Original Article

The Outcome of Non Invasive Ventilation in Acute Exacerbation of COPD

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Abstract

Background : Non invasive ventilation (NIV) is an excellent modality in the management of patients with acute exacerbation of Chronic Obstructive Pulmonary Disease (COPD) with respiratory failure, which minimizes the need for invasive ventilation with its attendant complications to a great extent.
Aim of the study : To determine the effectiveness of NIV in acute exacerbation of COPD and to assess the factors determining the outcome of NIV.
Methodology : A prospective observational study was conducted in the Intensive Respiratory Care Unit of a tertiary care centre in North Kerala during January 2012 to August 2013. All patients admitted with acute exacerbation of COPD, with respiratory rate > 25/min, acidosis (pH < 7.35) and hypercapnia ($PaCO_2$ >45mm Hg) were included in the study. Those with contraindication for NIV were excluded. NIV was instituted in these patients via full face mask and monitored respiratory rate, SpO_2, pulse rate, blood pressure and arterial blood gas analysis (ABG) at 1hr, 12 hrs and 24 hrs. Statistical analysis was done using SPSS software version 16. Comparison of blood gas parameters pre and post NIV, quantitative variables and qualitative variables were done with paired t test, t test and chi square respectively.
Results : Out of total 79 patients 70.9% were successfully treated with NIV. The mean body mass index (BMI) was 23.69 and 21.23 in NIV success group and NIV failure group respectively. The mean pH was 7.28 and 7.23 in NIV success group and NIV failure group. The mean $PaCO_2$ fell from the baseline of 85 ± 16.5 mm of Hg to 77.3 ± 14.7 mm of Hg at 1 hour. Thirty five percent of patients with NIV failure had evidence of infection and only 11% had evidence of infection in patients with NIV success.
Conclusion : Non Invasive ventilation as an early treatment modality can significantly improve hypercapnea in acute respiratory failure in COPD. The factors determining the outcome are baseline pH, evidence of infection and BMI.
Keywords : COPD, NIV, ARF(Acute respiratory failure)

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a major health problem and leading cause of morbidity and mortality worldwide[1]. Acute exacerbation of chronic obstructive pulmonary disease(AECOPD) are periods of acute worsening which greatly affect the health status of patients with an increase in hospital admission and mortality[2]. Estimates of in-patient mortality range from 4% to 30%, but patients admitted due to acute respiratory failure (ARF) experience a higher rate, in particular elderly patients with co-morbidities (up to 50%) and those requir-

ing intensive care unit (ICU) admission (11%–26%)[3-7]. Noninvasive ventilation(NIV), which refers to the delivery of mechanical ventilation to the lungs using techniques that do not require an endotracheal airway, has been shown to reduce intubation rates, mortality, and duration of hospital stay in several studies[8-13]. Although its clinical efficacy has been demonstrated in the management of patients with acute exacerbation of COPD from the west, there are few studies from this part of the country. This study was done to assess the effectiveness of NIV as a therapeutic modality in acute exacerbation of COPD and to assess various factors determining its outcome in south Indian population.

Materials and Methods

This study was prospective observational study, conducted in the Intensive Respiratory Care Unit of a major tertiary hospital in North Kerala. The study was conducted during January 2012 to August 2013 after ethical clearance from institutional ethics committee.

All patients admitted with COPD acute exacerbation, not improving with standard medical treatment with respiratory rate > 25/min, acidosis (pH < 7.35) and hypercapnia ($PaCO_2$>6.0kPa, 45mm Hg) were included in the study. Patients with life-threatening hypoxaemia, severe co-morbidity, confusion, agitation, severe cognitive impairment, facial burns or trauma, recent facial or upper airway surgery, vomiting, fixed upper airway obstruction, undrained pneumothorax, upper gastrointestinal surgery, patients with inability to protect the airway, copious respiratory secretions, moribund patient and patients with bowel obstruction were excluded.

Detailed history, complete physical examination including anthropometry were done and all patients were subjected to routine blood investigation, Chest X Ray (CXR), 12 lead surface electrocardiogram and Arterial Blood Gas Analysis(ABG).

NIV was instituted using either Resmed VPAP IV or Resmed Stellar 100 devices, via full face mask of appropriate size with initial ventilator settings of Inspiratory Positive Airway pressure (IPAP) of 10 cmH_2O and Expiratory Positive Airway pressure (EPAP) of 4 cmH_2O. Monitoring of respiratory rate, SpO_2, pulse rate, blood pressure and ABG at 1hr, 12 hrs and 24 hrs was done. Other parameters monitored were level of consciousness, patient comfort, chest wall movement, presence of leak and accessory muscle use. IPAP was increased by 2 cm of H_2O increments during the first hour according to patient tolerance, achievement of effortless breathing and SpO_2 improvement, up to a maximum of 20 cm H_2O.

Any deterioration in terms of patient's respiratory effort- respiratory rate, level of consciousness, intolerance to NIV, worsening blood gas parameters were indicators of switch over to invasive ventilation. The NIV was used as much as possible in the first 48 hours and subsequently weaned off according to clinical improvement and ABG results.

NIV failure was considered when there was failure to improve or deterioration in arterial blood gas tensions, development of new symptoms or complications such as pneumothorax, sputum retention, nasal bridge erosion, intolerance or failure of coordination with the ventilator, deteriorating consciousness level, patient and carer wish to withdraw treatment.

The factors studied were age, body mass index (BMI), COPD duration, presence of comorbidities, premorbid status-dyspnoea on exertion (DOE), smoking score, Anthonisens classification, leucocyte count, serum electrolytes, serum albumin, respiratory rate prior to NIV, IPAP and EPAP levels, pre NIV and post NIV blood gas parameters, total duration of NIV use and development of complication.

Statistical analysis was done using SPSS software version 16. Comparison of blood gas parameters pre and post NIV was done with paired t test. Comparison of quantitative variables were done with t test and that of qualitative variables were done with chi square test.

Observations

A total of 79 patients were enrolled in the study. Out of these, 56 (70.9%) were successfully treated with NIV and 23 (29.1%) were NIV failures. All were males, with 40 patients between the age group of 40-59 years and 39 patients above 60 years. Thirty patients were hypertensive, 30 diabetic and 12 had coronary heart disease. There was one patient with history of chronic kidney disease and 3 had bronchiectasis.

Out of 79 patients 64 (81%) had a premorbid DOE Grade – 3, cor pulmonale was present in 42(53.2%) and 43(54.4%) patients were admitted with Type 3 Anthonisen class of acute exacerbation of COPD.

Table 1 :

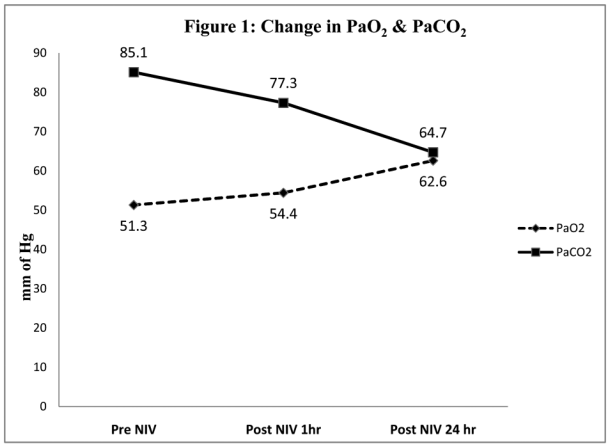
The baseline characteristics of the study population

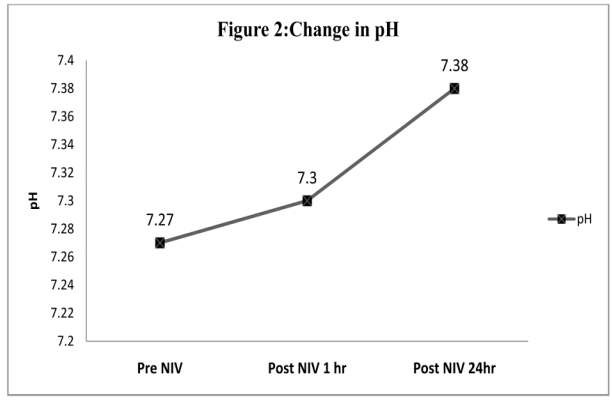
Characteristic	Minimum	Maximum	Mean	Std Deviation
COPD Duration (Years)	2	25	8	3.7
Smoking Score	125	3800	1093	718.8
Duration of exacerbation (Days)	2	20	8	4.3
Total leukocyte count (cu/mm)	1000	40500	12353.8	5526.2
Serum Na (mEq/L)	117	144	131	6.2
Serum K (mEq/L)	2.3	6.3	4	1
Serum Albumin (g/dl)	2.3	4.4	3.3	0.4
Glagow Coma scale	12	15	14	1.1
Respiratory Rate	25	50	34	4.9
PaO_2 (mmHg)	28	95	51.3	12.5
$PaCO_2$ (mmHg)	63	125	85	16.4
pH	7.12	7.35	7.27	0.1
HCO_3 (mmEq/L)	24	60.2	36.2	9.4

Mean IPAP was 14.3 ± 2.4 cm of H_2O and EPAP was 7.1 ± 1.1 cm of H2O. Maximum IPAP used was 20 cm of H_2O and EPAP was 8 cm of H_2O .

The mean SpO_2 rose from the baseline of 51.3± 12.5 mm of Hg to 54.4 ± 10.8 mm of Hg and 62.6 ± 9.5 mm of Hg at 1hour and 24 hours respectively (p <0.05) and mean $PaCO_2$ fell from the baseline of 85.1 ± 16.5 mm of Hg to 77.3 ± 14.7 mm of Hg and 64.7 ± 13.3 mm of Hg at 1 hour and 24 hours respectively (p <0.05) as in figure 1

The mean pH rose from the baseline of 7.27 ± 0.06 to 7.3 ± 0.07 and 7.38 ± 0.07 at 1 hour and 24 hours respectively (p <0.05) as in figure 2.





The mean duration of NIV use was 110.2 hours and mean hospital stay was 15 days. In the study population 32 (41%) patients developed complications, most common being eye irritation 14 (17%). Other complications include ear pain, skin irritation, hypotension, oronasal dryness, gastric distension and nasal congestion.

The mean age in NIV Success group was 58.64 yrs whereas that in the NIV Failure group was slightly higher 62.48yrs and this difference was not statistically significant (p value 0.066).

The mean BMI in NIV success group was 23.69 and that in the NIV failure group was 21.23 and this difference was statistically significant (p value 0.001).

The mean duration of COPD in NIV success group and NIV failure group were 7 ± 3.4 years and 8.7 ± 4.1 years respectively, with a p value of 0.065. The majority of patients had grade 3 DOE in premorbid state. Only 3 patients had grade 4 DOE and all of them had unfavourable outcome (p 0.007).

Another parameter which showed significant difference between the NIV success group and NIV failure group was the evidence of infection - mean leucocyte count and presence of fever. The mean leucocyte count was 11,175 and 15,224 in NIV success and NIV failure group respectively (p 0.003). In NIV success group only 6 (11%) patients were febrile whereas in NIV failure group 8 (35%) were febrile (p 0.0011).

The respiratory rate of the patients at time of commencement of NIV in the two groups was compared. It was found that the mean respiratory rate in the NIV success group was 33/minute whereas in the NIV failure group was 36/minute.

Table 2 :

Pretreatment respiratory rate and blood gas parameters

	NIV Success	NIV Failure	p Value
Respiratory Rate (per minute)	33	36	0.01
pH	7.28	7.23	0.004
PaO_2 (mm Hg)	51.8	50.1	0.59
$PaCO_2$ (mm Hg)	83.6	88.6	0.22

The ABG parameters at the time of commencement of NIV in the two groups were compared. It was found that the mean pH was 7.28 and 7.23 in NIV success group and NIV failure group respectively with the p value of 0.004, mean PaO_2 was 51.8mm of Hg and 50.1mm of Hg in NIV success group and NIV failure group respectively with the p value of 0.59, and mean $PaCO_2$ was 83.6mm of Hg and 88.6mm of Hg in NIV Success group and NIV Failure group respectively with the p value of 0.219.

There was no statistically significant correlation seen between the outcome and smoking score, serum electrolytes and serum albumin.

Table 3 :

Comparing the pretreatment and post treatment Blood gas parameters

	Mean	Std Deviation	Significance
Change in PaO_2 at 1hr	3.12	9.89	0.006
Change in PaO_2 at 24hrs	10.93	12.06	0.00
Change in $PaCO_2$ at 1 hr	7.74	8.24	0.00
Change in $PaCO_2$ at 24hrs	19.85	13.71	0.00
Change in pH at 1 hr	0.03	0.037	0.00
Change in pH at 24hrs	0.10	0.068	0.00

Discussion

Non-invasive ventilation is well established treatment option in the management of acute hypercapnic respiratory failure in acute exacerbations of COPD. The present study proved that the use of NIV in patients admitted for AECOPD with respiratory failure can obviate the need for intubation. About 80% of patients enrolled in the study were successfully treated with NIV.

BMI is a strong independent predictor of mortality in both stable COPD and acute exacerbation of COPD. We found that higher the BMI probability of NIV success was greater. Similar observation was found by Ambrosino et al[14], who studied the effect of nutrition expressed as % ideal body weight in NIV outcome in patients with acute respiratory failure due to COPD.

In contrast to previous studies[14] it was observed that high initial $PaCO_2$ had no bearing in the poor outcome of NIV in COPD acute exacerbation. Thus patients with initial high $PaCO_2$ can be given NIV trial before invasive ventilation.

In stable COPD, the co morbidity burden (usually measured by Charlson Index) is an established predictor of mortality [15]. In acute exacerbation of COPD, co morbidities like ischemic heart disease, congestive cardiac failure, chronic liver disease, chronic renal failure and diabetes are liable to decompensate and hence increase mortality. We found no statistical significance in outcome in relation to the presence of co morbidity. This may be due to small number of patients in NIV failure group. An-

other reason may be, because the study was conducted in an ICU setting, where continuous monitoring and timely appropriate measures were instituted in case of deterioration of co morbidities.

Patients with premorbid DOE grade 4 had unfavourable outcome, which implies that higher degree of physiological dysfunction during the stable state has poorer outcome. The presence of corpulmonale, higher smoking score, longer COPD duration, longer duration of present exacerbation or Anthonisens class had no bearing on the outcome in the present study. We found that evidence of infection viz presence of fever, leucocytosis had a negative impact on the outcome, similar to previous studies[16].

The best marker of severity of COPD acute exacerbation is the pH which reflects acute deterioration in alveolar hypoventilation [17,18]. In the present study mean pH was 7.28 and 7.23 in NIV success group and NIV failure group respectively which was comparable with the previous study results. Thus baseline pH is a significant predictor for successful NIV. This implies the fact that non invasive mechanical ventilation should be instituted early in every patient before a severe acidosis ensues.

Conclusion

1. Non invasive ventilation as an early treatment modality can significantly improve hypercapnia in acute respiratory failure in COPD, thereby avoiding the need for invasive mechanical ventilation and its complications

2. The factors determining the outcome are baseline pH, evidence of infection and BMI.

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