Study of non-invasive mechanical ventilation in ICU patients : clinical and prognostic relevance

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ABSTRACT

Non-invasive ventilation (NIV) is the provision of ventilatory support to the lungs without the use of an endotracheal airway. It has emerged as an important tool in the treatment of diverse forms of acute respiratory failure. It not only reduces the need for invasive mechanical ventilation and its associated complications, but also reduces the complications associated with stay in the intensive care unit, length of hospital stay, and mortality in selected patients.

This descriptive study was conducted on 50 critically ill patients with acute respiratory failure.

All patients were subjected to full history taking, complete physical examination, chest and cardiac imaging and laboratory investigations.

KEY WORDS:CPAP, BiPAP, COPD, ILD, pulmonary edema, obstructive sleep apnea, mechanical ventilation, non-invasive ventilation.

INTRODUCTION

NIV is currently a first line treatment for acute respiratory failure in patients with COPD (in exacerbations or during weaning). It is also well accepted as a treatment in patients with asthma, cystic fibrosis, postoperative respiratory failure and avoidance of extubation failure and in patients who have declined intubation.

Essentially, there are two modalities of NIV: continuous positive airway pressure (CPAP) and pressure support ventilation (NIPSV). In acute pulmonary edema (APE) both modalities have shown a faster improvement in gas exchange and physiologic parameters with respect to conventional oxygen therapy.

PATIENTS AND METHODS

- The aim of this work is to identify which patients with acute respiratory failure should be considered for NIV and to compare the outcome of application of CPAP and BIPAP in management of acute respiratory failure.

- All patients were subjected to full history taking, complete physical examination, chest and cardiac imaging and laboratory investigations.

RESULTS

- In Group 1 (COPD group)

-There was no significant difference in improvement in the arterial neither PaO_2 nor O_2 saturation by using BIPAP in comparison to using CPAP on admission and after 6, 48 h. There was a significant improvement in the arterial $PaCO_2$, arterial pH, duration of stay at ICU, avoiding endotracheal intubation (ETI) and static compliance by using BIPAP in comparison to using CPAP after 6 and 48 h.

- In Group 2 (ILD group)

-There was no significant difference in improvement in the arterial PaO_2, O_2 saturation, RSBI, PaO_2/FiO_2 and RR by using BIPAP in comparison to using CPAP on admission and after 6, 48 h. There was a significant improvement in the arterial $PaCO_2$, arterial pH, avoiding endotracheal intubation (ETI), static compliance and duration of stay at ICU by using BIPAP in comparison to using CPAP on admission and after 6, 48 h.

- In Group 3 (Pulmonary edema group)

-There was a faster improvement in the arterial PaO_2 and O_2 saturation by using CPAP in comparison to using BIPAP on admission and after 6, 48 h. There was no significant difference in improvement in the arterial $PaCO_2$, arterial pH, avoiding endotracheal intubation (ETI), RSBI, PaO_2/FiO_2, RR, C static and duration of stay at ICU by using CPAP in comparison to using BIPAP on admission and after 6, 48 h.

- In Group 4 (Obstructive Sleep Apnea Syndrome)

-There was a faster improvement in the arterial PaO_2 and O_2 saturation by using CPAP in comparison to using BIPAP on admission and after 6, 48 h. There was no significant difference in improvement in the arterial $PaCO_2$, arterial pH, avoiding endotracheal intubation (ETI), RSBI, PaO_2/FiO_2, RR, C static and duration of stay at ICU by using CPAP in comparison to using BIPAP on admission and after 6, 48 h.

Table13 : Effect of CPAP and BIPAP on intubation in different groups of the study

Mode	Group 1 (22)					Group 2 (10)					Group 3 (10)					Group 4 (8)				
	N	Intubated		Not intubated		N	Intubated		Not intubated		N	Intubated		Not intubated		N	Intubated		Not intubated	
		N	%	N	%		N	%	N	%		N	%	N	%		N	%	N	%
CPAP	11	8	72.73	3	27.27	5	3	60	2	40	5	1	20	4	80	4	0	0	4	100
BIPAP	11	2	18.18	9	81.82	5	1	20	4	80	5	3	60	2	40	4	2	50	2	50
p value	0.001					0.003					0.035					0.022				

Table 21 : Comparison between the four groups as regard number of cases weaned from ventilator

Group	CPAP				BIPAP				*p* value
	Weaned		Not weaned		Weaned		Not weaned		
	N	%	N	%	N	%	N	%	
Group 1 (22)	3	27.3	8	72.7	9	81.8	2	18.2	0.001
Group 2 (10)	1	20	4	80	4	80	1	20	0.003
Group 3 (10)	3	60	2	40	2	40	3	60	0.043
Group 4 (8)	3	75	1	25	2	50	2	50	0.007

Table 22 : Comparison between the four groups as regard duration of stay at ICU

	CPAP Mean±SD	BIPAP Mean±SD	*p* value
Group 1	10.4 ± 4.2	5.7 ± 2.3	0.002
Group 2	11.45 ±4.3	6.4 ±2.2	0.002
Group 3	4.2 ± 1.6	5.9 ± 1.4	0.163
Group 4	3.2 ± 1.8	5.6 ± 2.2	0.026

SD: Standard Deviation

- In this study, comparison between complications in CPAP groups and BIPAP groups showed no significant difference with *p* value 0.824.
- Clinical assessment revealed non significant difference between the four groups as regard respiratory rate,
pulse, systolic and diastolic blood pressure (SBP and DBP) and conscious level at time of admission.
- Regarding APACHE II score, there was a significant statistical difference in the prognosis.
- Also, there was a statistically significant difference between study groups regarding previous using of bronchodilators before admission at ICU.
- Regarding BMI, there was a significant statistical difference in the prognosis.
- There was a significant statistical difference in the prognosis regarding previous recurrent admission at hospital and/or ICU.

DISCUSSION

In our study in COPD patients there was significant improvement in $PaCO_2$ by using BIPAP in comparison to using CPAP after6 h and 48 h with *p* value 0.002 and 0.001 respectively supporting the superiority of BIPAP over CPAP in management of COPD patients.

Similarly, ***Clini et al., 2010*** evaluated the effect of early use of noninvasive ventilation on gas exchange in patients with acute exacerbation of COPD and concluded that reduction of hypercapnia was greater in patients who received BIPAP ventilation.

As regard duration of stay in ICU, in our study in COPD patients there was shorter duration of stay in patients using BIPAP in comparison to patients using CPAP.

The current results are in agreement with ***Strumpf et al., 2017*** who studied the effect of

positive pressure ventilation BIPAP in patients with severe chronic obstructive pulmonary disease and found that they needed shorter duration of ventilation in comparison to patients used CPAP.

There was a significant improvement in $PaCO_2$ by using BIPAP in comparison to using CPAP in cases of ILD on admission and after 6 and 48 h supporting the better control of respiratory failure in ILD with BIPAP.

Krachman et al., 2014 evaluated the effect of non invasive ventilation on gas exchange in respiratory failure. This study shows that in patients with ILD undergoing an episode of ARF the improvement in gas exchange during NIV treatment depends on the etiology of the ARF, but not the radiological pattern of ILD. Particularly, an improvement in oxygenation during NIV is detected when pneumonia, but exacerbation of fibrosis, is the triggers of ARF.

In the current study, patients with pulmonary edema showed significant more rapid improvement in PaO_2 and Oxygen saturation in patients using either CPAP compared to BIPAP after 6h. In addition, CPAP had achieved more above-normal PaO_2 level than BIPAP after 48h. On the other side, both subgroups showed parallel (rise to normal) $PaCO_2$ started within 6 h and reached normal levels after 48h.

In our study, conversely to COPD and ILD groups, patients with pulmonary edema managed with CPAP had more significant statistical difference in avoiding endotracheal intubation compared to patients managed by BIPAP (60% versus 40% respectively).

In agreement to our study ***Gray A et al., 2008*** in a study of 1069 patients (mean [±SD] age, 77.7±9.7 years; female sex, 56.9%) were assigned to standard oxygen therapy (367 patients), CPAP (346 patients), or NIPPV (356 patients) found that there was no significant difference in the combined end point of death or intubation within 7 days between the two groups of patients undergoing noninvasive ventilation (11.7% for CPAP and 11.1% for NIPPV, p=0.81).

In our study, OSA patients reported a faster improvement in the arterial PaO_2 and O_2 saturation by using CPAP in comparison to using BIPAP after6 and 48 h with p value 0.016 and 0.022 respectively.

Similarly ***kolodzie et al., 2008*** reported that CPAP is the goal standard treatment in OSA but the most prevalent complaints were related to asynchrony and inability to tolerate pressure level settings. They concluded that BIPAP is not necessary for most people with uncomplicated Obstructive Sleep Apnea. It is sometimes used for people who have a hard time adapting to CPAP.

In the current study, management with BIPAP could achieve significant shorter duration of ICU stay in patients with COPD and ILD: [5.7 ± 2.3 and 6.4 ± 2.2 days (mean ± SD)] respectively, compared to patients managed by CPAP [(10.4 ± 4.2 days in COPD and 11.45 ± 4.3 days in ILD (mean ± SD)] along with its higher efficacy in more rapid control of such patients and more rapid and easy weaning from NIV and lesser need for IMV. Thus we recommend BIPAP as the best optional management of NIV in such patients. On the other side, management with CPAP could achieve higher efficacy in more rapid control of such patients and more rapid and easy weaning from NIV and lesser need for IMV hand in hand with significant shorter duration of ICU stay in patients with pulmonary edema and OSA (4.2 ± 1.6 and 3.2 ± 1.8 days respectively) compared to patients (5.9 ± 1.4 days in pulmonary edema and 5.6 ± 2.2 days in OSA) appreciating CPAP as the treatment of choice in such patients. These benefits achieved by each mode in categorized patients has the potential for lesser adverse effects of MV, prolonged untreated RF and prolonged hospital stay and ultimately all carry more favorable hospital outcome.

CONCLUSION

It is concluded that non-invasive ventilation is an effective, feasible and tolerable method with negligible side effects in management of most patients with acute respiratory failure admitted to ICU. It is effective in management of respiratory failure secondary to various etiologies including chronic obstructive pulmonary disease, interstitial lung disease, cardiogenic pulmonary edema and obstructive sleep apnea. It provides effective and early gas exchange and improvement of the various deranged physiological parameters associated with respiratory failure, thus allows early weaning and provides lesser need of invasive mechanical ventilation that carries its well-known serious complications. Both CPAP and BIPAP proved effective in management of respiratory failure secondary to various etiologies but BIPAP is more effective in more rapid gas exchange and physiological improvement, provide more frequent and successful early weaning and achieving lesser hospital stay in case of COPD and ILD whereas CPAP is more efficient in all of these parameters when managing CPO and OSA. Identifying various pathological co-morbidities in managing patients with respiratory failure by NIV is addressed in the current study and is should be always considered for tailoring therapeutic modalities during in-ICU management and after hospital discharge.

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