ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 6, Issue – 2, March – 2021 , Page No. : 99 - 104

Physiological Determinants of Non-Invasive Ventilation Success in Highly Susceptible COPD Individuals

[1]Dr.Brijmohan Meena, Assistant Professor, Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, India - 324005

[2]Dr.Renu Meena, Senior Resident, Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, India - 324005

[3]Dr.Anita Meena, Senior Resident, Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, India - 324005

Corresponding Author: Dr.Anita Meena, Senior Resident, Government Medical College and Associated Group of Hospitals, Kota, Rajasthan, India - 324005

Citation this Article: Brijmohan Meena, Renu Meena, Anita Meena, "Physiological Determinants of Non-Invasive Ventilation Success in Highly Susceptible COPD Individuals", IJMSIR- March - 2021, Vol – 6, Issue - 2, P. No. 99 – 104.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Chronic obstructive pulmonary disease (COPD) is a disease associated with high mortality and morbidity across the globe known to be aggravated by several factors like age, socio-economic status, lifestyle, underlying genetic causes, environmental conditions, diseases etc. Tracheal intubation and mechanical ventilation has so far been the standard therapy for such patients. The ability to predict to predict those likely to fail with NIV is crucial.

Keywords: COPD, India, NIV, Ph, PCo2

Introduction

Chronic obstructive pulmonary disease (COPD) is a disease associated with high mortality and morbidity across the globe.Several factors like age, socio-economic status, lifestyle, underlying genetic causes, environmental conditions, diseases etc. are known to aggravate/increase a persons' chances of developing COPD. Patients with end-stage COPD are offer seen to develop chronic hypercapnic respiratory failure (CHRF) often leading to death. In this stage of disease, almost all the patients experience extremely disabling symptoms of dyspnoea with limited treatment options. Patients with COPD are also prone to exacerbations with progression of their disease, which often lead to hypercapnic respiratory failure.

Usually, the progression of COPD is gradual, although the disease often presents exacerbations of respiratory symptoms requiring hospitalization. This leads to greater use of medical resources and increases direct and indirect costs. Tracheal intubation and mechanical ventilation has so far been the standard therapy for such patients. The frequency of assisted ventilation in hypercapnic respiratory failure varies from 16-35% with a significant overall mortality.

A major problem is the prolonged duration of ventilation and difficult weaning from ventilation necessitating prolonged stay in intensive care units. Non-invasive ventilation refers to the technique of augmenting alveolar ventilation without a direct

conduit to the airway. Such 3 techniques were used earlier during the polio epidemics of the last century but gradually fell into disuse. Renewal of interest in these techniques has occurred due to the availability of commercial masks and non-invasive ventilators as a spin-off of the marked explosion in the field of sleep medicine. In addition, several well-conducted studies have demonstrated the utility of this ventilator mode for patients with Type 2 respiratory failure in COPD.

Non-invasive ventilation (NIV) in the management of acute type II respiratory failure in patients with chronic obstructive pulmonary disease (COPD) represents one of the major technical advances in respiratory care over the last decade. The National Institute for Health and Clinical Excellence (NICE) recommend the NIV be available in all hospitals admitting patients with COPD. Non-invasive ventilation (NIV) refers to the provision of ventilator support through the patient's upper airway using a mask or similar device. This technique is distinguished from those which bypass the upper airway with a tracheal tube, laryngeal mask, or tracheostomy and are therefore considered invasive. The Recent critical care literature has seen an explosion of articles on non-invasive respiratory support for patients presenting to hospital with respiratory failure of diverse etiology, with numerous published randomized controlled trials (RCTs) and meta-analyses on this topic. Many advantages of using NIV include avoidance of tracheal intubation and its associated morbidity and mortality. On NIV use patients is able to eat, drink, cough and expectorate, take medication by taking break from treatment.

NIV use in now common in India. The ability to predict to predict those likely to fail with NIV is crucial. Intubation would not be delayed in a person with high risk of failure. In the current study we analysed the impact of NIV in COPD patients under the following criteria:

1. Initial pH
2. Initial pCO2

Our observations indicate an important role of each of the above mentioned factors in determining the success rate of NIV in individuals.

Materials and Methods

Study Design: The study was done in Kamla Nehru chest hospital, DR S N Medical College Jodhpur, a tertiary care centre for respiratory diseases in western part of Rajasthan, India. The study is a prospective observational study performed to evaluate the role of Non Invasive ventilation in the management of Type 2 Respiratory failures.

Sample Size

Sample size was calculated at 95% confidence level, 0.05 alpha errors, assuming 78% success of Non Invasive Mechanical Ventilation in COPD with acute respiratory failure, at 10% of relative allowable error. 110 COPD cases with acute hypercapnic respiratory failure were included in the present study.

Inclusion Criteria for the Study

A. Age above 18 years
B. Those giving informed consent
C. Hemodynamically stable
D. Conscious cooperative patient.
E. Ph45mmHg, PaO2>45mmHg, PaO2<92% with oxygen by mask
F. Primary diagnosis of COPD exacerbation

Exclusion Criteria of the study

A. Recent facial or upper airway
B. Surgeries
C. Facial burns/trauma
D. Hemodynamic instability
E. Inability to protect the airway

F. Un co-operative patients

G. Severe co-morbidity

Results

NIV has been established as a useful therapy for the management of respiratory failure in acute exacerbation of COPD. NIV is more important in resource limited countries like India where cost is a major factor.

A total 110 patients were included in the present study with 88 males and 22 females. Mean age of the population was 60.6+8.6 years. Maximum number of patients was in the age group of 60-69 years in both males and females.

1) Importance of Initial pH on NIV

In the present study we took patients with initial pH range of 7.21- 7.35. These patients were divided into three groups of pH, 7.21-25, 7.26- 7.30 and 7.31-7.35. Mean pH of the patients were 7.28+0.036. Success rate of NIV was significantly better in patients with pH between 7.26-7.30 (86.6%) and pH 7.31 -7.35 (85.7%) as compared to those with severe 78 acidosis pH 7.21 – 7.25 (40.7%). This difference was found to be statistically significant (P <0.001).

Acidosis is an indicator of a more severe form of COPD and has been shown to predict mortality in acute exacerbations of COPD. Although using a discriminant analysis a number of variables such as neurological status, baseline pH, PaCO2 and pH during NIV had a predictive value of >0.80 for successful NIV, when tested together using logistic regression analysis only baseline pH maintained a significant predictive effect with a sensitivity of 97% and specificity of 71%. Although NIV is less likely to be effective when patients are more acidotic but the patients should be given a trial of NIV as the advantages are more.

Also subjects with successful outcome of NIV showed gradual increase in mean pH from 7.29 at start to 7.32 after 3 hours and this increase was statistically significant (P P<0.001), whereas patients with NIV failure showed a significant decrease in mean pH form 7.259 to 7.25 after 3 hours (P<0.05).

Table 1: Distribution of study subjects according to initial pH

pH at start	Male		Female		Total	
	N	%	N	%	N	%
7.21-7.25	19	21.59	5	22.73	24	21.82
7.26-7.30	45	51.14	11	50.00	56	50.91
7.31-7.35	24	27.27	6	27.27	30	27.27
Total	88	100.00	22	100.00	110	100.00

[Chi square= 0.014 & 2 df; p value 0.992 (NS)]

Table 2: Outcome of NIV in relation to initial pH

pH at start	Success		Failure		Total	
	N	%	N	%	N	%
7.21-7.25	8	33.33	16	66.67	24	100.00
7.26-7.30	46	82.14	10	17.86	56	100.00
7.31-7.35	26	86.67	4	13.33	30	100.00
Total	80	72.73	30	27.27	110	100.00

[Chi square= 24.22 & 2 df; p value <0.0001(HS)]

Our findings indicate that success rate of NIV was significantly better in patients with pH between 7.31-7.35 (86.67%) and pH 7.26-7.30 (82.14%) as compared to those with server acidosis pH 7.21 – 7.25 (33.33%). This difference was found to be statistically significant at P<0.001; i.e. Outcome of NIV was found to be successful in patients with better pH values at the start.

2) pCO2 is crucial in determing success of NIV:

In the present study, we took patients with PaCO2>50 mm Hg. Patients were divided in four groups on basis of initial PaCO2. Mean PaCO2 of the study patients at start was 71.90+10.89 mm Hg. 16 patients. (14.55%) had initial PaCO2 The success rate of NIV was highest in patients with pCO2 80mm Hg (36%). This difference was found to be statistically significant (P <0.05); i.e. the outcome of NIV was found to be significantly

associated with initial pCO2. Outcome of NIV was more likely to be successful in patients with lower initial pCO2. The subjects with successful outcome of NIV showed gradual decrease in mean pCO2 from 69.07 mm Hg to 64.19 mm Hg after 3 hours and this decrease was statistically significant Patients with NIV failure showed significant increase in mean pCO2 from 80.57 to 84.54 mm Hg after 3 hours (P<0.001).

Table 3: Distribution of study subjects according to initial pCO2

Initial pCO2 (mmHg)	Male		Female		Total	
	N	%	N	%	N	%
≤60	13	14.77	3	13.64	16	14.55
61-70	36	40.91	9	40.91	45	40.91
71-80	23	26.14	4	18.18	27	24.55
>80	16	18.18	6	27.27	22	20.00
Total	88	100.00	22	100.00	110	100.00

[Chi square= 1.197 & 3 df; p value 0.753(NS)]

Table 4: Outcome of NIV in relation to initial pCO2

pCO2 at start	Success		Failure		Total	
	N	%	N	%	N	%
≤60	16	100.00	0	0.00	16	100.00
61-70	36	80.00	9	20.00	45	100.00
71-80	20	74.07	7	25.93	27	100.00
>80	8	36.36	14	63.64	22	100.00
Total	80	72.73	30	27.27	110	100.00

[Chi square= 24.89 & 3 df; p value <0.0001(HS)]

Table 3 reveals that most of the females (40.9%) had initial pCO2 60- 70 mm Hg and 27.27% had pCO2 (>80) mm Hg whereas 40.91% of the male subjects had pCO2 60-70 mm Hg and 26.14% males had pCO2 71-80 mm Hg. Male and female subjects were comparable in relation to their initial pCO2 (P=0.753).

Table 4 shows that success rate of NIV was highest in patients with pCO2<60 mm Hg (100%) and gradually decreases with increase in pCO2.This difference was found to be statistically at P<0.05; i.e. Outcome of NIV was more likely to be successful in patients with lower initial pCO2.

Discussion

The use of NIV in general respiratory wards is both feasible and clinically effective at reducing the demand for invasive ventilator support and the in-hospital mortality associated with acute ventilator failure in patients with a clinical diagnosis of COPD. The monitoring require is much lesser than in cases of invasive mechanical ventilation. There is an easier learning curve for the use of NIV compared to that of invasive mechanical ventilation, both for the nursing staff and also for the doctors. NIV may also help to reduce the number of days of admission and it reduces complication of invasive mechanical ventilation like ventilator acquired pneumonia. But, NIV use is limited due to various reasons.

Date available at the time NIV is initiated and after a short period can predict the likelihood of success or failure with a reasonable degree of precision. Acidosis at start, higher levels of pCO2 higher pulse rate, and history of mechanical ventilation may be used to as parameters which could predict NIV failure. Patients with number of these factors may be admitted to the ICU and arrangements made for Invasive mechanical ventilation if need arises, and those with none may be kept in the ward under close observation. We propose that patients who have a pH of less than 7.25 and a pCO2 more than 72.5 are better managed in the ICU, whereas those with better parameters may be managed in the ward under close supervision. In patients in the latter group, those who tolerate NIV and those who show improvement of pH, pCO2 after 1 hour may be continued in the ward. Patients with lower pH and higher pCO2 also may be given trial of NIV, but ideally they should be admitted to the ICU with close

monitoring of vitals and arrangements made for IMV in the need arises.

Conclusion

NIV is a cost effective intervention in acute exacerbation of COPD with hypercapnic respiratory failure. Effective use of NIV results in fewer complications, shorter length of hospital stay, and lower mortality. The need for mechanical ventilation is also reduced. In a low resource setting as we find in our country, admission practices to wards and ICU is usually made arbitrarily. Hence, we propose few parameters which may help in predicting the outcome of NIV in these patients. Patients who have had a history of mechanical ventilation in the past, should be considered high risk and be under close supervision irrespective of their pH and pCO2 . We propose that patients who have a 2 pH of less than 7.25 and a pCO more than 72.5 are better managed in 2 the ICU, whereas those with better parameters may be managed in the ward under close supervision.

Acknowledgement

Authors wish to thank Dr. Shailendra Vashistha, MD (Assistant Professor, Department of IH&TM, Govt. Medical College, Kota) and VAssist Research (www.thevassist.com) for their contribution in manuscript preparation.

References

1. Celli BR, Machnee W, ATS/ERS Task Force. Standards for the diagnosis and treatment of patients with COPD: A summary of the ATS/ERS position paper. Eur Respir J. 2004;23:932-46.2

2. Medical research council working party report. Long term domiciliary oxygen therapy in chronic hypoxic corpulmonale complicating bronchitis and emphysema. Lancet.1981;1:681-5.

3. Mccrory DC, Brown C, Gelfand SE, Bach PB. Management of acute exacerbations of COPD: A summary and appraisal of published evidence. Chest. 2001;119:1190-209.

4. Plant PK, Elliot MW. Chronic obstructive pulmonary disease: Management of ventilator failure in COPD. Thorax. 2003;58:537-42.

5. Seneff MG, Wagner DP, Wagner RP. Hospital and 1-year survival of patients admitted to intensive care units with acute exacerbations of chronic obstructive pulmonary disease. JAMA. 1995;274:1852-7.

6. Keith RL, Pierson DJ. Complications of mechanical ventilation: A bedside approach. Clin Chest Med. 1996;17:439-52.

7. National collaborating centre for chronic conditions. Chronic obstructive pulmonary disease: National clinical guideline on management of chronic obstructive pulmonary disease in adults in primary and secondary care. Thorax. 2004;59(Suppl 1):1-232.

8. Scarpazza P, Incorvaia C, Franco G. Effect of noninvasive mechanical ventilation in elderly patients with hypercapnic acute-on-chronic respiratory failure and a do-notintubate order. Int J COPD. 2008;3(4):797-801.

9. Taga S. Predictors of the need to initiate noninvasive ventilation in stable outpatients with acute exacerbation of chronic obstructive pulmonary disease. Intern Med. 2013;52(16):1781-6.

10. Malaughlim KM, Murray IM, Thain G, Currie GC. Ward-based non-invasive ventilation for hypercapnic exacerbations of COPD: A real-life perspective. Q J Med. 2010;103:505-10.

11. Ambrosino N, Foglio K, Rubini F. Non-invasive mechanical ventilation in acute respiratory failure due to chronic obstructive airways disease: Correlates for success. Thorax. 1995;50:755-7.

12. Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti, G Rauss A, et al. NIV for acute exacerbations of chronic obstructive pulmonary disease. N Engl J Med. 1995;333:817-22.

13. Bhatt SP, Peterson MW, Wilson JF, Durairaj L. Noninvasive positive pressure ventilation in subjects with stable COPD. Int J of COPD. 2013;8:581-9.

14. Hasegawa W, Yamauchi Y, Yasunaga H, et al. Factors affecting mortality following emergency admission for chronic obstructive pulmonary disease. BMC Pulm Med. 2014;14:151.

15. Fagon JY, Chastre J, Hance A, Montravers P, Novara A,Giber C. Nosocomial pneumonia in ventilated patients: a cohort study evaluating attributable mortality and hospital stay. Am J Med. 1993;94:281-7.

16. Benhamou D, Girault C, Faure C, et al. Nasal mask ventilation in acute respiratory failure. Chest. 1992;102:912-7.