Role of Bi-Pap in Acute Respiratory Failure due to Acute Exacerbation of COPD

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Abstract

Objective: To assess the efficacy of Bi-level Positive Airway Pressure (Bi-pap), administered by nasal mask in patients with acute respiratory failure due to acute exacerbation of COPD.
Design: Prospective non-randomized study in a hospital setting.
Methods: Eighteen patients were recruited from those admitted in the Chest Unit of Jinnah Postgraduate Medical Centre, Karachi with acute exacerbation of COPD. Alongwith conventional treatment, Bi-pap was administered by a nasal mask. Arterial blood gas analysis, respiratory and heart rate and subjective sensation of dyspnoea, before and during Bi-pap application were monitored.
Results: The respiratory rate decreased from 33.2±5.3/mm to 22.0±3.5 (P<0.001), heart rate also decreased from 113.2±7.6/mm to 90.2±11.9 (P<0.001). A rise in pH was observed from 7.2±0.09 to 7.4±0.06 (P>0.41 n.s.), PaCO2 decreased from 76.5±15.5 to 51 .3±1 0.5 (P<0.001). PaO2 also increased from 52.1±14.3 to 62.9±11.5 (P<0.01). The mean hospital stay was shorter i.e., 10.6±5.6 days and the hospital mortality rate 11.1%. Bi-pap administered by nasal mask was generally well tolerated with few minor complications.
Conclusion: Bi-pap is particularly useful in patients presenting with acute respiratory failure due to acute exacerbation of COPD particularly in our setting where invasive ventilation is not easily available (JPMA 51 :414,2001).

Introduction

Chronic obstructive pulmonary disease is the fifth commonest chronic disease worldwide[1] and is a major cause of morbidity and mortality. According to the World Health Organization estimates, COPD kills 2.9 million people a year with cigarette smoking being a single major contributory cause[2,3]. Although the exact prevalence of COPD in Pakistan is not known but the prevalence of smoking reported to be 21 .6%[4].

Patients of COPD during acute exacerbation often develop ventilatory failure and need hospitalization. Many of them need assisted ventilation via endotracheal intubation, which has been the standard means of administering ventilatory assistance to these patients. Following endotracheal intubation complications occur both during intubation and after extubation which include nosocomial pneumonia, barotrauma, laryngeal and tracheal injury[5,6]. For endotracheal intubation a well equipped Intensive Care Unit along with well trained personnel is necessary apart from heavy finances. In developing countries, the government sector is unable to provide these types of facilities to all patients and many patients die due to lack of access to ICUs.

To avoid endotracheal intubation and complications associated with it, non invasive positive pressure ventilaton (NIPPV) has been used in selected patients of acute respiratory failure, due to exacerbation of COPD. NIPPV is administered via a nasal or oronasal mask. It has several advantages over endotracheal intubation, in that airway defence mechanism, speech and swallowing functions are left intact, trauma to the larynx and trachea is avoided and patient comfort may be improved[7]. Studies have shown that the use of NIPPV in patients of acute respiratory failure, with exacerbation of COPD has decreased the need for endotracheal intubation and reduced the length of hospital stay and mortality rate[5,8].

The present study was done to assess the efficacy of Bi-pap administered by nasal mask in patients suffering from acute respiratory failure due to acute exacerbation of
COPD.

Patients and Methods

Eighteen patients were recruited from those admitted in the Chest Unit of JPMC, Karachi with acute respiratory failure, due to acute exacerbation of COPD, who fulfilled the following, criteria: Dyspnoea lasting for less than 2 weeks plus any two of the following criteria i.e. respiratory rate of more than 25 breaths/minute, PaO2 of less than 60 mmHg at room air, $PaCO_2$ more than 45 mmHg or pH less than 7.38.

Exclusion criteria included respiratory rate of less than 12 breaths/minute, respiratory arrest or need for immediate intubation, cardiac arrest within the previous five days, cardiogenic pulmonary oedema, hypotension (systolic BP <90 mmHg), psychiatric illness, upper airway obstruction, respiratory diseases other than COPD or inability to co-operate.

Informed consent was obtained from the patients and if they were too ill from the relatives and demographic data was recorded in a proforma.

Bi-Pap was administered via a tightly fitted nasal mask and conventional treatment was started which included bronchodilator, steroid, antibiotic and supplemental 02. Inspiratory positive airway pressure (Ipap) was set at 10 cmH2O and Expiratory positive airway pressure (Epap) was set at 5 cmH_2O.

Respiratory rate and heart rate were recorded and arterial blood gases were measured immediately before starting Bi-pap. The patients were asked to report their sensation of dysponea as improved, unchanged or worse before and after Bi-pap breathing.

Bi-pap was maintained continuously during the first 24 hours until clinical and oxygenation status had improved. When significant improvement was achieved the duration of Bi-pap was reduced progressively. Bi-pap was withdrawn when clinical stability had been acquired.

Changes in respiratory rate, heart rate and arterial blood gases at 0, 3,12, 24, 48 and 72 hours were evaluated alongwith the sensation of dyspnoea and degree of compliance. The comparison of means among different groups were analyzed by student ‘t’ test. Statistical values were taken as significant for $P<0.05$, otherwise nonsignificant.

Results

A total of 18 patients were recruited in this study. There were 13 males and 5 females whose ages ranged between 45 and 80 years (mean age 60.± 10.2 years) (Table 1).

Table 1. Demographic characteristics of patients and outcome.

No.	Age (Years)	Sex	Outcome
1	80	M	Improved and discharged
2	60	M	Improved and discharged
3	60	M	Improved and discharged
4	45	F	Improved and discharged
5	65	M	Improved and discharged
6	65	M	Improved and discharged
7	70	F	Improved and discharged
8	55	M	Improved and discharged
9	50	M	Improved and discharged
10	70	M	Improved and discharged
11	55	F	Intubated
12	50	M	Expired
13	45	F	Improved and discharged
14	55	F	Improved and discharged
15	80	M	Improved and discharged
16	55	M	Improved and discharged
17	60	M	Improved and discharged
18	60	M	Expired

The respiratory rate and heart rate decreased in 17 patients and increased in one patient (Table 2).

Table 2. Physiologic measurements.

No.	H.R.			R.R.			Feeling of dyspnoea
	I	A:3 Hrs	F	I	A:3 Hrs	F	
1	106	90	82	48	30	22	ϕ
2	104	98	83	32	28	20	ϕ
3	118	100	80	28	22	22	ϕ
4	115	96	82	32	26	18	ϕ
5	120	106	78	28	22	18	ϕ
6	111	100	84	30	22	20	ϕ
7	116	102	82	34	28	20	ϕ
8	120	100	86	32	26	22	ϕ
9	116	105	90	38	30	20	ϕ
10	90	82	80	35	22	18	ϕ
11	120	122	122	26	27	27	ψ
12	118	108	96	35	30	25	ψ
13	120	116	108	30	26	20	ϕ
14	108	106	92	26	24	20	ϕ
15	112	80	80	35	26	22	ϕ
16	116	104	100	36	30	24	ϕ
17	110	100	100	40	34	30	ψ
18	118	110	100	34	30	28	ψ
Mean ± SD	113.22±7.67	101.39±10.37	90.27±11.94	33.28±5.37	26.83±3.5	22.0±3.51	ϕ77.77% ψ 22.22%

I:	Initial	A:3 Hrs:	After 3 hours
F:	Final	HR:	Heart rate
RR:	Respiratory rate	ϕ:	Improved
ψ:	Unchanged		

The average respiratory rate and heart rate significantly decreased after three hours of Bi-pap administration and progressive decline was observed at the end (Table 3). The sense of dyspnoea decreased in 14 patients after one hour of breathing by Bi-pap but 4 patients did not feel any change (Table 2).

The arterial pH rose from 7.2±0.09 to 7.3±0.07 ($P<0.001$) after 3 hours and further rise was observed at the end i.e., 7.4±0.06 ($P>0.41$ n.s.) (Table 3).

Table 3. Physiologic measurements before starting Bi-Pap (Initial) after 3 Hours (A:3 Hrs) and at end of it (Final).

	Initials	A:3 Hrs	Final
HR	113.2±7.67	101.39±10.37	90.27±11.94
		P<0.001	P<0.001
RR	33.28±5.37	26.83±3.5	22.00±3.51
		P<0.001	P<0.001
pH	7.25±0.09	7.38±0.07	7.43±0.06
		P<0.001	P>0.41 (N.S.)
PCO_2	76.59±15.58	59.44±16.67	51.36±10.51
		P<0.002	P<0.001
PO_2	52.17±14.35	56.67±10.12	62.98±11.58
		P>0.28	P<0.01

The $PaCO_2$ fell from 76.5±15.5 to 59.4±16.67 (P<0.002) after 3 hours and further fall was observed at the end i.e., 51.3±0.5 (P The PaO2 rose from 52.1±14.3 to 56.6±10.1 (P>0.28) after 3 hours and further rise was observed at the end i.e. 62.9±11.58 (P<0.01) (Table 3). The individual changes in blood gas levels are shown in Table 4.

Tabale 4. Arterial Blood Gas Levels of Individual Cases before Starting Bi-pap (Initial) After 3 Hours (A:3 Hrs) and at end of it (Final).

No.	pH			PCO_2			PO_2		
	I	A:3 Hrs	F	I	A:3 Hrs	F	I	A:3 Hrs	F
1	7.28	7.51	7.51	71.0	47.0	49.0	39.3	43.0	47.0
2	7.39	7.49	7.50	88.0	69.0	52.0	45.0	55.6	78.0
3	7.13	7.27	7.41	89.8	69.5	53.9	36.0	40.0	46.0
4	7.26	7.40	7.40	69.0	50.0	50.0	50.7	67.0	67.0
5	7.19	7.38	7.38	47.0	35.0	35.0	48.0	57.0	57.0
6	7.26	7.33	7.46	79.0	56.0	38.0	52.0	60.0	64.6
7	7.22	7.33	7.50	65.4	50.0	42.0	57.0	57.0	60.0
8	7.26	7.34	7.34	77.0	63.0	63.0	49.0	62.0	62.0
9	7.14	7.42	7.50	83.0	57.0	49.0	35.0	51.2	60.0
10	7.38	7.44	7.44	52.0	39.0	39.0	68.0	74.0	74.0
11	7.27	7.35	7.35	55.0	66.7	66.7	53.0	47.0	47.0
12	7.26	7.39	7.41	82.0	56.0	51.0	52.0	50.0	57.0
13	7.33	7.34	7.44	109.0	106.0	67.0	77.0	77.0	66.0
14	7.28	7.28	7.39	77.0	76.0	55.0	38.0	45.0	81.8
15	7.13	7.45	7.45	96.0	36.0	36.0	86.0	55.0	55.0
16	7.16	7.29	7.32	84.9	61.8	55.0	43.0	58.9	74.0
17	7.40	7.38	7.50	70.0	64.0	55.0	69.0	66.5	83.0
18	7.32	7.43	7.43	83.6	68.0	68.0	45.0	54.0	54.3
Mean±SD	7.25±0.09	7.38±0.07	7.43±0.06	76.59±15.58	59.44±16.67	51.36±10.51	52.17±14.35	56.67±10.12	62.98±11.58

The Bi-pap was used for an average of 3.2±1.2 days. It was well tolerated by the patients. One patient had a dry nose but this effect was not so severe as to discontinue Bipap. The average length of hospital stay was 10.6±5.6 days (range 3 to 23 days). Fifteen of the 18 patients improved and were discharged, one needed endotracheal intubation and two patients expired (11%).

Discussion

The use of non-invasive positive pressure ventilation (NIPPV) in acute respiratory failure (ARF) due to acute exacerbation of COPD was evaluated in late 1950s and early 1960s. It was observed that both gas exchange and tolerance of supplemental oxygen were improved after a short period of administration. Subsequently the interest in using NIPPV declined as administration of mechanical ventilation via endotracheal tubes became the standard therapy for ARF. But endotracheal intubation has many complications, to avoid these, the interest in the use of NIPPV has resurged again[9].

The present study indicates that NIPPY (Bipap) when added to conventional treatment is an effective treatment in patients with acute respiratory failure due to acute exacerbation of COPD. NIPPV rapidly improves vital signs, acid base disturbances and gas exchange within the first few hours. In addition it also decreases hospital length of stay, mortality rate and is well tolerated with minor complications. The clinical effect of NIPPY in ARF during episodes of acute exacerbation of COPD have been studied in various clinical trials on patients of COPD[5,10-13].

The results in the present study show that respiratory rate and heart rate decreased significantly within 3 hours of administration of NIPPY and the sense of dyspnoea also improved in most of the patients in the initial hours.

Arterial blood gases also reversed dramatically in the first 3 hours. A significant rise in pH 7.25±0.09 (initial) to 7.38±0.07 (after 3 hours) (P<0.00l) and decrease in PaCO2 76.5±15.1 (initial) to 59.4±16.6 (after 3 hours) (P<0.002) were observed. Oxygen tension also improved to some extent initially but significantly improved later on. Such a rapid improvement is not possible with conventional treatment

alone. Similar findings have been reported by various authors[5,7].
In this study only one patient needed endotracheal intubation which is similar to Brochard's and co-workers study in which only one of 13 patients with COPD exacerbation required intubation when treated with NIPP[8].
We found a low mortality rate in this study which is nearer to the Brochard's study i.e., 9% with the use of NIPPY. NIPPV is associated with rapid improvement in gas exchange, decreased need for endotracheal intubation and decreased complications[8].
The hospital length of stay was low i.e. 10.6±5.6 with the use of NIPPY. Rapid reversal of blood gases, absence of sedation, reduced number of complications and shorter weaning time of NIPPY, all probably contribute in shortening the hospital stay. The shorter hospital stay with the use of NIPPY may be cost effective as compared to conventional treatment alone where hospital stay is long.
This study indicates that Bi-pap (NIPPY) is particularly useful in patients presenting with acute respiratory failure, due to acute exacerbation of COPD particularly in settings where invasive ventilation is not easily available.

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