ORIGINAL RESEARCH

Predictors of Success and Outcome of Non-Invasive Ventilation in Acute Exacerbation of COPD

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ABSTRACT

Background and objectives: Non-invasive ventilation (NIV) has been evaluated in a large number of trials, often with clinically important benefits, but its use remains highly variable across institutions. Hence, in the present study, we aimed to identify the factors that predict the success and outcome of non-invasive ventilation in acute exacerbation of COPD. **Methods:** This was a prospective observational study of 150 adult patients admitted with AECOPD. Demographic information such as Age, Sex, history of smoking, etc. and clinical parameters like Respiratory Rate, Heart Rate, blood pressure, and Arterial Blood Gas variables like pH, PaO2, PaCO2, HCO3, and SaO2 were measured at just before NIV, at 6thhr and 18th hr after the start of NIV. The outcome was recorded as success and failure with NIV. **Results:** Respiratory Rate was lower and showed significant improvement at 6th hr in subjects who successfully improved with NIV. Oxygen saturation was found to be significantly higher among subjects successfully managed with NIV at 18th hr (90.35 ± 3.391 vs 82.00 ± 2.828) as compared to patients who required intubation. pH was found to be higher (7.47 ± 0.05 vs 7.27 ± 0.27) and PaCO2 levels were lower before NIV and significant improvement in pH and PaCO2 at 6th hr and 18th hr respectively was observed in NIV success patients. Out of 150 patients, 132 (88%) managed successfully with NIV and in 18 subjects (12%) NIV failed. Among NIVfailure subjects, 5 died and 13 subjects were intubated, out of which, 11 were discharged, and 2 subjects died. **Conclusion:** In the present study, low BMI, improvement in parameters like heart rate, respiratory rate, PaO2, PaCO2, pH, SaO2 and HCO3 at 6th hr of NIV are the factors predicting the success and outcome of NIV among AECOPD patients.

Keywords: AECOPD, NIV, Respiratory rate, PaO2, SaO2, PaCO2, HCO3

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a type of obstructive lung disease characterized by long-term breathing problems and poor airflow.[1,2] COPD is a progressive disease, typically worsens over time. Eventually, everyday activities such as walking or dressing become difficult. Chronic bronchitis and emphysema are older terms used for different types of COPD. The main symptoms include shortness of breath and cough with mucus production. The most common cause of COPD is tobacco smoking, with a smaller number of cases due to factors such as air pollution and genetics. In the developing world, common sources of air pollution are wood combustion and cooking fires.

Exacerbation of COPD is defined as acute worsening of respiratory symptoms that results in additional therapy.[3] Exacerbations are usually caused by a viral or bacterial lung infection, but they may also be triggered by things or situations that make it difficult

for you to breathe, such as smoking or being exposed to smoke or airpollution. The COPD diagnosis is based on poor airflow as measured by lung function tests.[4] Patients affected with COPD are prone to respiratory failure, often resulting in admission to hospital. Between a fifth and a third of patients admitted with hypercapnic respiratory failure secondary to acute exacerbation of COPD will die in hospital, despite mechanical ventilation.[5-7] The aim of treatment in COPD patients with acute exacerbation is to reduce current exacerbation and to prevent further exacerbations.[7,8]

Ventilatory support via endotracheal intubation (ETI) is the standard mode of therapy for such patients. However, endotracheal intubation is associated with several complications, including nosocomial pneumonia, injury to upper airways causing ulceration, haemorrhage and long-term complication like tracheal stenosis.[8-10] The term non-invasive ventilation (NIV) refers to the application of artificial ventilation without any conduit access to the airways, i.e., without an endotracheal or tracheostomy tube. Recently, NIV has assumed a prominent role in the management of acute respiratory failure. By avoiding endotracheal intubation, NIV prevents complications associated with invasive ventilation like airway problems, nosocomial pneumonia (21%) and sinusitis (5-25%). The use of non-invasive positive pressure ventilation has increased dramatically in the last decade due to the availability of a more accessible interface and the desire to avoid complications of intubation. Its success in various conditions finds support in the literature. [10,11]

It is evident from the available literature information that the benefits of NIV for patients with AECOPD have been proven, and whether these benefits apply to all patient groups and in all settings deserves more assessment. Inadequate patient selection and incorrect management of NIV increases mortality. With this scenario in the current study, we aimed to determine the predictors of success and outcome of non-invasive ventilation in acute exacerbation of COPD.

Hence; the present study was conducted for predicting success and outcome of non- invasive ventilation in acute exacerbation of COPD.

MATERIALS & METHODS

The present study was conducted for predicting success and outcome of non- invasive ventilation in acute exacerbation of COPD. The main source of data for the study are the 150 patients attending outpatient and inpatient in the department of respiratory medicine of J.J.M Medical College and Bapuji Hospital, Davangere. One hundred and fifty patients aged 25 years or more who were admitted with acute exacerbations of chronic obstructive pulmonary disease (AECOPD) in the department of respiratory medicine at J.J.M Medical college and Bapuji hospital, Davangere were included for the study. Sociodemographic details like age, gender, occupation, education, socio- economic status, history of smoking, previous admissions etc. and clinical data were collected at the time of admission. At the time of discharge, details like length of stay in the hospital, treatment history were recorded. Candidate predictors included stable demographic, clinical and functional indices, including markers of ill-health. Weight and height were measured following standard guidelines, and BMI was calculated. The parameters viz. heart rate (HR), respiratory rate (RR), blood pressure (BP) and arterial blood gas (ABG) were assessed. The data for all the above parameters were collected at; just before non-invasive ventilation (NIV), at 6th and at 18th hr of NIV. Outcome was recorded as success and failure with Non-invasive ventilation. All the results were recorded and analysed using SPSS software.

RESULTS

Out of 150 (100%) subjects, the minimum age of the subjects was 46 yrs and the maximum age of 92 yrs with a mean age of the subjects was 69.70 ± 9.269 yrs. The mean age of the subjects with NIV success was 70.21 ± 9.123 yrs, and the mean age of the subjects with NIV failure was 65.94 ± 9.735 yrs. Out of 150 (100%) study subjects, male predominance was observed, i.e., 85 (56.7%) as compared to females 65 (43.3%). The mean duration of illness was higher for subjects with NIV failure, i.e., 4.11 ± 3.394 days as compared to subjects with NIV success, i.e., 3.83 ± 2.156 days with a minimum duration of 1 day and a maximum duration of 15 days. An Independent sample test was applied to compare the mean duration of illness between the groups and showed no statistically significant difference between the groups (p=0.62). Out of 150 (100%) study subjects, there was an improvement seen in the majority of the study subjects, i.e., 132 were discharged, 5 died, 13 were intubated. Out of 13 subjects who were intubated, 11 were discharged, and 2 subjects died. Among study subjects with NIV success, hypertension (HTN) was seen in 43 (32.6%) subjects followed by type 2 Diabetes mellitus (T2DM) was found in 40 (30.3%) subjects, ischemic heart disease (IHD) was present in 9 (6%) subjects, and hypothyroidism was seen in 8 (5.3%) subjects. Hypertension was seen among 3(16.7%) subjects, T2DM was seen among 4(22.2%) subjects, IHD was seen in 1 (5.6%) subject, and no hypothyroidism was reported in subjects with NIV failure. The Chi-square test was applied to determine the association of the co-morbidities with the outcome. Chi-square test showed no statistically significant association between HTN (p=0.17), T2DM (p=0.48), IHD (p=0.93), hypothyroidism (p=0.28) and outcome.

TABLE 1: Comparison of the mean age based on theoutcome usingindependent sample T-TEST

Outcome	N	Minimum(Yrs)	Maximum(Yrs)	Mean(Yrs)	SD	Meandiff	p-value
NIVsuccess	132	50	92	70.21	9.123		
NIVfailure	18	46	85	65.94	9.735	4.26	0.06
Meanage	150	46	92	69.70	9.269		

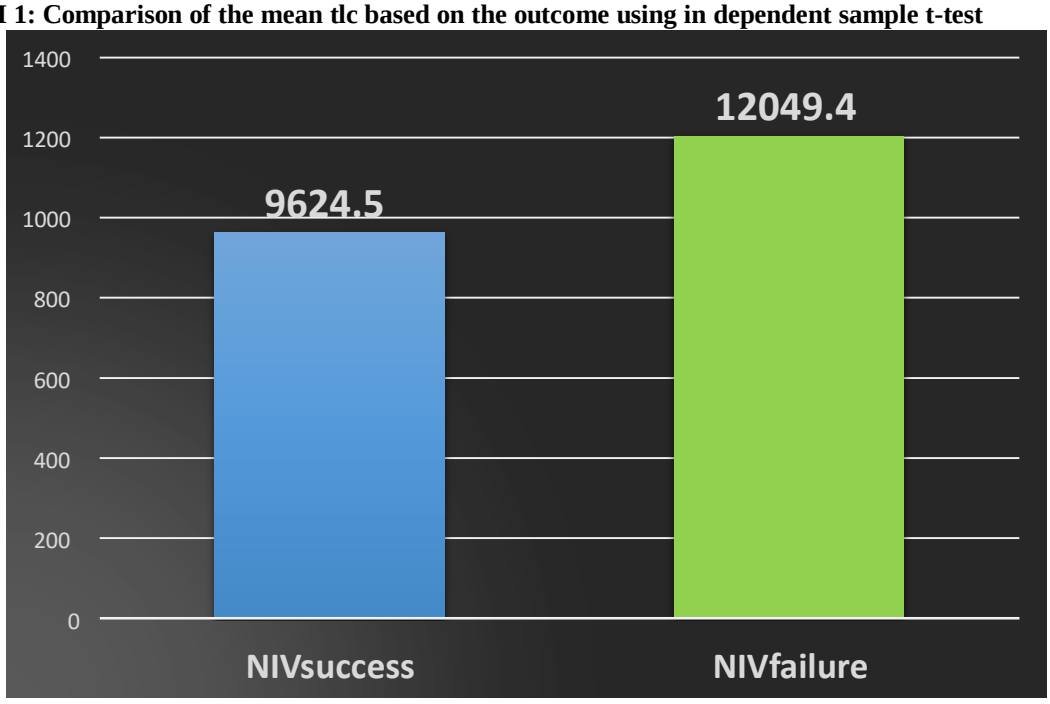
TABLE 2: Distribution of the subjects based on co-morbidities

Co-morbidities			OUTCOME		Total	Chi-square value	p-value
			NIV Success	NIV failure			
HTN	NO	Count	89	15	104	1.88	0.17
		%	67.4%	83.3%	69.3%		
	YES	Count	43	3	46		
		%	32.6%	16.7%	30.7%		
T2DM	NO	Count	92	14	106	0.49	0.48
		%	69.7%	77.8%	70.7%		
	YES	Count	40	4	44		
		%	30.3%	22.2%	29.3%		
IHD	NO	Count	124	17	141	0.007	0.93
		%	93.9%	94.4%	94.0%		
	YES	Count	8	1	9		
		%	6.1%	5.6%	6.0%		
HYPOTHYROIDISM	NO	Count	124	18	142	1.150	0.28
		%	93.9%	100.0%	94.7%		
	YES	Count	8	0	8		
		%	6.1%	0.0%	5.3%		

Table3: Distribution of the subjects based on outcome

Outcome		N	%
Discharged		132	88
Death		5	3.3
Intubated-13(8.67%)	Discharged	11	7.3
	Death	2	1.3

GRAPH 1: Comparison of the mean tlc based on the outcome using in dependent sample t-test



DISCUSSION

In the present study, it was observed that the minimum age of the subjects was 46 yrs and the maximum age of 92 yrs with a mean age of the subjects was 69.70 ± 9.269 yrs. The mean age of the subjects with NIV success was 70.21 ± 9.123 yrs, and the mean age of the subjects with NIV failure was65.94 ± 9.735 yrs. This is similar to the study conducted by Steriade et al., wherein authors reported the mean age of 67.6 ± 10yrs.[12]

In the present study, among study subjects with NIV success, hypertension (HTN) was seen in 43 (32.6%) subjects followed by type 2 Diabetes mellitus (T2DM) was found in 40 (30.3%) subjects, ischemic heart disease (IHD) was present in 9 (6%) subjects, and hypothyroidism was seen in 8 (5.3%) subjects. Hypertension was seen among 3(16.7%) subjects, T2DM was seen among 4(22.2%) subjects, IHD was seen in 1 (5.6%) subject, and no hypothyroidism was reported in subjects with NIV failure. We did not find any significant NIV failure or improvement associated with any specific comorbidity. A study reported by Chung et al. did not find any correlation between the number of co-morbidities and in-hospital or long-term mortality.[13]

Leukocytosis is a potential confounder in COPD patients who are on steroid therapy and are suspected of having a concomitant bacterial infection. It is often unclear whether the leukocytosis is due to steroids or the infection in these patients. The mean total leucocyte count (TLC) of the study was found to be higher in subjects with NIV failure- 12049.44 ± 8408.113cells/cu.mm of blood as compared to subjects with NIV success- 9624.58 ± 4673.897 cells/cumm of blood in the present study without any statistical significance. Hence,TLC does not predict the NIV outcome in the present study.

To ensure the success of NIV, close monitoring is necessary, especially of respiratory rate , heart rate, blood pressure , parameters of ABG analysis i.e., pH, PaO2, HCO3 and PaCO2. NIV in patients with severe COPD exacerbation is effective in reducing respiratory acidosis and improving respiratory rate.[14]In the present study, the respiratory rate (RR) among the study subjects was reduced before NIV from 23.75 cpm to 21.14 cpm at 6th hr and to 18.19 cpm at 18th hr in NIV success subjects. Similarly, a reduction in the respiratory rate was seen from 30.39 cpm to20.5 cpm at 18th hr and no reduction was observed at 6th hr in NIV failure subjects.

We found that RR was significantly improved with NIV success subjects at 6th hr compared to NIV failure. Whereas there was no significant difference seen in RR at 18th hr. Similar results were reported by Plant et al. study wherein authorsdemonstrated a decrease in respiratory rate after 4 hours and it was associated with successful NIV outcome.[15]Shaheen et al. also found that the respiratory rate reduced after NIV treatment wherein respiratory rate was reduced from 31.7 ± 5.2cpm to 25.2± 4.2cpm after 24 hrs was associated with NIV success.88 In the present study, patients in NIV success group had low respiratory rate before NIV and at 6th hr compared to NIV failure patients. Hence, it is concluded that baseline RR and RR at 6th hr following NIV are associated with NIV success according to the present study.

Oxygen saturation is an important parameter in cases of COPD. The oxygen saturation (SaO2) was increased from 87.29% to 90.35% from just before NIV to 18th hr in NIV success subjects. Whereas, SaO2 reduced from 80.17% to 74.24% from just before NIV to 6th hr and increased to 82% at 18th hr was observed in the present study. Moreover, a statistically significant difference was seen between the groups at all the time intervals. Similar to our study findings, in Yu et al. study, the median % was found to be 93.5 in NIV success subjects and 92.0 in NIV failure subjects. There was an improvement in the SaO2 by NIV treatment.[16]

In the present study, the mean duration of hospital stay among study subjects was found to be higher in subjects with NIV failure- 14.28 ± 9.833 days as compared to subjects with NIV success- 6.74 ± 2.555 days and it was statistically significant between the groups. From this we can conclude that NIV decreases the stay in hospital and favors early discharge of patients from the hospital.This is in accordance with study conducted by L.Brochard et al. in which the mean duration of hospital stay was 23±17 days in NIV success patients when compared to 35±33 days in failure patients.[17]

In our study, we found that non-invasive ventilation was successful in 132 (88%) cases out of 150 cases (100%), whereas 18 (12%) cases out of 150 (100%) was found failure. Among NIV failure subjects, 5 died and 13 subjects were intubated, out of which, 11 were discharged, and 2 subjects expired. The probable cause of death was Myocardial infarction or pulmonary embolism in three patients and two patients had supraventricular tachycardia. The baseline ECGs were normal in these patients and the cause of death was not confirmed as we did not do autopsy in these subjects. 13 (7.3%) subjects were intubated; among them, 2 (1.3%) subjects died, and 11 (7.3%) subjects recovered and discharged.

The usefulness of the present study lies in management of patient showed that low BMI,baseline HR, RR, HCO3, SaO2 and pH and their further improvement at6th hr in patients who were put on NIPPV is very likely to be maintained at 18th hour. Improvement in PaO2 and PaCO2 levels at 6th hr compared to baseline is a indicator of NIV success. Hence these patients improved over a period of few days and were discharged from the hospital, being put on appropriate medical treatment. On the contrary, patients with high BMI and showing deterioration in HR, RR, HCO3, SaO2, pH, PaO2 and PCO2 after 6 hours of NIPPV required intubation. It is evident from the current study as well as previous studies discussed that timely initiation on noninvasive ventilation in

COPD except contraindicated can prevent endotracheal intubation and mechanical ventilation and hence associated complications.

CONCLUSION

In the present study, 88% patients (132) were managed successfully with non-invasive ventilation, 5 patients died (3.3%) and 13 patients were intubated (8.4%). Low BMI, baseline respiratory rate, heart rate, ABG variables like pH, HCO3, SaO2 and their improvement after 6 hrs of start of NIV and maintaining the improvement at 18 hrs proved to be predictors of success of non-invasive ventilation in hypercapnic patients in this study. Improvement in PaO2 and PaCo2 levels after 6 hrs of starting of NIV compared to baseline were associated with good NIV outcome. Similarly, patients with high BMI, high respiratory rate (tachypnea), heart rate (tachycardia), low SaO2, low pH, low HCO3 on ABG at baseline with no significant improvement in these parameters at the end of 6th hr of NIV showed to be predictors for failure in COPD subjects. Patients with low pH and high PaCO2 levels at the end of 6th hr of NIV likely require intubation and mechanical ventilation. The indices like low BMI, improvement in parameters like heart rate, respiratory rate, PaO2, PaCO2, pH, SaO2 and HCO3 at 6th hr are the factors predicting the success and outcome of NIV among AECOPD patients.

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