Evaluation of a Respiratory Intermediate Care Unit in Ankara: Two Year Analysis

Özlem Ural Gürkan, MD; Özlem Berk, MD; Akın Kaya, MD; Gökhan Çelik, MD; Özlem Kumbasar, MD; Turan Acıcan, MD; Sevgi Saryal, MD

Ankara University, Medical Faculty, Chest Dept, Ankara, Turkey

Abstract

Objective: The role of respiratory intermediate care units in the management of critically ill patients has been recently evaluated in Europe.

A respiratory intermediate care unit was established two years ago in our 200-bed pneumology ward. It has 6 beds and has the availability of both invasive and noninvasive ventilatory support. Our aim is to make a two years' analysis of our unit. 179 patients were admitted to our respiratory care unit either from the emergency department, pneumology ward or from the general intensive care unit.

Design: A retrospective study.

Setting: A six-bed respiratory intermediate care unit at the University of Ankara.

Patients: Records of 144 episodes of acute attacks, which were eligible for the study, were analyzed retrospectively. 37 cases were admitted to the unit for monitorization for hemodynamic instability, 84 received noninvasive ventilatory support and 23 invasive ventilatory support.

Measurements and Results: The mean age was 59.94±12.92 years (mean±SD). The average length of stay was 12.65±9.63 days.

Patients with acute respiratory failure due to chronic obstructive pulmonary disease (COPD), chest wall deformities, sequela of tuberculosis, idiopathic pulmonary fibrosis (IPF), bronchiectasis, obstructive sleep apnea (OSA) and obesity-hypoventilation syndrome and pneumonia received ventilatory support; either invasive or noninvasive.

Decompansated respiratory acidosis (pH:7.29±0.06), severe hypoxemia, hypercapnia were present on admission of the patients, who were noninvasively ventilated. APACHE II scores of the noninvasive group was 18.39±4.49. The blood gas parameters improved significantly with noninvasive intermittent positive pressure ventilation with a daily application of at least 8 hours.

In the invasive group ABG revealed $PaCO_2$: 72.98±25.49, mmHg, PaO_2: 40.36±8.57, pH: 7.23±0.13. APACHE II score of this group was 22.65±7.23.

The overall mortality rate under ventilatory support was 20.5%. These patients mostly had end-stage disease with concomitant other organ failures. When the blood gas analysis, age and APACHE II scores were evaluated as the determinants of survival, APACHE scores seemed to predict survival significantly ($p<0.05$)

Conclusion: Respiratory care unit is beneficial in the follow up of patients with acute respiratory failure in terms of close monitorization and ventilatory support.

Turkish Respiratory Journal, 2001;2 (2):20-25

Key words: *Respiratory intermediate care unit, noninvasive mechanical ventilation, invasive mechanical ventilation, noninvasive intermittent positive pressure ventilation, bi-level positive airway pressure, acute respiratory failure*

Correspondence: *Dr. Özlem Ural Gürkan*
Ankara Tıp Fakültesi Göğüs Hastalıkları Cebeci, Ankara, Türkiye
E-mail: ozlemgurkan@dr.com

Introduction

During the epidemic of poliomyelitis in 1952, large number of patients with respiratory failure were concentrated in specialized units and improvement in survival was observed. This fact formed the basis of the idea of intensive care units. At that time noninvasive ventilation with tank ventilators was the preferred method. After successful application of the positive pressure ventilation through endotracheal tube or tracheostomy, intensive care unit (ICU) became the field of anaesthesiology. In 1960's Dr. Petty recommended specialized respiratory intensive care units (RICU), where patients with acute or chronic respiratory failure due to any pulmonary disease were treated (1,2). This idea raised great interest in the USA. The widened and successful application of nasal positive pressure ventilation increased the popularity of the respiratory care units. The role of RICU in the management of critically ill patients is still being evaluated in Europe, and especially in our country.

A RICU ws established two years ago in our 200-bed pneumology ward. In this study, we aimed to make the two years' analysis of our unit; namely to evaluate the benefits achieved with the respiratory care units, and the importance of noninvasive intermittent positive pressure ventilation (NIPPV) in different types of diseases and to evaluate the results of the invasive mechanical ventilation (IMV) in severe acute respiratory failure (ARF).

Materials and Methods

Demographics: The RICU has been established in the Ankara University in December 1997, in a 200-bed pneumology ward. It has 6 beds and invasive and noninvasive ventilatory support is available. Noninvasive monitoring (electrocardiography (ECG), oxygen saturation (SaO_2) and blood pressure) is the preferred monitoring method, where invasive monitoring is reserved for selected patients.

There is always at least one doctor on duty. The nurse- to-patient ratio is 1:2 or 1:3 for the day shift and 1:3 or 1:6 in the night shift. A part time physiotherapist is present for performing postural drainage, passive or active training of limb and respiratory muscles. Total parenteral nutrition is planned by a specialized team.

Patient population: The records of 144 episodes were evaluated. These patients were transferred to our unit either from the emergency department, pneumology ward or from the general ICU.

Age, gender, underlying diseases, comorbid pathologies, APACHE II scores on admission (3), arterial blood gas (ABG) analysis on admission and discharge, and the outcomes were recorded (4). Patients were grouped into three categories as monitorization, NIPPV and IMV.

Ventilatory assistance: Invasive ventilation is performed via Hamilton (Veolar or Amadeus; Switzerland) or Evita 4, Drager, Lübeck, Germany and noninvasive mechanical ventilation is performed by Respironics STD 30; Respironics, BIPAP Vision, Pennsylvania, USA or Puritan Bennett Knightstar, CA; USA. NIPPV was applied via a full-face mask or a nasal mask. Commercially available masks were used. The full-face mask was preferred in patients who were unconscious due to severe CO_2 narcosis or who made pursed lip breathing. The mask best fitting the patient's face was chosen.

NIPPV: The patients who were noninvasively ventilated received assistance with BIPAP (bi-level positive pressure ventilation) or pressure controlled mode. The device settings were adjusted as follows: inspiratory positive airway pressure (IPAP) was adjusted to achieve a tidal volume of 7-10 ml/kg; the expiratory positive airway pressure (EPAP) was set at 5 cmH_2O; oxygen was administered through the mask and was titrated in order to achieve SaO_2 over 85-90%. EPAP level was increased in increments of 1 cmH_2O until fractional inspired oxygen (FiO_2) requirement was less than 0.5. During the first hour the patient comfort with the device, adequacy of the mechanical ventilation, and the monitorization parameters were observed. The effects on the respiratory rate, depth, effort were also evaluated. During the initial hour, one nurse and a physician stayed with the patient to offer reassurance. If the patient became anxious, then removal of the mask for short periods was permitted.

The patient was encouraged to continue NIPPV as much as he/she could. Intervals were permitted for eating and drinking. The overall duration of NIPPV was determined according to the clinical criteria and arterial blood gas analysis.

If the patient failed to achieve in NIPPV, then the therapy was converted to IMV. The major criteria to perform endotracheal intubation (ETI) included respiratory arrest, respiratory pauses with loss of consciousness, a heart rate below 50 beats/minute with loss of alertness and hemodynamic instability with systolic arterial blood pressure below 70 mmHg or severe cardiac arrhythmia. The patients who needed ETI were ventilated by the pressure-controlled modes and were weaned with the pressure support mode.

All the patients were ventilated in a semirecumbent posi-

tion to avoid aspiration. Enteral feeding tubes were preferred for nutrition in most of our patients.

ECG, SaO_2, heart rate and blood pressure were monitored noninvasively in most of the patients.

Statistical analysis: The Statistical Package for Social Sciences was used to analyse the data. The changes in arterial blood gas analysis (ABG) on admission and discharge were evaluated by paired samples *t*-test. Mann-Whitney U test was performed for the differences between the survivors and nonsurvivors of the IMV group and also to evaluate the differences between the invasive and noninvasive ventilation groups. The results are expressed as mean ±SD. P<0.05 was accepted as significant.

Results

The monitorization group: The patients with severe pneumonia (6 patients), pulmonary embolism (6 patients), status asthmaticus (1 patient) or in need of cardiac or close hemodynamic monitorization (10 and 14 patients respectively) were monitorized. The mean age of this group was 63.41±12.71 (25-84). Mean APACHE score was 19.92±5.83. Twenty-four (65%) patients were discharged and 13 (35%) died during respiratory care unit stay. Most of the nonsurvivors were COPD patients, but they had concomitant diseases such as cerebrovascular accident, acute renal failure, atherosclerotic heart disease

NIPPV group: Eighty-four patients with various underlying diseases were transferred to the unit for NIPPV (Figure 1).

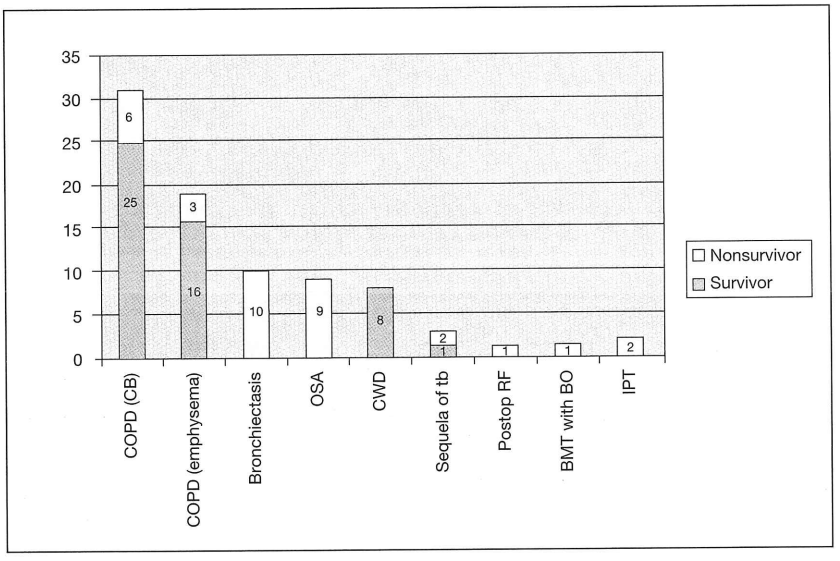

Figure 1: *The underlying diseases of the patients who received noninvasive ventilatory support.*
COPD (CB): Chronic bronchitis
Tb: tuberculosis
Postop RF: postoperative respiratory failure
BMT with BO: Bone marrow transplant with bronchiolitis obliterans

On admission, ABG analysis revealed prominent respiratory acidosis, hypercapnia and severe hypoxemia. During discharge, the improvement was statistically significant (Table 1).

Table 1. ABG values on admission and discharge from RICU

	Admission mean±SD	Discharge mean±SD	*P*
pH	7.29±0.06	7.39±0.03	P<0.001
$PaCO_2$	73.78±12.11	56.30±8.08	P<0.001
PaO_2	38.76±6.9	49.35±6.98	P<0.001
SaO_2	68.80±9.65	80.39±6.3	P<0.001

When the patients who received NIPPV were grouped according to their underlying diseases(as COPD, chest wall deformity (CWD), bronchiectasis, overlap syndrome), ABG analysis parameters improved significantly in each group (p<0.05).

The duration of the application for the first day ranged between 8 and 20 hours. The patient was encouraged to continue NIPPV as much as he could. Decrements of two hours were applied after pH has been stabilized.

Causes of discontinuation: In 9 of 84 patients (10.71%), invasive ventilatory support was needed due to failure in NIPPV. In 7 of these patients COPD was complicated with cardiac heart failure, atrial fibrillation, pneumonia, cardiomyopathy or cerebrovascular accident. One patient had posttransplant bronchiolitis obliterans and pneumothorax and the other had chest wall deformity and gastrointestinal bleeding. 8 of these patients died. The surviving patient had COPD and cerebrovascular accident.

Three patients could not tolerate noninvasive ventilation. One patient had electrocardiographic changes (chest pain, accompanying T inversion on ECG) which required cessation of ventilatory support. In four cases no improvement with NIPPV was obtained; three of them had the diagnosis of bronchiectasis.

Complications of NIPPV: The most common complication due to NIPPV was the nasal skin abrasion. In one patient, who had the diagnosis of bronchiolitis obliterans after bone marrow transplantation, pneumothorax was observed. This complication can either be explained by the underlying

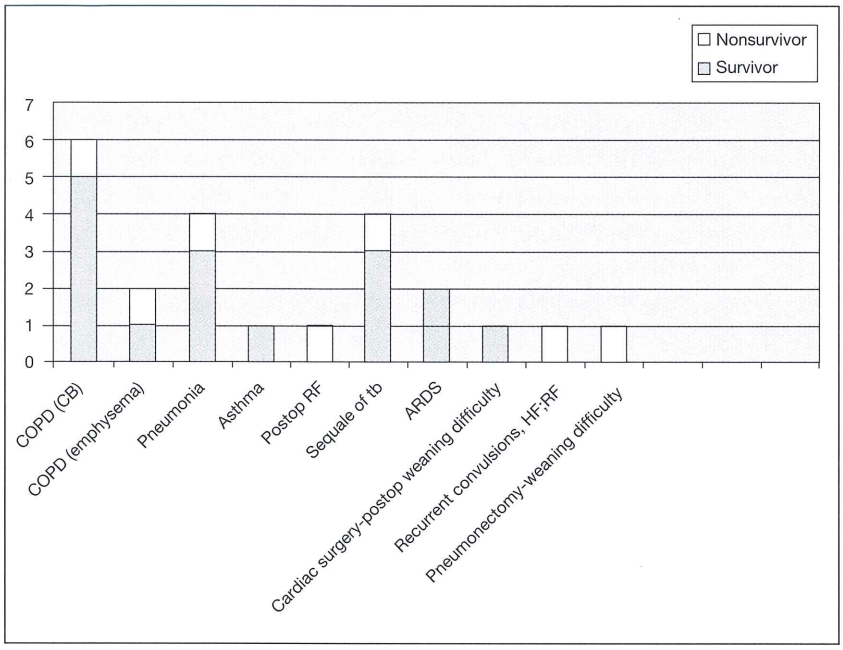

Figure 2: *The underlying diseases of the IMV group*

disease or the application of positive pressure ventilation.

Invasive ventilation group: 23 patients received invasive ventilation on admission to the RICU. The mean age was 59.30±18.14 years and the APACHE score was 22.65±7.23. The underlying diseases causing the need for intubation are demonstrated on Figure 2.

Eight patients in this group had died. Cardiac arrythmia, diabetes mellitus, renal failure, or severe cardiomyopathy were the concomitant diseases in the nonsurvivor group. 4 cases were weaned with noninvasive ventilation.

The arterial blood gas analysis of the invasive ventilation group on admission showed decompansated respiratory acidosis with prominent hypercapnia and moderate hypoxemia (Table 2).

Table 2: Comparison of the age, APACHE II score and arterial blood gas analysis parameters of the patients in the invasive and noninvasive ventilation group

	IMV Group	NIPPV Group	*P*
Age	59.30±18.14	58.60±11.09	P>0.05
APACHE II	22.65±7.23	18.46±4.49	P<0.05
Length of ICU stay (day)*	15.20±14.40	12.34±6.64	P>0.05
pH	7.23±0.13	7.29±0.06	P<0.05
$PaCO_2$ (mmHg)	72.98±25.49	73.78±12.11	P>0.05
PaO_2 (mmHg)	40.36±8.57	38.76±6.9	P>0.05
SaO_2 (mmHg)	71.59 ±10.55	68.80±9.65	P>0.05

*Only the surviving patients' length of stay is evaluated

Although statistically insignificant, ABG values were worse and APACHE scores were higher and the ages were older among the nonsurvivors in the IMV group (Table 3).

Comparison of the invasive and noninvasive group: The APACHE II score was higher in the IMV group and respiratory acidosis was deeper in the IMV group. Length of ICU stay in the NIPPV group was shorter although the difference was not significant (Table 2).

Outcome: The overall mortality among the patients who received ventilatory support was 20.5%. 20 patients who had died, had comorbid pathologies mostly having cardiac problems. When survivors and nonsurvivors who received either invasive or noninvasive ventilatory support were compared in terms of ABG values, APACHE scores and age, only APACHE scores showed significance ($p<0.05$).

Discussion

RICU is still being discussed in many countries. The equipment, staff, nature of the care (invasive vs. noninvasive) are all matter of discussion. According to the USA records, at the end of the 1980's the approximate costs of intensive care medicine comprised approximately 20% of the hospital associated health costs. It is obvious that critical care beds are very precious (1). In one report chronic critically ill patients represented only 3% of the total number of patients admitted to the ICU's and occupied 40% of the total patient days of care (1).

Byrick et al, have shown that the number of non-emergency ICU admissions increased from 18% to 27% after the closure of an intermediate care unit and the APACHE II scores decreased significantly. This showed that less

Table 3: Mean ABG values and APACHE scores of the survivors and nonsurvivors of the IMV group

	Survivors mean±SD	Nonsurvivors mean±SD	*P*
pH	7.24±0.14	7.23±0.1	P>0.05
$PaCO_2$ (mmHg)	72.1±20.33	75.34±26.38	P>0.05
PaO_2 (mmHg)	42.6±10.37	36.6±4.91	P>0.05
SaO_2 (mmHg)	73.28±10.59	68.67±7.52	P>0.05
APACHE	21.6±8.04	25±4.71	P>0.05
Age	55.8±21.07	65.88±8.41	P>0.05

severely ill patients were treated at a higher cost after the NRCU (noninvasive respiratory care unit) was no longer available (5).

Intermediate care units were developed as a cheaper option for patients receiving long term mechanical ventilation and for basic noninvasive monitoring and management of high-risk, critically ill patients (1). These units are believed to be less costly for patients who do not need ICU care, but still close monitorization as well as better alternatives for difficult-to-wean patients is required. In a respiratory intermediate care unit the recommended nurse-to-patient ratio is 1:3 or 1:4, and doctor-to-patient ratio is 1:6. We have to admit that our unit is not a good representative of intermediate or noninvasive care unit since intubated patients are not transferred to traditional critical care units and were followed-up in our unit. The application of IMV is not compatible with the proposed guidelines for admission to an intermediate care unit. However, with the preference of noninvasive monitoring and noninvasive mechanical ventilation and the ratio of medical staff is in accordance with the intermediate respiratory care units (1).

ARF refers to severe deterioration in gas exchange, which may require ventilatory assistance. Meanwhile, time needed to correct the underlying condition can be obtained. This assistance was given via endotracheal intubation in the past. Traumatic injury to the upper airway, the increased risk of ventilator associated pneumonia (VAP), the necessity of sedation are the unwanted complications of this modality. The complications observed with this traditional method have led to a resurgence of interest in NIPPV among physicians.

Recent studies have well defined the role of NIPPV in the management of ARF or acute onset chronic respiratory failure (6-16). The addition of NIPPV to standard care has a beneficial effect on survival and decreases the need for ETI (9-11). And the effect on survival is greatest in patients presenting with an acute exacerbation of underlying COPD.

It is hard to predict which patients would succeed in noninvasive ventilation. Ambrosino et al, has reported that only the baseline pH predicted success (sensitivity 97%, specificity 71%) (6). In randomised studies the efficacy of NIPPV, in avoiding ETI and improving the immediate outcome during the acute attacks in patients with COPD compared to the conventional therapy, has been shown (8,10,11,12). The improvement observed in patients with COPD can be explained by the improvement in the activity of the respiratory muscles, which is the main reason for the ventilatory failure.

In Brochard's study reduction in the transdiaphragmatic pressure and electromyographic activity of the diaphragm is observed with the application of NIPPV (8). The duration of NIPPV is controversial. In our study the duration of NIPPV was approximately 12 days. We preferred longer duration at the initial application and then switched to sequential use if the arterial pH ameliorated.

Confalonieri has reported that NIPPV in COPD improved not only immediate but also long-term outcome (13).

In patients with chest wall deformities, the benefit of NIPPV in acute and also chronic use is well defined in several studies (14-15). NIPPV raises the lung volume, improves lung compliance, and reduces dead space by recruitment of atelectatic lung. When we analyse our data, these patients with chest wall deformities showed significant improvement, although they all formed the elderly age group . And this group was the most compliant group during the application of NIPPV.

Although no benefit from this therapy was achieved in four of these patients, significant improvement was observed in the bronchiectasis group. The patients with severe cystic bronchiectasis due to severe childhood infections showed no amelioration.

The effect of NIPPV in patients with obstructive sleep apnea (OSA) is undebatable (15,16). Usually continous positive airway pressure (CPAP) is recommended in these patients, but our study group consisted of patients with overlap syndrome, therefore applying BIPAP seemed reasonable. Significant amelioration was obtained also in this group.

We performed NIPPV as a weaning mode as well (17). In four patients, NIPPV was used after extubation and the need for reintubation did not occur. Nava et al, has observed that NIPPV could be a good alternative as a weaning mode, especially in patients with COPD in whom the complications due to length of intubation is usually observed.

There is not much data revealing the use of NIPPV in patients with idiopathic pulmonary fibrosis (IPF). These patients usually present with hypoxemia. We tried this therapy since all the patients were in respiratory distress with severe hypoxemia. Both of these patients had honeycomb lung with end-stage disease. And this therapy resulted in symptomatic relief for a short period of time.

When we compared with the IMV group, ICU stay was shorter in the NIPPV group, although the difference was not significant.

When we evaluate the IMV group, it is obvious that IMV seems to be more effective in patients who don't have any other accompanying organ failures. And also it was interesting that we did not observe any VAP. This may be due to the isolated nature of our clinic (separate building), and also to the exclusion of trauma or postsurgery patients. This feature added to right antibiotic policies and the continuous education of the medical staff on the hygiene and hand washing are believed to be the reasons.

In conclusion, the respiratory care unit is beneficial in the follow-up of patients with ARF in terms of close monitorization and ventilatory support. The success of NIPPV in different types of underlying diseases decreases the need for IMV and thus decreasing the complication rate related to ETI. And it also increases bed availability in the traditional ICU's where some patients do not actually need intensive care causing a decrease in the health-related cost.

References

1. Nava S, Confalonieri M, Rampulla C. Intermediate Respiratory Intensive Care Units in Europe: A European Perspective. Thorax 1998; 53:798-802.
2. Elliott MW, Latham M. Noninvasive ventilation on a general ward. In: Roussos C. Mechanical ventilation from intensive care to home care. European Respiratory Monograph 1998; 8:348-363.
3. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med. 1985;13(10):818-29
4. Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti G, Rauss A, Simonneau G, Benito S, Gasparetto A, Lemaire F, Isabey D, Harf A. Noninvasive mechanical ventilation for acute exacerbations of chronic obstructive pulmonary disease. NEJM 1995; 333(13):817-822.
5. Byrick RJ, Mazer DC, Caskennette GM. Closure of an intermediate care unit, impact on critical care utilization. Chest 1993; 104:876-81.
6. Ambrosino N, Foglio K, Rubini F, Clini E, Nava S, Vitacca M. Non-invasive mechanical ventilation in acute respiratory failure due to chronic obstructive pulmonary disease: correlates for success. Thorax 1995; 50:755-57.
7. Meduri GU, Fox RC, Abou-Shala N, Leeper KV, Wunderink RG. Noninvasive mechanical ventilation via face mask in patients with acute respiratory failure who refused endotracheal intubation. Crit Care Med 1994; 22(10):1584-90.
8. Brochard L, Isabey D,Piquet J, Amaro P, Mancebo J, Messadi A, Brun-Buisson C, Rauss A, Lemaire F, Harf A. Reversal of acute exacerbations of chronic obstructive lung disease by inspiratory assistance with a face mask. NEJM 1990; 323:1523-30.
9. Hilbert G, Gruson D, Gbikpi-Benissan G, Cardinaud JP. Sequential use of noninvasive pressure support ventilation for acute respiratory exacerbations of COPD. Intens Care Med 1997; 23:955-961.
10. Kramer N, Meyer TJ, Meharg J, Cece RD, Hill NS. Randomized, Prospective trial of noninvasive positive pressure ventilation in acute respiratory failure. Am J Respir Crit Care Med 1995; 151:1799-806.
11. Çelikel T, Sungur M, Ceyhan B, Karakurt S. Comparison of non-invasive positive pressure ventilation with standard medical therapy in hypercapnic respiratory failure. Chest 1998; 114(6):1636-42.
12. Keenan SP, Kernerman PD, Cook DJ, Martin CM, McCormack D, Sibbald WJ. Effect of noninvasive positive pressure vventilation on mortality in patients admitted with acute respiratory failure. Crit Care Med 1997; 25(10): 1685-92.
13. Confalonieri M, Parigi P, Scartabellati A, Aiolfi S, Scorsetti S, Nava S, Gandola L. Noninvasive mechanical ventilation improves the immediate and long-term outcome of COPD patients with acute respiratory failure. Eur Respir J 1996; 9:422-30.
14. Criner GJ, Brennan K, Travaline JM, Kreimer D. Efficacy and compliance with noninvasive positive pressure ventilation in paitents with chronic respiratory failure. Chest 1999; 116(3): 667-75.
15. Shivaram U, Cash ME, Beal A. Nasal continuous positive airway pressure in decompansated hypercapnic respiratory failure as a complication of sleep apnea. Chest 1993; 104:770-74.
16. Piper AJ, Sullivan CE. Effects of short term NIPPV in the treatment of patients with severe obstructive sleep apnea and hypercapnia. Chest 1994; 105:434-440.
17. Nava S, Ambrosino N, Clini E, Prato M, Orlando G, Vitacca M, Brigada P, Fracchia C, Rubini F. Noninvasive mechanical ventilation in the weaning of patients with respiratory failure due to chronic obstructive pulmonary disease. Ann Intern Med 1998; 128(9):721-8.