Original Research Article

Outcome of non-invasive ventilation in patients with acute exacerbation of chronic obstructive pulmonary disease

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Abstract

Background: Non-invasive ventilation (NIV) is applied to this group of patients suffering from increased work of breathing; we can reduce the duration of NIV and also prevent the progression of this stage to acidosis. The key interest in our study was relating the outcome of NIV therapy concerning the association between respiratory rate, electrocardiogram, and comorbidities though previous other studies related the outcome NIV therapy concerning arterial PH and $PaCO_2$.

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

Materials and methods: The study was conducted in the Department of Respiratory Medicine, Government Stanley Medical College, Chennai between January 2019 to January 2020. Total numbers of 131 patients were enrolled in this study of consecutive patients admitted with acute exacerbation of COPD with increased work of breathing and normal pH where recruited in this study. The sample size was taken for convenience. Thorough history about smoking pack-years, occupation, duration of symptom exacerbation, wheeze history, clinical examination like measurement of respiratory rate, heart rate, blood pressure, work of breathing, accessory muscle activity and pulse oximetry for oxygen saturation.

Results: Total number of 131 patients was enrolled in this study of which females were 32.1% and males 67.9%. The mean age of enrollment in this study was 54.85 (S.D $\pm$ 6.248). We record our finding that of 131 patients, 121 patients got improved with NIV treatment, and the remaining 10 patients failed to improve due to various reasons which were discussed below. The mean duration of

NIV to revoke patients with acute exacerbation and increased respiratory rate to near normalcy was 19.44 hours. Duration of NIV treatment depends upon the following factors: Respiratory rate at the time of admission, Sputum consistency, and Current history of smoking, Presence of comorbidities like Corpulmonale, Diabetes, and Coronary artery disease.

Conclusion: If NIV therapy is administered earlier in patients with acute exacerbation of COPD, we can certainly reduce the duration of NIV treatment, duration of hospital stay, and thereby reducing the cost of treatment. We also strongly put forward that in patients with associated co-morbidity failure rate is higher with NIV therapy and utmost care should be taken.

Key words

Chronic obstructive pulmonary disease, COPD, Non-Invasive Ventilation, NIV, Acute Exacerbation of Chronic obstructive pulmonary disease, AE COPD.

Introduction

Chronic obstructive pulmonary Disease (COPD) is a major health problem and a leading cause of morbidity and mortality worldwide [1]. Moreover, the burden of the disease is expected to rise in the future. World Health Organization has predicted that by the end of 2020, COPD will be the 5th most prevalent disease worldwide (currently ranked 12th) and will be among the three leading causes of death [2]. Acute exacerbations of COPD (AECOPD) are largely responsible for the morbidity and mortality associated with the disease. Andersson and colleagues have estimated that almost 35-45% of the total per capita health-care costs account for COPD exacerbations [3]. The efficacy of NIV in patients with AE-COPD has been extensively studied. Several randomized control trials and meta-analyses found a reduction in intubation rate, hospital-acquired pneumonia, and mortality when NIV was added to supportive care [4]. Several guidelines strongly recommend NIV versus standard care alone in moderate to severe COPD exacerbation [5]. However, only two small randomized controlled trials (RCT) directly compared the efficacy of NIV and IMV and found that NIV use resulted in fewer complications and lower readmission rates without changes in mortality.

Materials and methods

The study was conducted in the Department of Respiratory Medicine, Government Stanley Medical College, Chennai during the year between January 2019 to January 2020. Total numbers of 131 patients were enrolled in this study of consecutive patients admitted with acute exacerbation of COPD with increased work of breathing and normal pH where recruited in this study. The sample size was taken for convenience. Thorough history about smoking pack-years, occupation, duration of symptom exacerbation, wheeze history, clinical examination like measurement of respiratory rate, heart rate, blood pressure, work of breathing, accessory muscle activity and pulse oximetry for oxygen saturation.

Inclusion criteria

- COPD patients with acute exacerbation with PaCO2 > 45 mmHg.
- pH (7.35 to 7.45) with increased work of breathing.
- Age >18 years.

Exclusion criteria

- Patient with acidosis (arterial pH < 7.35).
- Patients with shock with a systolic blood pressure of < 90 mmHg despite fluid challenge or need for vasopressor agents.
- Altered conscious state (GCS < 8).
- Copious respiratory secretions that could not be cleared easily by the patients.
- Recent Myocardial infarction, Unstable Angina, Recent facial trauma, Upper abdominal surgery.

Statistical analysis

The study participants were randomized into either GnRH analog or Recombinant HCG group by SPSS generated random number. Data entry was made in the Microsoft Excel software in codes and analysis was done with an SPSS-20 computer package. Categorical variables were expressed as percentages whereas continuous variables are expressed as mean ± standard deviation. Association between the categorical variable was found by the chi-square test and the relationship between the continuous variable was assessed by Student's *t*-test. P-value <0.05 was considered as statistically significant.

Results

Total numbers of 131 patients were enrolled in this study of which females were 32.1% and males 67.9%. The mean age of enrollment in this study was 54.85 (S.D ±6.248), the minimum age of the patient was 42, the maximum age was 75. The mean age for the male patient was 57.07 and the female patient was 48.97. None of the study group members had a history of Atopy. Childhood symptoms were present in one patient and who also had a significant history of smoking. None of the study group members had a family history. Seasonal exacerbation was found in 3 out of 131 patients. Mean pack years for males was found to be 29.26. Females included in our study were nonsmokers. They had exposure to second-hand smoking and biomass fumes exposure making them vulnerable to COPD. The mean duration of symptoms for males was 16.40 (S.D ± 6.564). The mean duration of NIV was 19.44 (S.D ± 13.889). The mean duration of hospital stay was 9.06 (S.D ± 3.982) while assessing the consistency of sputum, 17 out of 131 patients had mucopurulent sputum and the remaining had mucoid sputum. We found that consistency of that sputum had an impact on the outcome of the study i.e. improvement of symptoms or failure of treatment. But also we found that consistency of sputum does have an impact on the duration of NIV i.e. patients with mucopurulent sputum had a longer duration of NIV than patients with mucoid sputum. Current smoking history was present in 8.4% of the study population; current smoking history influences NIV duration and outcome of treatment. Except for two patients, all members of the study population had wheeze on auscultation. Seven members of our study population had comorbidities like diabetes, hypertension, corpulmonale, and coronary artery disease. The study also showed that the presence of comorbidity had a significant influence on NIV outcome i.e. increased failure rate in NIV treatment. Increased respiratory rate was observed in almost all patients in our study group with increased accessory muscle activity except was one patient in whom muscle activity was not prominent due to his obesity, symptoms and signs of MI. In this way, we found patients with the previous history of CAD on treatment and developed new MI leading to the withdrawal of NIV therapy, showing that treatment outcome was poor in patients with comorbidities. In the chest, X-ray hyperinflation was a predominant finding (**Table – 1 to 4**).

Table – 1: Hyperinflation.

	Frequency	**Percent**
Hyperinflation	117	89.5
Normal	11	8.3
Hyperinflation with cardiomegaly	1	.8
Pneumonia with hyperinflation	2	1.5
Total	131	100.0

Discussion

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: Complex mechanisms are involved in airflow obstruction, which leads to increased airway resistance [6]. COPD can affect airway, lung parenchyma, pulmonary vasculature and the lesion can correlate to change in pulmonary function tests and clinical appearance. COPD is ranked fourth in the worldwide case mortality

rate and the disease is both treatable and preventable. In search study used questionnaires and spirometry, hence, it correlates poorly with symptoms. The drawback of this study is that it might miss asymptomatic individuals with early spirometric abnormalities which might be significant [7].

Table – 2: Chest X-ray outcome.

Chest X-ray		Outcome		Total
		Failure	Improved	
Hyperinflation	Count	7	121	128
	% of total	5.3%	92.5%	97.8%
Hyperinflation with cardiomegaly	Count	1	0	1
	% of total	0.8%	0.0%	0.8%
Hyperinflation with pneumonia	Count	2	0	2
	% of total	1.5%	0.0%	1.5%
Total count		10	121	131
% of total		7.6%	92.94%	100%

Table – 3: Comparison of various parameters about success and failure, 1 indicates success, and 0 indicates failure.

Outcome code		N	Mean	Std. Deviation	Std. Error Mean
Age	0	10	56.10	2.685	.849
	1	121	54.75	6.450	.586
Duration of symptom in days	0	10	18.00	6.360	2.011
	1	121	16.26	6.589	.599
Pack years	0	10	22.80	20.010	6.328
	1	121	19.64	16.222	1.475
Heart rate	0	10	111.70	7.543	2.385
	1	121	99.57	8.174	0.743
Respiratory rate	0	10	37.000	1.9437	0.6146
	1	121	31.868	4.2816	0.3892
Hb	0	10	11.890	1.1020	0.3485
	1	121	11.498	.8123	0.0738
Wbc	0	10	9500.00	2600.855	822.462
	1	121	8398.35	2065.268	187.752
Duration of hospital stay	0	10	17.90	3.985	1.260
	1	121	8.33	2.990	0.272

Spirometric lung function test is needed for diagnosis. The presence of obstructive lung disease is diagnosed by post-bronchodilator $FEV_1/FVC<0.70$ and the severity of the disease are assessed by Post bronchodilator FEV_1.COPD assessment is important because it helps to assess the severity of the disease, predicts hospital admission, or death and risk of subsequent exacerbation [8]. Acute exacerbation of COPD is due to either viral infection of upper respiratory tract or infection of the conducting airways like tracheobronchitis 40% and 2.3±1.9 exacerbations in patients with post-bronchodilator FEV_1 <40% predicted Respiratory acidosis (arterial pH < 7.35 and / or $PaCO_2$>6.0 kPa, 45 mmHg). Severe dyspnea with clinical signs characterized by the fatigue of respiratory muscles maximized work of breathing or both such as the increased

activity of accessory muscles, abdominal paradox, or intercostal muscle in drawing [9], we can reduce the duration of NIV and also prevent the progression of this stage to acidosis. The key interest in our study is relating the outcome of NIV therapy concerning the association between respiratory rate, Electrocardiogram, Comorbidities, though previous other studies related the outcome NIV therapy concerning arterial PH and $PaCO_2$. Another important reason behind my interest in this study is to compare the association of sputum consistency and smoking duration of NIV therapy. The patients were subjected to NIV treatment in the general ward itself which was convenient, cost-effective, feasible, and alleviating need for intensive care settings [10].

Table – 4: Reason for failure.

	Frequency	**Percent**
Acute myocardial infarction	121	92.4
Infarction associated	1	.8
Corpulmonale	2	1.5
Claustrophobia and fighting against ventilator	4	3.1
Necrotising pneumonia	1	0.8
Parapneumonic effusion	1	0.8
Total	131	100.0

The above-mentioned parameters were the important reasons that led to failure in our treatment.

COPD patients with acute exacerbation will have an increased respiratory rate. If this stage is left untreated, the disease may progress to acute respiratory failure. When NIV is combined with standard medical treatment duration of hospital stay is reduced, recovery from illness is faster, thereby improving their disease outcome. Compared to stable COPD patients, unstable COPD patients are more prone to hypercapnic respiratory failure, hence, there is a need to start NIV therapy early. Reason for not administrating oxygen therapy in patients with spo2 > 88% as first-line therapy is that such an act will blunt hypoxic ventilatory drive further worsening exacerbation [11]. Hence, patients with spo2 >88% were not subjected to oxygen therapy. In a review of past studies, we found that most of the studies were done in patients with respiratory acidosis (ph 7.25-7.35) but relatively few studies are available on patients with ph> 7.35. In our study, we have included COPD patients with acute exacerbation, ph>7.35 and documented NIV outcome concerning success or failure in them [12]. In our study, we followed BTS guidelines and set minimum duration of NIV therapy as six hours and made the following observations: In patients with respiratory rate $\leq$ 30, a minimum of six hours of therapy was administered even if patients recovered earlier to avoid relapse. In patients with respiratory rate 30-40, NIV was administered during day time and sleep (excluding time for physiotherapy, nebulization, and personal activities). If significant improvement with minimal increase in work of breathing, the patient was supported with NIV during next day sleep alone, but if no satisfactory improvement is attained NIV is continued next day both during the day and sleep till improvement is reached. (The maximum duration of NIV therapy observed in our study is 3-4 days) while considering the intolerance level to NIV therapy among various studies, it is drawn that this rate is highly variable and the reason for which is not studied [13]. About this aspect we took much effort to reduce the rate of intolerance, patients were given good counseling regarding the positive benefits of receiving the therapy thereby alleviating their claustrophobia and anxiety. Despite such immense effort patients who were still fighting with a ventilator, we set the escalation of inspiratory positive pressure (RAMP) at 20 min and slowly brought

it down to their peer group rate thus achieving the goal of reduction in intolerance level [14]. The respiratory rate at the time of admission, Sputum consistency, Current history of smoking, and Presence of comorbidities like corpulmonale, diabetes, and coronary artery disease. Patients with claustrophobia were treated with medical therapy and were closely monitored for signs of respiratory failure, they stayed in the hospital for longer duration but finally got improved and were discharged [15]. One patient with previous CAD history developed MI during NIV therapy hence NIV therapy was stopped, MI treatment was prioritized and medical therapy was continued. Two patients with diabetes developed pneumonia, for them, pneumonia was treated, and NIV therapy was given for a longer time. Two Patients with corpulmonale required a longer duration of NIV therapy [16].

Conclusion

COPD with acute exacerbation is treated until now with medical therapy and ventilatory support. Our field has seen in recent past years few types of research done on NIV therapy in patients with acute exacerbation of COPD with pH>7.35. This study is one of them. If NIV therapy is administered earlier in patients with acute exacerbation of COPD, we can certainly reduce the duration of NIV treatment, duration of hospital stay, and thereby reducing the cost of treatment. We also strongly put forward that in patients with associated co-morbidity failure rate is higher with NIV therapy and utmost care should be taken to control comorbid conditions and start other options like mechanical ventilation whenever needed.

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