs. 7.37±0.08. P^H levels correlated well with $PaCO_2$ levels. P value is 0.0001 indicating extreme statistical significance. Pearson correlation coefficient was 0.13 indicating positive correlation. One study conducted in Queen Elizabeth hospital has shown a 7.24±0.11 as an indicator of mechanical ventilation. Another study conducted in north India[7] also showed a pH of 7.26 as a cutoff for the need of mechanical ventilation. This fact has been proven by multiple earlier studies like Khilnani *et al*.[7], Hoo *et al*.[14] and Sluiter *et al* [17]. Khilnani *et al*. and Hoo *et al*. identified a threshold of 7.25.The group of patients needing mechanical ventilation had

significantly higher heart rate and respiratory rate. The patients needing mechanical ventilation had a mean heart rate of 115.07±18.73 vs 103.11±13.47. The P value was 0.006 which signifies extreme statistical significance. A Pearson correlation of 0.534 was obtained signifying a good positive correlation [18].A mean respiratory rate of 30.80±5.90 in ventilatory group vs. 25.68±3.44 has been detected in the present study. There is an extreme statistical significance between the 2 groups with P value of 0.0001. Highest correlation has been noted between tachypnea and need for mechanical ventilation with a correlation coefficient of 0.760. Generally agreed level of respiratory for mechanical ventilation was 25 [20].Goldhill and colleagues reported that 21% of ward patients with a respiratory rate of 25–29 breaths/minute assessed by a critical care outreach service died in hospital. Reduced GCS score is also found as an indicator of need for mechanical ventilation. Current study has found a GCS of 14.46±1.09 in ventilatory group vs. 15/15 GCS in non-ventilatory group. There is extreme statistical significance between the two groups with a P value of 0.0014. Reduction in GCS in COPD is caused by respiratory failure. In hypoxemic respiratory failure, decreased supply of oxygen to brain leads to obtundation. Increased carbon dioxide levels cause CO_2 narcosis, leading to confusional state and coma.

CONCLUSIONS

Present study was conducted to identify the predictors of mechanical ventilation in acute exacerbation of COPD with acute respiratory failure.

This study has found that high first day P_aco_2, low arterial pH, high heart rate, high respiratory rate, low GCS are the predictors of mechanical ventilation. High P_aco_2, low pH and high respiratory rate had highest correlation with the need for mechanical ventilation aided by demographic and clinical presentation. Patients with more number of acute physiological derangements had higher incidence of mechanical ventilation rates. Patients with chronic organ failure, acute kidney injury and reduced GCS are the candidates for invasive mechanical ventilation. Endotracheal intubation increases the length of ICU stay, morbidity and mortality in patients with COPD. Most of COPD patients can be managed on NPPV without the need for intubation and they can be managed in a High Dependency Unit without the need for ICU stay. NPPV decreased the length of hospital stay and need for ICU admission.

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