SAS Journal of Medicine ISSN 2454-5112
SAS J. Med., Volume-1; Issue-4 (Nov-Dec, 2015); p-184-190
Available online at http://sassociety.com/sasjm/

Research Article

# Overview of Non Invasive Ventilation in Patients Presenting with Respiratory Distress at Tertiary Care Hospital - Research Article

**Eema Chaudhary, Vikas Sikri, Ashwini Malhotra, Lubna Habib**
Department of Pulmonary Medicine & Critical Care, Indraprastha Apollo Hospital, Sarita Vihar, Delhi – 110076

***Corresponding author**
Dr. Eema Chaudhary
Email: eema.dr@gmail.com

**Abstract:** Noninvasive ventilation (NIV) refers to the delivery of mechanical ventilation to the lungs using techniques that do not require an endotracheal airway [1]. NIV has been shown to be an effective treatment for acute hypercapnic respiratory failure, particularly in chronic obstructive pulmonary disease [1]. Within both the intensive care unit and the ward environment, it has been shown in randomized controlled trials and systematic reviews to reduce intubation rate and mortality in COPD patients with decompensated respiratory acidosis (pH <7.35 and PaCO2 >6 kPa) following immediate medical therapy [2]. Ours being a tertiary care hospital, we receive a lot of patient who present with respiratory distress. We formulated a study to look into epidemiological profile of these patients along with background illnesses and how they fared on NIV.

**Keywords:** Noninvasive, Ventilation, respiratory failure, hypercapnic, obstructive air way diseases

## INTRODUCTION

The earliest noninvasive ventilators were the 'body ventilators', they assisted ventilation by applying negative or positive pressure to various regions of the body. The earliest was a tank-type negative pressure device by the Scottish physician John Dalziel in 1838 [3]. The first electrically powered body ventilator used widely was the iron lung (Figure1), developed in 1928 by Philip Drinker [4].

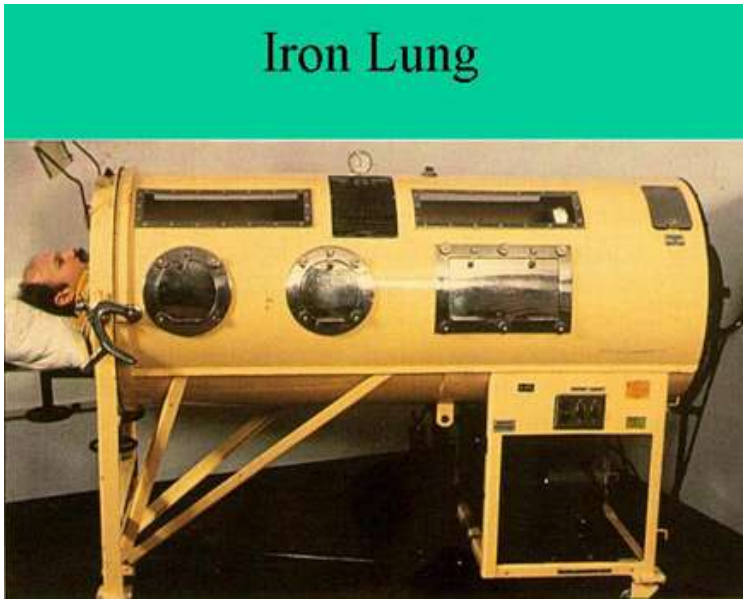


**Fig-1: Tank ventilator or 'Iron lung' J.H. Emerson Co. Cambridge, MA [5]**

Subsequently, chest shells (Figure 2) were developed which consisted of an iron shell covering the anterior part of the thorax, with an air-filled rubber edge that created a tight seal. The first mass-produced chest shells, the Fairchild-Huxley chest respirator and the Monaghan Portable Respirator, were introduced in 1949.

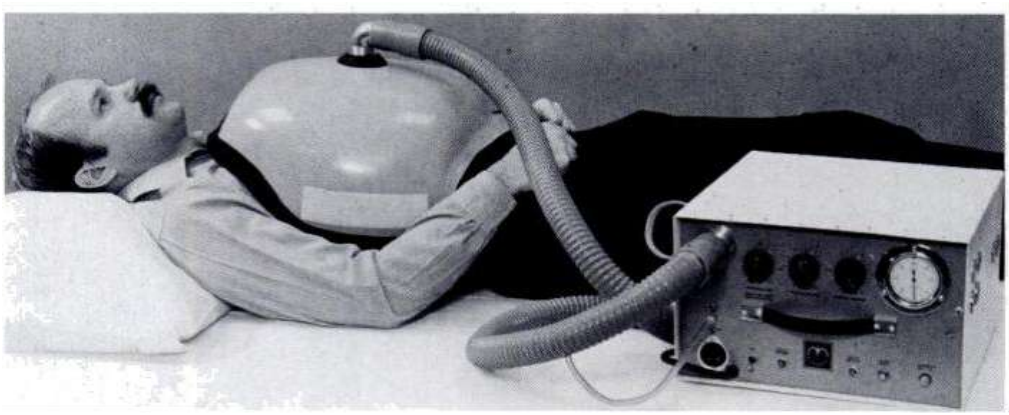

**Fig-2: Chest Shell fitted over anterior chest and abdomen attached to a negative pressure ventilator [5]**

Further development of ventilators lead to invention of various other models which included rocking bed, pneumo belt, Bragg-Paul Pulsator, so on and so forth. The noninvasive application of positive pressure dates back to the 1930s, when the pioneering studies of Alvan Barach demonstrated that continuous positive airway pressure could be useful in the treatment of acute pulmonary edema [6]. First described in1947, intermittent positive pressure breathing (IPPB) administered via a mouthpiece was used widely until the early 1980s in acute care hospitals in the United States [7]. Fraimow and Colleagues [8] observed that IPPB reversed the increase in $Pa_{CO2}$ occurring in patients with emphysema receiving oxygen.

The interest in NIV has grown over the time as in contrast to invasive ventilation, noninvasive ventilation leaves the upper airway intact, preserves airway defense mechanisms and allows patients to eat, drink, verbalize, and expectorate secretions. Various mechanisms of Action [9] of NIV have been described in literature which includes improvement in pulmonary mechanics and oxygenation, augmentation of alveolar ventilation, partial unloading of respiratory muscles, reduction of - transdiaphragmatic pressure, pressure time index of respiratory muscles and diaphragmatic electromyographic activity.

We formulated a study at a tertiary care hospital with the following aims:

1. To study the clinical profile and outcome of patients requiring NIV.
2. To study the associated pre existing lung and other systemic diseases in these patients requiring NIV.
3. To study the outcome in these patients in terms of requirement of invasive ventilation and mortality.

## MATERIALS AND METHODS

The study was conducted at The Department of Respiratory and Critical Care Medicine, in a tertiary care Hospital. Patients with Acute Hypoxemic or Hypercapnic respiratory failure satisfying clinical and physiologic parameters indicating the need for NIV were randomly taken into the study. Fifty patients were enrolled and followed up to either discharge or expiry. The following parameters were looked into:

- The age at presentation.
- The symptoms at the time of presentation.
- Pre existing lung conditions and other co-morbidities, if any.
- The indication for NIV and the type of NIV applied.
- Outcome of the patient in terms of need of intubation and /or mortality.
- Inclusion criteria [2] were as following:
- COPD exacerbation with pH <7.35 despite medical treatment and controlled oxygen therapy
- Severe dyspnea at rest
- A respiratory rate greater than 25 breaths per minute
- Use of accessory muscles of respiration
- Paradoxical abdominal motion
- Hypoxemia refractory to oxygen therapy
- $PaCO_2$>45mm Hg

Exclusion criteria [2] included:

- Life-threatening hypoxemia requiring intubation & ventilation
- Severe co-morbidity
- Confusion/agitation/severe cognitive impairment
- Facial burns/trauma/recent facial or upper airway surgery
- Nausea and vomiting
- Undrained pneumothorax
- Upper gastrointestinal surgery
- Inability to protect the airway
- Copious respiratory secretions
- Haemodynamically unstable
- Patient moribund
- Bowel obstruction

## RESULTS

Fifty patients were studied requiring NIV Support. Twenty nine were males and 21 females with male: female ratio of 1.38: 1.00. Maximum number of patients (34%) was found to be in the age group of 61-75 yrs. (Figure 3) the mean age for males was 50.5 years while for females was 58.8 years. Minimum age

in study group was 15 years and maximum was 94 years.

.

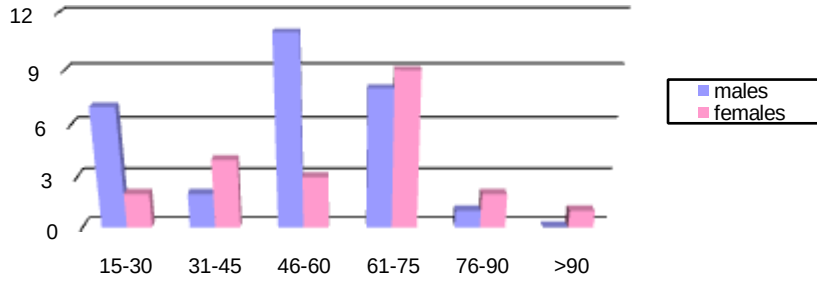


**Fig-3: Showing graphical presentation of male: female distribution as per age**

In the study 16 patients had pre existing lung diseases, 8 were of Chronic Obstructive Pulmonary Diseases (COPD) while 4 of Bronchial Asthma, 2 patients had malignancy involving lung and 2 patients had history of treated pulmonary tuberculosis in past (Figure 4). Associated co-morbidities were also studied; diabetes was present in 17 out of 50 (34%) patients and hypertension in 24(48%) patients (Table 1). Most common co-morbidity in patients with no underlying lung disease was essential hypertension.

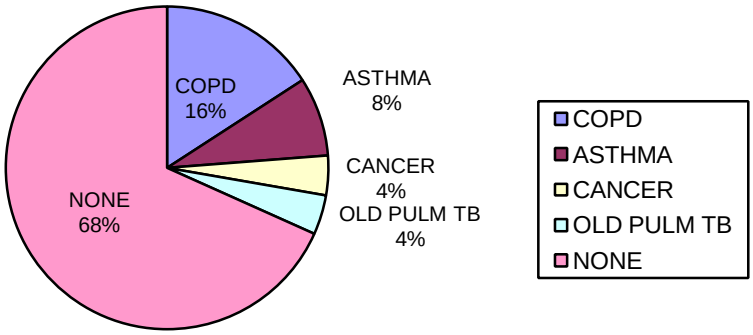


**Fig-4: Pie diagram showing proportion in which pre-existing lung disease was present amongst the study group**.

**Table 1: Associated co-morbidities**

| CO MORBIDITIES | No. OF PATIENTS | Percentage (n=50) | NIV failure | Mortality |
|---|---|---|---|---|
| Diabetes | 17 | 34 % | 6 (35%,n=17) | 2 (11.7%) |
| Hypertension | 24 | 48 % | 8 (33%, n=24) | 4 (16.5%) |
| Cardiac disease | 11 | 22 % | 2 (18%, n=11) | 2 (18%) |
| Renal disease | 4 | 08 % | 2 (50%, n=4) | 1 (25%) |
| Anemia | 2 | 04% | 0 | 0 |
| Thyroid disorder | 5 | 10 % | 1 (20%, n=5) | 0 |
| Cancer | 3 | 06 % | 2 (66%, n=3) | 2 (66%) |

The presenting complaints in order of decreasing frequency were breathlessness (82%), fever (52%), cough (42%), chest pain (8%) and hemoptysis (6%). 27 out of 50 (54%) patients had tachypnea with respiratory rate between 20-30 prior to application of NIV while 20 patients out of 50 (40%) had respiratory rate in the range of 31-40. At time of admission, oxygen saturation at room air was recorded by pulse oxymetery and correlated with rate of intubation and mortality. Patients with saturation less than 75% were noted to have higher mortality (Table 2).

**Table 2**

| $SpO_2$ | No. of patients | Intubation required | Percentage | NO survival/ death | Percentage |
|---|---|---|---|---|---|
| <75 | 3 | 1 | 33% (n=3) | 2 | 66%(n=3) |
| 76-80 | 3 | 1 | 33% (n=3) | 0 | 0% (n=30 |
| 81-85 | 6 | 3 | 50% (n=6) | 1 | 17%(n=6) |
| 86-90 | 23 | 9 | 39%(n=29) | 4 | 17%(n=23) |
| >90 | 15 | 4 | 27%(n=15) | 2 | 13%(n=15) |

Similarly, data based on pH (Figure 5) was evaluated and it was noted that the maximum percentage of patients requiring intubation were in group of pH< 7.25 (100%) followed by those in group 7.25-7.35 (37.5%). On correlation between $pCO_2$ values and mortality, the highest mortality was seen in group with $pCO_2$>60mm Hg (33%).

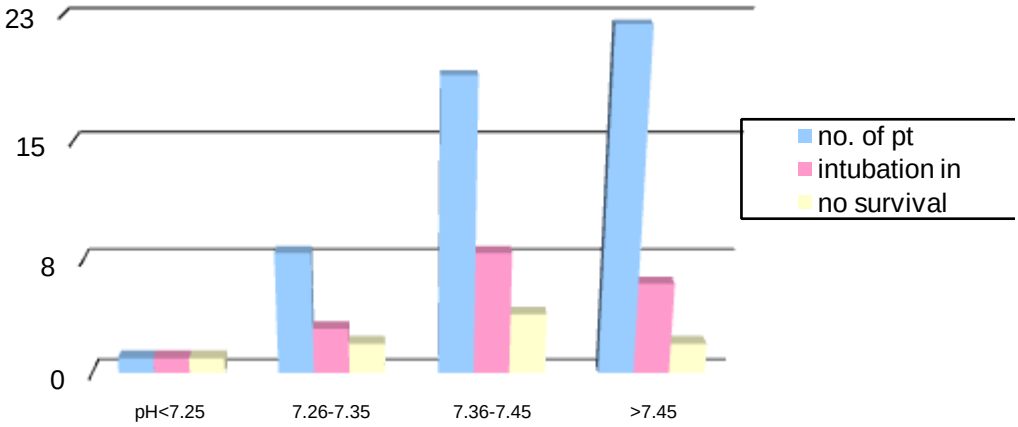


**Fig-5: Graphical presentation of correlation between pH, intubation rate and mortality**

Patients' final diagnosis was studied in relation to the outcome in terms of NIV failure i.e. need intubation required and mortality. Highest mortality rates were observed in patients with bronchial asthma (50%) followed by those diagnosed with malignancy (40%) while the highest rate of NIV failure was seen in patients with neuromuscular disease (100%). However, the overall mortality in the patients with neuromuscular disease who required NIV was not high. Patients in whom NIV failed and required intubation had 50% mortality while mortality in patients who initially improved on NIV but later expired was 3%.

In the patients with no pre-existing lung diseases, 12 out of 34 had ARDS (35.2%), 6 out of these had NIV failure (50%) while 2 expired (16.6%). Next common diagnosis was pneumonia (n=7) amongst these patients, out of which 3 had NIV failure (42.8%) and there was no mortality. Rest was diagnosed as malignancy (17.6%), pulmonary edema (14.7%) and ILD (5.8%). (Table 3). Among the patients with COPD (n=8), exacerbation was the cause of presentation in 50% and NIV was successful in all of them. Pneumonia was admitting diagnosis in 2 patients out of these 1 expired. In the other 2 patients of COPD, ARDS was seen in 1 and malignancy was diagnosed in another.

**Table 3: Pre-existing lung diseases, final diagnosis in each group, related NIV failure and mortality.**

| Pre existing lung disease | Number of pt.s | Percentage | Final diagnosis | NIV failure | Mortality |
|---|---|---|---|---|---|
| None | 34 | 68% | Pneumonia-7,<br>ARDS-12,<br>Cancer-6,<br>ILD-2,<br>Pulm. edema-5 | 3<br>6<br>2<br>0<br>0 | 0<br>2<br>2<br>0<br>0 |
| COPD | 8 | 16% | Exacerbation-4<br>Pneumonia-2<br>ARDS-1<br>Cancer-1 | 0<br>1<br>0<br>1 | 0<br>1<br>0<br>0 |
| Asthma | 4 | 8% | Exacerbation-1<br>Cancer-1<br>Pneumonia-1<br>ILD-1 | 0<br>0<br>0<br>0 | 1<br>0<br>0<br>0 |
| Ca lung | 2 | 4% | Primary ds-2 | 2 | 2 |
| Old pulmonary TB | 2 | 4% | ARDS-1<br>Pneumonia-1 | 1<br>1 | 1<br>0 |

Asthma was pre-existing disease in 4 patients; these had individual causes for presentation – exacerbation, Cancer, Pneumonia and Interstitial lung disease. In all of them, Intubation could be avoided, while the one with exacerbation expired in a few days due to cardiac arrest. There were 2 patients with prior diagnosis of malignancy; both expired after NIV failure and subsequent intubation. In 2 patients with prior history of Pulmonary Tuberculosis, one subsequently developed ARDS, NIV failed in her and she later expired while the other had pneumonia and recovered with NIV and other supportive treatment. Overall successful outcome in NIV was seen in 64% patients. Mortality was noted in 18% of the patients in the study group.

**DISCUSSION**

Our study included 50 patients who required use of Non Invasive Ventilatory support for the respiratory distress. We used BiPAP in all patients except one patient of cardiogenic pulmonary edema, where CPAP was applied. The male to female ratio was found to be 1.38 : 1.00 in our study group vis a vis ratio of 1.00 : 1.10 in a study by George et al.; [10] , 1.10 : 1.00 in Prasad et al.; study while Rai et al.; [12] quoted ratio of 1.8:1.0. The age of patients included in the group ranged from 15-94 years and the Mean age was 54.6 years compared to 72.2 years in Antro et al.; [13] study. The Mean Age in George et al.; [10] study was 54.7 years, in Rai et al.; [12] study, 68.32 years and in R.k.Mani [14] study , it was 59.5 years . It was 70 years in the study by Meduri et al.; [15] involving 10 patients and was 61.11 years in Prasad et al study [11].

The mean respiratory rate (per minute) of patients was 31.92 in our study group with a standard deviation of 5.42. In the study by George et al.; [10], the mean respiratory rate was 32.78 and in R.K.Mani's[14] study, it was 29.5. It was higher i.e. 34 in Meduri et al.; [15] study and 39 in Prasad et al study[11].

We correlated the history of any prior lung disease in the study group with the presentation and outcome of patients and observed that majority (68%) of the patients did not give prior history of any pre-existing lung disease. The final diagnosis in these patients was Acute Respiratory distress Syndrome (24%), Pneumonia (14%) and malignancy (12%).

We also studied presence of comorbidities in these patients requiring NIV support, 48% patients were hypertensive and 34% had diabetes. The maximum rate of NIV failure (66%) and mortality (66%) was found in patients with a prior known Malignancy. This was followed by patients of renal disease who had a NIV failure rate of 50% and mortality of 18%.

In our study, most patients (46%) at presentation had resting saturation at room air, between 86-90%. While the maximum rate (in 50% patients) of intubation was seen in patients with saturation in range of 81-85%, the mortality was more (66%) in the group with saturation <75%. The most common presenting complaint was breathlessness, i.e. in 82% patients followed by fever which was there in 52% patients and then cough in 42% patients. The mean pH in our study was 7.43 with a Standard Deviation of 0.08 while in study by R.k.Mani [14] mean pH was 7.24. It was 7.25 in George et al study [10], 7.30 in Prasad et al.; [11] studyon, 7.26 in Rai et al.; [12] study. All these quoted studies had mean $pCO_2$ of > 70 mm and hence the variation from our study could be explained on the fact that other studies had more of hypercapnic patients. The highest mortality in our study was in the group with pH<7.25.

Among the patients with pre existing lung diseases, COPD contributed 16% of the patients. In this (COPD) group acute exacerbation was seen in 50% as presenting complaint, 25% had pneumonia while ARDS and malignancy each contributed 12.5% of COPD patients as the cause for presentation. NIV failure was seen in 12.5% of COPD patients. Mortality was seen in 12.5% of COPD patients and this was seen in patient presenting with pneumonia. In COPD, NIV success rate was 87.5% in our study. Comparatively in other studies on COPD patients NIV success rate in the study by Bott et al.; [16] was 90%, Kramer [17] and Plant et al.; [18] quoted success rate of was 68.7% and 84.7% respectively. The mean pH in COPD patients was 7.41 and means $pCO_2$ was 49.55 while in a study by Mani[14], mean $pCO_2$ was 89. In Meduri et al.; [15] study, there were 6 patients of COPD out of 10 and in these, there was 33 % NIV failure and 33% mortality. COPD Patients in our study fared better on NIV but this may be attributed to lower $pCO_2$ and better pH range in our patients.

NIV success in cardiogenic pulmonary edema cases was seen in 78.6% of patients in the study by Antro et al.; [13] while in our study NIV was 100% successful in patients with pulmonary edema. Meduri and colleagues [15] in their study reported that one of two patients with acute pulmonary edema had an excellent response to NPPV. The same investigators have also described eight patients with acute pulmonary edema treated with face mask PSV; intubation could be avoided in four of the patients.

In pneumonia cases, NIV failure was seen in 50% patients and mortality was 10% compared to Antro et al.; [13] study where they divided the patients with Pneumonia into those with prior COPD and those without COPD and found that the NIV failure rate in the two groups was 71.4% and 63% respectively and mortality was 50% and 57% respectively. In a study carried out by Meduri et al.; [19] , on patients with status asthmatics, 17 patients had an average initial pH of 7.25 and $Pa_{CO2}$ of 65 mm Hg. These were treated with face mask Pressure Support Ventilation. NIV

failure was seen in 11.7% and no mortality occurred. In our study there were 2 patients of Status asthmatics, one was elderly patient of 94 years in whom intubation could be avoided but expired during hospital stay because of cardiac arrest and in the other NIV was successful and patient was later discharged. Hence NIV may be useful in patients of Asthma but more studies with larger group of patients are required to put NIV in Asthma into recommendation.

Global NIV success in various studies had a wide range, varying from 60% to 93%. NIV success rate in our study was 64% while in Mani's [14] study it was 91.6%. It was 60.5% in Antro et al.; [13] study. In Prasad et al.; [11] study in 2002 of 8 patients, success of NIV was noted to be 87.5%. In Meduri et al.; [20] study, NIV was successful in 70% patients and mortality of 20%. In the study by Antonelli et al.; [21], amongst the NIV group, success rate was 68.7% and the mortality in that group was 28%. In Honrubia et al.; [22] controlled study, intubation could be avoided in NIV group in 52% patients and in Martin et al.; [23] study it was 72% while in the study by George et al.; [10] it was 85%.

Overall mortality was 18% in our study and 34.5% in Antro et al.; study [13] while it was 32% in NIV group in Honrubia et al.; [22] study. In our study, mortality in NIV non responders was 50%. The mortality in NIV non responders was 75.9% in the study by Antro et al.; [13]. This may be due to higher pH range, lower pCO2 levels, lesser age of patients in our study group compared to previous studies.

**CONCLUSION:**

Our study further re-enstates that NIV is successful in more than 60% cases of acute respiratory failure whether it be hypoxemic respiratory failure or that with associated hypercapnia. The patients may present without any history of prior lung disease. The associated co-morbidities may play a role in outcome of patients. The patients with a lower oxygen saturation (<75%), lower pH (<7.25) and a higher $pCO_2$ (>60 mm) have the poor outcome.NIV may be very useful in patients with cardiogenic pulmonary edema, if used early in course and appropriately.

**REFERENCES**


1. BTS guidelines; Non Invasive Ventilation in Acute Respiratory Failure. 2002.
2. Chronic Obstructive Pulmonary Disease: Non-Invasive Ventilation with Bi-phasic Positive Airways Pressure in the Management of patients with Acute Type 2 Respiratory Failure. Concise Guidance to Good Practice series ; Royal College of Physicians, British Thoracic Society, Intensive Care Society., No 11. London: RCP, 2008.
3. Dalziel J; On Sleep and Apparatus for Promoting Artificial Respiration ; Br Assoc Adv Sci1838;1:127.
4. Drinker P, Shaw LA; An Apparatus for the prolonged administration of Artificial Respiration: I. Design for adults and children. J Clin Invest 1929; 7:229–247.
4. N.S.Hill; Clinical Applications of Body Ventilators; Chest 1986; 90: 897-905.
5. Barach AL, Martin J, Eckman M; Positive Pressure Respiration and its Application to the Treatment of Acute Pulmonary Edema. Ann Intern Med1938; 12:754–795.
5. Motley HL, Lang LP, Gordon B; Use of Intermittent Positive pressure Breathing Combined with Nebulization in Pulmonary Disease ; Am J Med1948;5:853–856.
6. Fraimow W, Cathcart R, Goodman E; The Use of Intermittent Positive Pressure Breathing in the Prevention of the Carbon Dioxide Narcosis associated with Oxygen Therapy ; Am Rev Respir Dis1960;81:815–822.
7. Non Invasive Ventilation: Anaesthesia UK: 28.03.2005.
8. Ige Abraham George, George John, Preeta John, John Victor Peter, Solomon Christopher; An Evaluation of the role of Non Invasive Positive Pressure Ventilation in the management of Acute Respiratory Failure in a Developing Country ; Indian Journal of Medical Sciences 2007; 61( 9): 495-504.
9. Prasad R, Rout A, Garg R, Kushwaha RAS, Ahuja RC; An Open Randomised Controlled Trial of Non Invasive Positive Pressure Ventilation in patients of Acute or Chronic Hypercapnic Respiratory Failure in a general respiratory ward setting: Lung India 2007; 24: 132-1381.
10. Lt Col S P Rai, Brig B N Panda, Lt Col K K Upadhyay; Noninvasive Positive Pressure Ventilation in Patients with Acute Respiratory Failure; MJAFI 2004; 60: 224-226.
11. C Antro, F Merico, R Urbino, V Gai ; Non Invasive Ventilation as a first-line treatment for Acute Respiratory Failure: ''real life 'experience in the Emergency Department; Emerg Med J 2005;22:772–777.
12. Raj Kumar Mani ; Non Invasive Ventilation for Hypercapnic Respiratory Failure In Patients of COPD ; Indian Journal of Critical Care Medicine Oct-Dec 2005; 9(4):217-224.
13. Meduri GU, Conoscenti CC, Menashe PH, Nair S; Noninvasive face mask ventilation in patients with acute respiratory failure. CHEST Journal, 1989; 95(4): 865-870.
14. Bott J, Carroll MP, Conway JH, Keilty SEJ, Ward EM, Brown AM, et al.; Randomised Controlled Trial of Nasal Ventilation in Acute Ventilatory Failure due to Chronic Obstructive Airways Disease. Lancet 1993; 341:1555–7.
15. Kramer N, Meyer TJ, Meharg J, Cece RD, Hill NS; Randomized, Prospective trial of Non Invasive Positive Pressure Ventilation in Acute Respiratory

Failure. American Journal of Respiratory & Critical Care Medicine 1995; 151:1799 -806.
16. Plant PK, Owen JL, Elliot MW; Early use of Non Invasive Ventilation for Acute Exacerbation of COPD; Lancet. 2000 June 3;355(9219):1931-5.
17. Meduri GU, Cook TR, Turner RE, Cohen M, Leeper KV ; Non Invasive Positive Pressure Ventilation in Status Asthmaticus. Chest 1996; 110: 767-774
18. Meduri GU, Turner RE, Abou-Shala N, Wunderink R, Tolley E; Non Invasive Positive Pressure Ventilation via face mask; Chest 1996; 109: 179-193.
19. Antonelli M, Conti G, Rocco M, Bufi M, DeBlasi RA, Vivino G, Gasparetto A, Meduri GU ; A comparison of Non Invasive Positive-Pressure Ventilation and Conventional Mechanical Ventilation in patients with Acute Respiratory Failure. N Engl J Med 1998; 339: 429-435.
20. Honrubia T, Garcia Lopez FJ, Franco N, Mas M, Guevara M, Daguerre M et al; Non Invasive vs Conventional Mechanical Ventilation in Acute Respiratory Failure: Multicenter, Randomized Controlled Trial. Chest 2005; 128(6):3916–3924.
21. Martin TJ, Hovis JD, Costantino JP, Bierman MI, Donahoe MP, Rogers RM et al.; A randomized, Prospective Evaluation of Non Invasive Ventilation for Acute Respiratory Failure. American Journal of Respiratory & Critical Care Medicine 2000; 161(3):807–13.