Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 04, 2024

Comparison of invasive andnoninvasive ventilation in acute exacerbation of COPD patients for ease of ventilation and weaning

Dr Ranjita Mohanty[1],Dr Geetanjali Panda[2],Dr Ramachandra Sahoo[3],Dr Rajesh Kumar Sahu[4]

[1]Associate Professor, Departmentof Anaesthesiology,Shri Jagannath Medical College,Puri

[2] Prof and HOD, Department of Respiratory Medicine,PGIMER and Capital Hospital,Bhubaneswar

[3]Senior Resident**,**Department of Anaesthesiology,Shri Jagannath Medical College,Puri

[4]Assistant Prof. Department of Anaesthesiology, Jajati Keshari Medical College, Jajpur

Corresponding Author:Dr Rajesh Kumar Sahu, Assistant Prof. Department of Anaesthesiology, Jajati Keshari Medical College, Jajpur ,Odisha

Abstract:

Aim: Acute exacerbation of the COPD can lead to respiratory failure which may requires assisted mechanical ventilation. But invasive mode of ventilation is usually associated with various complications like weaning failure, lengthy hospital stay and more mortality and morbidity. So wecompared noninvasive and invasive mechanical ventilation and their clinical outcome.

Material & methods: 60 patients with acute exacerbation of COPD were randomized in to two groups of 30 each. One group received Non Invasive Ventilation (NIV) and other group received Invasive Mechanical Ventilation (IMV). Ease of ventilation was studied by serial estimation of tidal volume (TV), respiratory rate (RR), pressure support needed (PC above PEEP), PaCO2, pH at 0 , 4th ,12th, 24th , 48th hr of mechanical ventilation and at the beginning of weaning.

Results: The mean tidal volume requirement was more in NIV group when compared to IMV group. Mean of Respiratory rate at the time of admission in NIV group was high, and there was gradual reduction in respiratory rate over time. At the time of admission mean PaCO2, PaO2 and PH were not statistically significant in both the groups but with time the improvement in PaCO2 was better in IMV group when compared to NIV group.

Conclusion: NIV leads to significant improvement in pulmonary parameters and it reduces duration of ventilation and total period of hospital stay, so it can be used as an alternative to invasive ventilation as first-line treatment in COPD.

Key words: COPD, invasive, noninvasive,ventilation,weaning

Introduction

Acute respiratory failure is a major complication of chronic obstructive pulmonary disease (COPD) that severely affects the health of the patient with increase in hospital admission and may require mechanical ventilation. It is characterized by airflow limitation not fully reversible, progressive in nature, and usually associated with inflammatory response of lungs to noxious particles in the air, for example, bronchitis and emphysema.Estimates from WHO's Global Burden of Disease and Risk Factors project show that, COPD is the fifth leading cause of death in high-income countries and the sixth leading cause of death in nations of low and middle income,

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 04, 2024

accounting for 4.9% of total deaths. Crude estimates suggest there are 30 million COPD patients in India.[1] India contributes a significant and growing percentage of mortality due to COPD which is estimated to be amongst the highest in the world (>20%) .There is no permanent cure for COPD, but the symptoms are treatable and its progression can be delayed by pulmonary rehabilitation, bronchodilators,corticosteroids and antibiotics.Acute exacerbation of the COPD can cause respiratory failure which requires ICU admission and invasive mechanical ventilation. Invasive mechanical ventilation has its limitations because of complications like infection and also difficulty in weaning the patient. This causes increase in the morbidity and mortality rate. Non invasive ventilation is a recently developed tool in managing respiratory failure due to acute exacerbation of COPD and has shown to have good outcomes in terms of reduction in mortality, need for intubation and mechanical ventilation and decreased duration of stay in the hospital. This study was conducted to compare the ease of ventilation, weaning, and outcome by using noninvasiveand invasive ventilation in acute exacerbation ofCOPD patients.

Material & methods

A prospective randomised non blind study was undertaken in 100 patients of either sex, age group 30 to 75 with acute exacerbation of COPD of moderate to severe degree on clinical and % predicted PEFR measurement basis, admitted to ICU of a tertiary care hospital. Informed consent from patients were taken and written permission from hospital ethical committee was obtained. On admission, each patient was thoroughly evaluated and the following patient data were collected: sex, age, weight and comorbidities.Severity of illness was assessed using Acute Physiology and Chronic Health Evaluation (APACHE II) score on admission. Patients were randomized in totwo groups. One group received Non Invasive Ventilation (NIV) and other group received Invasive Mechanical Ventilation (IMV). Pressure Control (PC mode) mode was used for maintenance and Pressure support (PS mode) mode was used for weaning of the patients on IMV group. Similarly NIV (PC) mode was used for maintenance and NIV (PS) mode was used for weaning of the patients on NIV group. Ease of ventilation was studied by serial estimation oftidal volume (TV), respiratory rate (RR), pressure support needed (PC above PEEP), PaCO2,pH at 0 , 4th ,12th, 24th , 48th hr of Mechanical ventilation and at the beginning of weaning .Ease of weaning was studied in terms of time needed for weaning, number of weaning trials attempted and percentage of weaning failure. Patients of age <30 yrs &>75 yrs, with history of liver, heart & kidney diseases and neuromuscular diseases were excluded from study. During ICU stay, patients received all necessary treatment required by their condition. All laboratory and clinical parameters were evaluated and corrected if necessary. All complications relating to invasive and non invasive ventilation were noted. For statistical analysis, IBM SPSS Statistics for window version 21 was used. Categorical variables were presented as frequencies and percentage continuous variables presented as mean and standard deviation. Chi-square test was used for categorical variables and independent student *t*-test for quantitative variables. $P < 0.05$ was taken as statistically significant.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 04, 2024

Results

Out of 100 patients, as per exclusion criteria 40 patients were excluded (28 patients died, 8 patients developed corpulmonale,4 patients converted from NIV to IMV).Remaining 60 patients were divided in to two groups IMV and NIV.

Table 1: Ease of ventilation

Variables	VT		RR		PS		P-Value
	IMV	NIV	IMV	NIV	IMV	NIV	
AT Admission	326.93	481.83	14.33	23.03	12.17	17.53	P < 0.001
AT 4 HRS	347.3	491.67	13.93	20.2	11.6	16.23	P < 0.001
AT 12 HRS	357.67	523.67	14.37	16.27	11.07	15.27	P < 0.001
AT 24 HRS	387.1	540.33	13.87	16	11.07	15.23	P < 0.001
AT 48HRS	405.07	542.67	12.77	15.9	9.67	14	P < 0.001
Weaning	427.1	582	12.23	14.77	8.03	10.1	P < 0.001

The mean tidal volume requirement was more in NIV group when compared to IMV group. Mean of Respiratory rate at the time of admission in NIV group was 23.03, and there was gradual reduction in respiratory rate over time, at 48 hrs it was 15.9 and at weaning it was 14.77(p value <0.001) but in IMV groupat admission the mean of respiratory rate in IMV group was 14.33 and at weaning mean respiratory rate was 12.23 (p value < 0.001).At admission the mean of pressure support required for NIV was 17.53 cm of H2O, when compared to IMV it was 12.17 cm of H2O (p value < 0.001) throughout the ICU stay the mean of pressure support requirement was more for patients in NIV group. At weaning mean pressure requirement in NIV group was 10.1 cm of H2O but in IMV group it was 8.03 cm of H2O.Ease of ventilation when compared on the basis of tidal volume (VT), respiratory rate (RR) and pressure support (PS) p value was found to be highly significant (p value < 0.001).

Table 2: pH and PaCO2 trend

PaCO2				pH		
	IMV	NIV	p-Value	IMV	NIV	p-Value
At Admission	117.7	114.8	0.35	7.26 ± 0.03	7.26 ± 0.03	1

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 04, 2024

At 4 Hrs.	90.73	104.43	p < 0.001	7.30 ±0.03	7.25 ± 0.02	p < 0.001
At 12 Hrs.	81.8	95.13	p < 0.001	7.34 ± 0.03	7.31 ± 0.02	p < 0.001
At 24 Hrs.	71.2	84.7	p < 0.001	7.35 ± 0.02	7.32 ± 0.01	p < 0.001
At 48 Hrs.	64.1	80.1	p < 0.001	7.36 ± 0.02	7.33 ±0.01	p < 0.001
At Weaning	54.73	60.07	p < 0.001	7.38 ± 0.03	7.33 ± 0.01	p < 0.001

Table 3: PaO2 trend

	IMV	**NIV**
At Admission	61.43	65.2
At 4 Hrs.	79.97	82.77
At 12 Hrs.	94.77	99.17
At 24 Hrs.	102.33	107.13
At 48 Hrs.	108.87	110.9
At Weaning	108.5	110.9

At the time of admission mean PaCO2, PaO2, and pH were not statistically significant in both the groupsbutwith time the improvement in PaCO2 was better in IMV group when compared to NIV group (p value < 0.001) and the correction of ph was rapid in IMV group when compared with NIV group.(p value <0.001). Patients on IMV needed more time for weaning when compared to NIV group. More number of weaning attempts were required in IMV group.In IMV group out of 30 patients 8 patients (26%) had complications but in NIV group only 2 patients (6%) showed compilcations. Duration of stay in ICU in IMV group was 7 days which was more than NIV group i.e 5 days.

Table 4: Ease of weaning

Variables	IMV	NIV	p-Value
Time needed (Days)	4 ±0.79	2 ± 0.66	P<0.001
No. of Trials	2 ± 0.67	1 ± 0.35	P<0.001
Weaning Failure	34%	6.8%	P<0.001
Complications	26.67%	6.67%	0.038
Days in ICU	7	5	

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 04, 2024

Discussion

COPD is one of several chronic diseases that are becoming increasingly problematic worldwide. Their increasing burden and monetary cost are a particular risk to low- and middle-income countries. COPD is predicted to become the third leading cause of death worldwide by 2030. In our study the ease of ventilation in both the groups were compared on the basis of ventilator parameters (respiratory rate, tidal volume, pressure support required) and pulmonary biochemistry parameters (ph , Paco2).In our study the mean tidal volume requirement was more in NIV group than IMV group i.e at admission in IMV group it was 325.93 ml in NIV group it was 481.83 ml , at weaning the tidal volume requirement in NIV group was 582 ml and in IMV group it was 427.1 ml with (pvalue< 0.001).In contrast,Ivo Matic et al [5]showed the tidal volume requirement 1 hour after admission in IMV group was 500ml and in NIV group was 330 ml (p value < 0.001) and at 48 hrs tidal volume requirement in NIV group was 400ml and in IMV group was 540 ml (p value < 0.001), in this study the tidal volume requirement for IMV group was more than NIV group.In present study , the mean of Respiratory rate at the time of admission in NIV group was 23.03/min, and there was gradual reduction in respiratory rate over time, at 48 hrs it was 15.9/min and at weaning it was 14.77/ min. but in IMV group the variation in respiratory rate was less , at admission the mean of respiratory rate in IMV group was 14.33/ min and at weaning mean respiratory rate was 12.23/ min (pvalue < 0.001).Similar results were found in studies by IvoMatic et al[5].In this study, at admission the mean of pressure support required for NIV was 17.53 cm of H2O, when compared to IMV it was 12.17 cm of H2O. The mean of pressure support requirement was more for patients in NIV group. At weaning mean pressure requirement in NIV group was 10.1 cm of H2O but in IMV group it was 8.03 cm of H2O, with p value < 0.001. No studies are there,where there is comparison of pressure support between both the groups. At the time of admission mean PaCO2 in IMV group was 115.7 mm of Hg and in NIV group was 114.8 mm of Hg which was statistically not significant (p value= 0.35) ,with time the improvement in PaCO2 was better in IMV group when compared to NIV group (p value was < 0.001) i.e highly significant.In other studies likeIvo Matic et al[5],Phua J et al[6]and Tsai et al[7],NIV was better in terms of improvement in Paco2.Mean ph at the time of admission in both the groups are similar i.e7.26± 0.03 (p value 1)the correction of ph was rapid in IMV group when compared with NIV group. At weaning the mean ph was 7.38± 0.03in IMV group, in NIV group it was 7.33 ± 0.01. (p value <0.001).Brochard et al[8]in a multicentric study, conducted on 85 COPD patients reported rapid improvement in PaO2, and slower correction of PaCO2. Even so, they conclude that NIV is not a good choice for patients with COPD because only 29% of patients in their study were suitable for successful NIV. They recommend that NIV can only be considered as an alternative procedure to IMV.In other studies like Ivo Matic et al[5],Phua J et al [6] and Tsai et al [7]NIV was better in terms of improvement in ph.In our study ease of weaning in both IMV and NIV group were compared on the basis of time needed for weaning (in days), no of trials attempted, weaning failure and complications encountered.Time needed for weaning in IMV group was 4 days ±0.76 when compared to NIV group it was 2 days± 0.66. Patients on mechanical ventilator needed more time

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 04, 2024

for weaning when compared to NIV group.In IMV group out of 30 patients 8 patients (26%) had complications but in NIV group only 2 patients (6%) showed compilcations.According to study by Ivo Matic et al [5],NIV had proven superiority than IMV in terms duration of total ICU length of stay and the need for tracheostomy in facilitating the weaning process. Furthermore, hospital pneumonia was recorded in only 2 patients in NIV group compared to 12 in the IMV group. But no statistical difference in mortality rates was recorded between groups. This was possibly due to relatively small sample size but also because most severe patients have similar mortality rates. Keenan et al [9] in their study confirmed the superiority of NIV over IMV in patients with acute exacerbation of COPD, reduces the need for endotracheal intubation , lowers mortality rate from 15% to 10% and reduces duration on ventilator from 6.83 to 4.57 days.Brochard et al [8] in a multicentric study showed patients randomized for NIV had significantly lower intubation rates, less complications (14%:45%, p <0.001) and reduced mortality (9%:29%, p=0.02), as well as shorter hospital treatment duration (23±17:35±33 days, p =0.02).Most recently Ferrer et al[10] randomized 43 patients who had failed 3 consecutive T-piece SBTs to either NIV (minimum of 24 h) or conventional weaning. NIV weaning was associated with shorter duration of invasive ventilation (9.5 vs 20.1 d), shorter ICU stay (14 vs 25 d), shorter hospital stay (28 vs 49 d), fewer tracheotomies (5 vs 59%), better ICU survival (90 vs 59%), fewer reintubations (14 vs 27%), and a lower incidence of nosocomial pneumonia and septic shock. Similar result also had shown by Girault et al [11] . Our results are different from the study done by Devi *et al.* They found better improvement in PaCO2 in IMV whereas better improvement in PaO2 in NIV group over 24 h.

Conclusion

Early initiation of noninvasive positive pressure ventilation leads to improved patient outcome and should be used as an alternative to conventional IMV to avoid complications of intubation. It should be used as first-line treatment of acute respiratory failure.

References

1. Global initiative for Chronic Obstructive Lung Disease, Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease NHLBI/WHO workshop report. National Institutes of Health, National Heart, Lung, and Blood Institute. 2013; 2014. Report No.: 2701
2. Jindal SK1, Aggarwal AN, Chaudhry K, Chhabra SK, D'Souza GA, Gupta D, Katiyar SK, Kumar R, Shah B, Vijayan VK; Asthma Epidemiology Study Group, Indian J Chest Dis Allied Sci. 2006 Jan-Mar;48(1):23-9
3. Meduri GU, Turner RE, Abou-Shala N, Wunderink R, Tolley E. Noninvasive positive pressure ventilation via face mask: first-line intervention in patients with acute hypercapnic and hypoxemic respiratory failure. Chest 1996;109(1):179–193
4. Vitacca M, Ambrosino N, Clini E, Porta R, Rampulla C, LaniniB,Nava S. Physiological response to pressure support ventilation deliveredbefore and after extubation in patients

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 04, 2024

not capable of totallyspontaneous autonomous breathing. Am J RespirCrit Care Med2001;164(4):638–641

5. Matic I, Majeric-Kogler V, Sakic-Zdravcevic K, Jurjevic M, Mirkovic I, Hrgovic Z. Comparison of Invasive and Noninvasive Mechanical Ventilation for Patients with COPD:Randomised Prospective Study. Indian J Anaesth 2008;52:419
6. Phua J, Kong K, Lee KH, Shen L, Lim TK.n Intensive Care Med. 2005 Apr;31(4):533-9. Epub 2005 Mar 2.
7. Tsai CL, Lee WY, Delclos GL, Hanania NA, Camargo CA Jr. J Hosp Med. 2013 Apr;8(4):165-72.
8. Brochard L, Rauss A, Benito S, Conti G, Mancebo J, Rekik N, etal. Comparison of three methods of gradual withdrawal from ventilator support during weaning from mechanical ventilation. Am JRespirCrit Care Med 1994;150(4):896–903.
9. Keenan SP, Sinuff T, Cook DJ, Hill NS. Which patients with acuteexacerbation of chronic obstructive pulmonary disease benefit fromnoninvasive positive-pressure ventilation? A systematic review ofthe literature. Ann Intern Med 2003;138(11):861–870
10. Ferrer M, Esquinas A, Arancibia F, Bauer TT, Gonzalez G, Carrillo A, et al. Noninvasive ventilation during persistent weaning failure: a randomized controlled trial. Am J RespirCrit Care Med 2003;168(1):70–76
11. Girault C, Daudenthun I, Chevron V,Tamion F, Leroy J, BonmarchandG. Noninvasive ventilation as a systematic extubation and weaning technique in acute-on-chronic respiratory failure: a prospective, randomized controlled study. Am J RespirCrit Care Med 1999;160(1):86–92
12. Devi P, Raja R, Kumar R, Shah A, Ansari SI, Kumar B. Invasive versus non-invasive positive pressure ventilation in chronic obstructive pulmonary disease complicated by acute respiratory failure. *Cureus.* 2019;11:e5418