

Effect of the presence of pneumonia on noninvasive ventilation success in chronic obstructive pulmonary disease cases with acute hypercapnic respiratory failure

Serdar AKPINAR^{1*}, Kazım ROLLAS¹, Evrim Eylem AKPINAR², Ali ALAGÖZ³, Nazire UÇAR¹, Yusuf Tuğrul ŞİPİT¹

¹Department of Chest Disease, Atatürk Chest Diseases and Chest Surgery Training and Research Hospital, Ankara, Turkey

²Department of Chest Disease, Faculty of Medicine, Ufuk University, Ankara, Turkey

³Department of Anesthesiology, Atatürk Chest Diseases and Chest Surgery Training and Research Hospital, Ankara, Turkey

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Aim: To investigate the effect of the presence of pneumonia on the success of noninvasive mechanical ventilation (NIMV) in chronic obstructive pulmonary disease (COPD) cases with acute respiratory failure.

Materials and methods: Sixty patients admitted to the intensive care unit (ICU) due to COPD exacerbation were included. The patients were divided into 2 groups as those with pneumonia (Group 1) and without pneumonia (Group 2). According to initial pH values, cases were also divided into 3 subgroups based on pH values. C-reactive protein (CRP), APACHE II scores, requirement of endotracheal intubation, mortality, and duration of ICU and hospital stay were also recorded.

Results: NIMV success was found to be 85.5% in Group 1 and 51.1% in Group 2. Endotracheal intubation rates were higher in Group 2 ($P = 0.008$). NIMV failure was 70.1% in Group 2 and 10% in Group 1 in patients with severe acidosis. The APACHE II scores and CRP levels were significantly higher and independent risk factors in patients with NIMV failure ($P < 0.002$, $P < 0.001$). A significant difference was not found between groups in terms of duration of hospital and ICU stays and mortality.

Conclusion: The presence of pneumonia in COPD cases is a factor that reduces NIMV success, but this does not affect mortality and the duration of ICU and hospital stay.

Key words: Respiratory failure, community-acquired pneumonia, noninvasive mechanical ventilation, chronic obstructive pulmonary disease

1. Introduction

Acute exacerbations are the most important cause of morbidity and mortality in chronic obstructive pulmonary disease (COPD) cases (1). Recurrent episodes (2 to 3 attacks per year) are frequently observed in the course of COPD (1,2). Hypoxic and hypercapnic respiratory failure may develop due to COPD exacerbation (3). Although endotracheal intubation and mechanical ventilation are life-saving procedures, dangerous complications such as infection and mechanical trauma are common. Noninvasive mechanical ventilation (NIMV) is an alternative approach to prevent complications in patients with respiratory failure. The advantages of NIMV are the maintenance of airway defense mechanisms, enabling to swallow and to speak, and the decreased sedation requirement (4,5). The advantages of NIMV, such as improvements in physiological parameters, respiration pattern, and arterial blood gases (ABG) measurements and decreases in complications, hospital stay, and

mortality, were demonstrated in controlled studies (6). Community-acquired pneumonia is a fatal infectious disease that has high treatment costs, particularly in elderly patients who have COPD, diabetes mellitus, congestive heart failure, and kidney failure (7). COPD is the most frequently observed (25%–50%) comorbidity in patients admitted to the hospital due to pneumonia (8). Although NIMV was found ineffective in the treatment of lower respiratory tract infections, it was demonstrated to reduce the intubation rate, intensive care unit (ICU) stay, and 2-month mortality rate in subgroups with underlying COPD (9–11). Particularly, a careful observation and the administration of NIMV under proper circumstances can be considered in pneumonia patients with underlying COPD. The presence of pneumonia accompanying acute COPD attacks that affect the achievement of NIMV is still under research. In this study, we aimed to investigate the effect of the presence of pneumonia on NIMV success in COPD cases with acute respiratory failure.

* Correspondence: drserdarakpinar@yahoo.com

2. Materials and methods

After approval from the institutional review board and patients, 60 COPD patients admitted to a respiratory ICU due to acute hypercapnic respiratory failure between March 2010 and March 2011 were included in this study. Patients with previously diagnosed COPD according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria and with any FEV1/FVC rate below 70% in spirometry were included in the study.

Cases with 1 major criterion (>38 °C temperature, coughing, presence of purulent secretion) or 2 minor criteria (dyspnea, chest pain, pulmonary consolidation findings in physical examination, leukocyte count $>12,000/\text{mm}^3$ or $<4000/\text{mm}^3$) confirming pneumonia, along with a newly formed infiltration in a chest X-ray, were considered as pneumonia. Cases in which pneumonia was considered to develop within 48 h after patient discharge from the hospital or 48 h after admission to the hospital were excluded (12). Cases were grouped as Group 1 (COPD acute respiratory failure [ARF] without pneumonia) and Group 2 (COPD ARF with pneumonia). In the case of an acute COPD attack, NIMV was routinely applied to patients based on general criteria (respiratory rate [RR] $>25/\text{min}$, $\text{PaCO}_2 >45$ mmHg, and pH <7.35). An acute attack was defined by the presence of 1 or several symptoms such as exacerbation in difficulty of breathing, purulent sputum production, coughing, fever, or an altered mental state for at least 24 h. Routine acute attack management included subcutaneous heparin, antibiotics, and bronchodilators (aerosolized salbutamol and ipratropium bromide, intravenous theophylline, corticosteroids), with the correction of electrolyte abnormalities started for all cases.

NIMV was performed using a standard-size oronasal mask with BIPAP (BiPap® Vision, Respironics, USA). Initially, the pressure-supported spontaneous mode expiratory positive airway pressure (EPAP) was adjusted to 5 cmH_2O , and the inspiratory positive airway pressure was adjusted to 12 cmH_2O . As long as it was tolerated by the patients and based on the changes in ABG, the pressure was then gradually increased to 1–2 cmH_2O . The maximum inspiratory positive airway pressure (IPAP) was 20 cmH_2O and the maximum EPAP was 8 cmH_2O .

Age, sex, body mass index (BMI), FEV1, the presence of an additional disease, serum CRP level, heart rate (HR), RR, APACHE II score, and the ABG measurements at the 1st, 4th, and 24th hours and after ICU discharge were all recorded. We also recorded complications, intubation requirements, first-month mortality, and the duration of ICU stay, hospital stay, and treatment.

Exclusion criteria were as follows: 1) respiratory and/or cardiac arrest; 2) intense secretion; 3) agitation and lack of cooperation; 4) unstable clinical condition (hypotensive shock, cardiac ischemia); 5) trauma, burns, or anatomic

disorders of the face that would prevent the mask from being secured; and 6) impaired cough and swallow reflex. These were all accepted as contraindications (13). The failure of NIMV was decided in cases of 1 major or 2 minor criteria within the first hour of NIMV (3). Major criteria were considered to be respiratory arrest, loss of consciousness, psychomotor agitation necessitating sedation, impaired hemodynamics (systolic blood pressure <70 mmHg or >180 mmHg), and bradycardia (HR <50 beats/min). Minor criteria were a RR of $>35/\text{min}$ that was also higher compared to the rate recorded at the time of initial presentation, arterial pH of <7.30 that was also lower compared to the initial presentation, PaO_2 being <45 mmHg despite oxygen support, and the absence of a cough reflex that would clear secretions. In addition, patients were divided into subgroups based on pH values as Group A (pH <7.25), Group B (pH 7.25–7.30), and Group C (pH ≥ 7.30). Intubation and mortality rates were compared for all groups.

2.1. Statistical analysis

Statistical analysis was performed using SPSS 16.0 (SPSS Inc., USA) for Windows. The results were expressed as mean \pm standard deviation. In the comparison between groups, the chi-square and t-tests were utilized. The Mann–Whitney U test was applied in the comparison between groups. The Friedman test was used to analyze the differences within time. The Bonferroni correction was administered when the differences within time were significant. P-values of less than 0.05 were considered to be statistically significant in all analyses.

3. Results

There was no statistically significant difference when groups were compared in terms of age, sex, BMI, accompanying diseases, FEV1 values during the stable illness before acute attack, and ABG values obtained at the time of admittance to the ICU. The RR, CRP levels, and initial APACHE II scores were found to be significantly higher in the group with pneumonia ($P = 0.013$, $P = 0.007$, and $P = 0.011$) (Table 1).

NIMV was performed in all cases, and it was successful for 85.5% of Group 1 and 51.1% of Group 2. When the groups were compared in terms of endotracheal intubation rate, it was significantly higher in Group 2 ($P = 0.008$) (Table 2).

A significant difference was not observed between the groups in terms of duration of ICU or hospital stay and mortality rate (Table 2). However, a significant improvement was found in both groups in terms of ABG, and there were no significant differences between the groups in terms of ABG parameters (Table 3). Intubation and mortality rate were found to be 10% in Group 1A (the COPD group, cases with pH of <7.25). These rates were

Table 1. Demographic, clinical, and functional characteristics of patients with COPD and COPD with pneumonia.

	COPD ARF (n = 35)	COPD + pneumonia (n=25)	P-value
Age (years)	69 ± 8	68 ± 9	0.79
Sex (female / male)	13 / 22	7 / 18	0.72
APACHE II score	18 ± 4	21 ± 4	0.011*
Respiratory rate (bpm)	28 ± 8	33 ± 6	0.013*
Body mass index	24 ± 3.9	24 ± 5	0.57
FEV1 (%)	38 ± 24	52 ± 11	0.14
C-reactive protein (mg/L)	7 ± 6	11 ± 6	0.007*
pH	7.27 ± 0.05	7.27 ± 0.04	0.772
PaCO ₂ (mmHg)	76 ± 15	74 ± 17	0.599
PaO ₂ (mmHg)	61 ± 37	50 ± 16	0.454
PaO ₂ / FiO ₂	165 ± 94	120 ± 58	0.029
HCO ₃ (mmol/L)	30 ± 8	29 ± 6	0.927

* P < 0.05 between the groups.

Table 2. Intubation requirement, duration of ICU and hospital stays, and mortality during noninvasive mechanical ventilation in patients with COPD and COPD with pneumonia.

	Group 1	Group 2	P-value
Intubation rate (% / n)	14.5 / 5	48.9 / 12	0.008*
Duration of ICU stay (days)	11 ± 8	12.5 ± 11	0.64
Duration of hospital stay (days)	21 ± 8	21 ± 14	0.38
Mortality (% / n)	11.4 / 4	28 / 7	0.17

*P < 0.05 between the groups.

Table 3. Arterial blood gas values in patients with COPD and COPD with pneumonia at admission, on the first day, and on their discharge from the ICU.

	Group 1			Group 2			P-value
	Admission	First day	Discharge	Admission	First day	Discharge	
pH	7.27 ± 0.05	7.40 ± 0.05	7.37 ± 0.12	7.27 ± 0.04	7.38 ± 0.05	7.35 ± 0.13	0.68
PaCO ₂ (mmHg)	76 ± 15	56 ± 13	50 ± 11	74 ± 17	55 ± 12	67 ± 35	0.05
PaO ₂ (mmHg)	61 ± 37	77 ± 22	70 ± 15	50 ± 16	66 ± 22	68 ± 20	0.56
PaO ₂ / FiO ₂	165 ± 94	210 ± 64	194 ± 54	120 ± 58	160 ± 71	162 ± 67	0.03
HCO ₃ (mmol/L)	30 ± 8	28 ± 8	27 ± 8	29 ± 6	31 ± 7	30 ± 8	0.37

found to be higher in Group 2A (71.4% and 28.6%) (Table 4). The CRP level and APACHE II scores were found to be significantly higher in groups with failed NIMV ($P = 0.002$, $P = 0.001$) (Table 5). APACHE II scores and CRP levels were also found to be independent risk factors for NIMV failure (odds ratio [OR] 1.21, 95% confidence interval [CI] 1.03–1.42, and OR 1.18, 95% CI 1.03–1.35).

4. Discussion

In the present study, NIMV treatment was successful for 85.5% of patients in Group 1 and 51.1% in Group 2. The rate of endotracheal intubation was higher in Group 2. NIMV failure was found at 70.1% in Group 2 and 10% in Group 1 in patients with severe acidosis. The APACHE II scores and CRP levels were significantly higher in patients with NIMV failure, whereas a significant difference was not found between the groups in terms of the duration of hospital and ICU stays and mortality.

Bacakoglu et al. found that NIMV treatment was successful in 63.0% of patients with respiratory failure due to COPD exacerbations, whereas treatment failure was observed in 20 (37%) patients (early failure in 11, late failure in 9) (14). NIMV success is still under debate in COPD cases with acute respiratory failure having pneumonia. Study results are variable in terms of the rates of mortality and endotracheal intubation in the presence of pneumonia accompanying COPD. High failure rates in NIMV in pneumonia-related ARF led to

disappointment. Failure rates of up to 66% have been reported for NIMV in ARF cases with severe community-acquired pneumonia (15,16). NIMV was demonstrated to reduce the endotracheal intubation rate, ICU stay, and 2-month mortality rates in only the group with underlying COPD among patients with severe community-acquired pneumonia (17). Zvezdin et al. reported pneumonia as the leading cause among early deaths in their postmortem analysis of 43 patients hospitalized due to COPD exacerbations (18). According to Rello et al., intubation and mortality rates were higher in pneumonia patients with COPD (88%) when compared to cases without COPD (30.1%) (19). In our study, the intubation and mortality rates were found to be higher in COPD ARF patients with pneumonia (48.9%) compared to the COPD ARF group (28%). We found high intubation and mortality rates, but they were lower than those of these other studies. These results confirmed the variability of study results.

Lieberman et al. compared 23 cases of COPD accompanied with pneumonia and 190 patients who had acute COPD attacks due to other reasons. According to their results, the intubation rate was 17%, the need for ICU 26%, and the rate of mortality 13% in the group with COPD with pneumonia (20). In our study, intubation and mortality rates were higher than in the study of Lieberman et al. The main reason for these results might be related to the high number of patients who had severe acidosis in the COPD pneumonia ARF group.

Table 4. Each group was divided into 3 subgroups as pH of <7.25, 7.25–7.30, and >7.30 based on the patients' initial pH values, intubation rate, and mortality.

	Subgroups			Subgroups		
	1A	1B	1C	2A	2B	2C
pH	< 7.25	7.25–7.30	7.30–7.35	< 7.25	7.25–7.30	7.30–7.35
n	10	13	12	7	11	7
Intubation % / n	10 / 1	23.1 / 3	8.3 / 1	71.4 / 5	36.4 / 4	42.9 / 3
Mortality % / n	10 / 1	15.4 / 2	8.3 / 1	28.6 / 2	18.2 / 2	42.9 / 3

Table 5. CRP level and APACHE II score in patients with success and failure with NIMV.

	NIMV success (n = 43)	NIMV failure (n = 17)	P-value
CRP (mg/L)	7.5 ± 6.4	12.9 ± 5.2	0.002*
APACHE II score	18.3 ± 4.1	22.4 ± 4.2	0.001*

CRP: C-reactive protein. * $P < 0.05$ between the groups.

Güngör et al. concluded that the presence of pneumonia did not influence the duration of ICU stay in COPD patients with ARF (21). Our results were similar in this study in terms of duration of ICU stay and hospital stay. Therefore, the presence of pneumonia is not a negative factor in performing NIMV in COPD cases.

It has been reported in previous studies that failure of NIMV occurred at rates ranging from 52% to 62% in COPD cases with severe respiratory acidosis (pH of <7.25) (17,22,23). Even though the risk of failure in severe cases is high, NIMV, if endotracheal intubation is not obligatory, is recommended to protect the airways and to prevent a loss of consciousness and difficulty in breathing in ARF due to COPD (17,22–24). Despite all these results, the number of randomized controlled studies on patients with COPD plus pneumonia with severe respiratory acidosis is quite low. Scala et al. performed noninvasive or invasive mechanical ventilation in a group of COPD patients who had an attack period with severe acidosis. According to their results, those who had noninvasive ventilation had a lower duration of hospital stay and mechanical ventilation and lower complication rates, and a difference was not observed between the 2 groups in terms of 1-year mortality and hospital mortality. They also reported the failure rate of NIMV as 35% (25). In our study, noninvasive ventilation failure in COPD pneumonia cases with severe respiratory acidosis (pH <7.25) was found to be 71.4%, and 1-month mortality was 28%. In ARF cases with COPD exacerbation due to other reasons, the intubation rate was found to be 10% and mortality rate to be 12%. In COPD pneumonia cases with ARF, NIMV success was quite low in patients with pH values below 7.25, and there is a need to observe randomized controlled studies that have a greater number of cases.

APACHE II is a frequently used scoring system in determining the severity of a disease and has a

high reliability (26). Amrossino et al. demonstrated significantly higher APACHE II values in the group in which NIMV failed compared to those who had success with NIMV (the mean APACHE II score was 24 in the failed group and 18 in the successful group) (27). Soo Hoo et al. measured the mean APACHE II scores as 21 ± 4 in the failed group and 15 ± 4 in the successful group (28). Confalonieri et al. reported good indicators for evaluating the prospects of success through 4 individual parameters, which were APACHE II scores, pH, RR, and the Glasgow Coma Scale (29). Kaya et al. evaluated 95 patients with acute hypercapnic respiratory failure and found that APACHE II scores and high CRP levels were predictable factors in NIMV failure (30). In our study, APACHE II scores and CRP levels were found to be significantly higher in the group with NIMV failure (the mean APACHE II scores were 22 ± 4 in the failed group and 18 ± 4 in the successful group). When both groups were compared, APACHE II scores and CRP levels were established as significantly higher in the group with COPD plus pneumonia. Moreover, both of these parameters were found as independent risk factors for NIMV success. These results show that in cases with high APACHE II scores and CRP levels, the possibility of failure was also observed to be strong.

In conclusion, the presence of pneumonia in COPD cases with acute respiratory failure is a factor reducing the success rate of NIMV, but it does not affect mortality or the duration of ICU and hospital stay. High APACHE II scores and serum CRP levels independently correlate with NIMV failure. However, the rate of NIMV failure is very high in COPD pneumonia cases with severe acidosis, and therefore NIMV should be an alternative in these cases. Detailed studies with a high number of severe acidosis cases are necessary to confirm these results.

References

1. Siafikas NM, Vermeire P, Pride NB, Paoletti P, Gibson J, Howard P et al. ERS consensus statement. Optimal assessment and management of chronic obstructive pulmonary disease (COPD). *Eur Respir J* 1995; 8: 1398–420.
2. Lightowler JV, Wedzicha JA, Elliott MW, Ram FS. Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. *BMJ* 2003; 326: 185–9.
3. Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti G, Raus A et al. Non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. *N Eng J Med* 1996; 333: 817–22.
4. Meduri GU, Conoscenti CC, Menashe P, Nair S. Non-invasive face mask ventilation in patients with acute respiratory failure. *Chest* 1989; 95: 865–70.
5. Brochard L, Isabey D, Piquet J, Amaro P, Manjebo J, Messabi AA et al. Reversal of acute exacerbation of chronic obstructive lung disease by assistants with face mask. *N Eng J Med* 1990; 323: 1523–30.
6. Bott J, Carroll MP, Conway JH, Keilty SE, Ward EM, Brown AM et al. Randomized controlled trial of nasal ventilation in acute ventilatory failure due to chronic obstructive airways disease. *Lancet* 1993; 341: 1555–7.
7. Niederman MS, McCombs JS, Unger AN, Kumar A, Popovian R. The cost of treating CAP. *Clin Ther* 1998; 20: 820–37.

8. Rosa Celis M, Torres A, Zalacain R, Aspa J, Blanquer J, Blanquer R et al. Metodos de diagnostico y tratamiento de la pneumonia adquirida en la comunidad en Espana: Estudio NACE [Diagnostic methods and treatment of community-acquired pneumonia in Spain: NACE study]. *Med Clin (Barc)* 2002; 119: 321–36 (article in Spanish with English abstract).
9. Antonelli M, Conti G, Moro ML, Esquinas A, Gonzales-Diaz G, Confalonieri M et al. Predictors of failure of noninvasive positive pressure ventilation in patients with acute hypoxemic respiratory failure: a multicenter study. *Intensive Care Med* 2001; 27: 1718–28.
10. Puha J, Kong K, Lee KH, Shen L, Lim TK. Noninvasive ventilation in hypercapnic acute respiratory failure due to chronic obstructive pulmonary disease versus other conditions: effectiveness and predictors of failure. *Intensive Care Med* 2005; 31: 533–9.
11. Confalonieri M, Potena A, Carbone G, Porta RD, Tolley EA, Meduri GU. Acute respiratory failure in patients with severe community-acquired pneumonia: a prospective randomized evaluation of noninvasive ventilation. *Am J Respir Crit Care Med* 1999; 160: 1585–91.
12. Turkish Thoracic Society. Consensus report on diagnosis and treatment of community-acquired pneumonia in adults. *Toraks* 2009; 10 (Suppl. 6): 1–24.
13. British Thoracic Society Standards of Care Committee. BTS guideline. Noninvasive ventilation in acute respiratory failure. *Thorax* 2002; 57: 192–211.
14. Bacakoğlu F, Taşbakan MS, Başoğlu ÖK, Öz AT, Ürkmez S, Midilli M et al. The factors affecting noninvasive mechanical ventilation failure in COPD exacerbations. *Turk J Med Sci* 2012; 42: 103–12.
15. Keenan SP, Sinuff T, Cook DJ, Hill NS. Does noninvasive positive pressure ventilation improve outcome in acute hypoxemic respiratory failure? A systematic review. *Crit Care Med* 2004; 32: 2516–23.
16. Joliet P, Abajo B, Pasquina P, Chevrolet JC. Non-invasive pressure support ventilation in severe community-acquired pneumonia. *Intensive Care Med* 2001; 27: 812–21.
17. Gursel G. Determinants of the length of mechanical ventilation in patients with COPD in the intensive care unit. *Respiration* 2005; 72: 61–7.
18. Zvezdin B, Milutinov S, Kojicic M, Hadnadjev M, Hromis S, Markovic M et al. A postmortem analysis of major causes of early death in patients hospitalized with COPD exacerbation. *Chest* 2009; 136: 329–30.
19. Rello J, Rodriguez A, Torres A, Roig J, Sole-Violen J, Garnacho-Montero J et al. Implications of COPD in patients admitted to the intensive care unit by community-acquired pneumonia. *Eur Respir J* 2006; 27: 1210–6.
20. Lieberman D, Lieberman D, Gelfer Y, Varshavsky R, Dvoskin B, Leinonen M et al. Pneumonic vs nonpneumonic acute exacerbation of COPD. *Chest* 2002; 122: 1264–70.
21. Güngör G, Yazıcıoğlu Moçin Ö, Acartürk E, Başbuğ Y, Saltürk C, Yalçınsoy M et al. The influence of community-acquired pneumonia to the clinical course in COPD cases admitted to intensive care unit with acute respiratory failure. *Tub Toraks J* 2010; 58: 408–17.
22. Amrossino N, Vagheggin G. Noninvasive positive pressure ventilation in the acute care setting: where are we? *Eur Respir J* 2008; 31: 874–86.
23. Conti G, Antonelli M, Navalesi P, Rocco M, Bufi M, Spadetta G et al. Noninvasive versus conventional mechanical ventilation in patients with chronic obstructive pulmonary disease after failure of medical treatment in the ward: a randomized trial. *Intensive Care Med* 2002; 28: 1701–7.
24. Squadrone E, Frigerio P, Fogliati C, Gregoretti C, Conti G, Antonelli M et al. Noninvasive versus invasive ventilation in COPD patients with severe acute respiratory failure deemed to require ventilatory assistance. *Intensive Care Med* 2004; 30: 1303–10.
25. Scala R, Nava S, Conti G, Antonelli M, Naldi M, Archinucci I et al. Noninvasive versus conventional ventilation to treat hypercapnic encephalopathy in chronic obstructive pulmonary disease. *Intensive Care Med* 2007; 33: 2101–8.
26. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: A severity of disease classification system. *Crit Care Med* 1985; 13: 818–29.
27. Ambrosino N, Foglio K, Rubini F, Clini E, Nava S, Vitacca M. Noninvasive mechanical ventilation in acute respiratory failure due to chronic obstructive pulmonary disease: correlates for success. *Thorax* 1995; 50: 755–7.
28. Soo Hoo GW, Santiago S, Williams J. Nasal mechanical ventilation for hypercapnic respiratory failure in chronic obstructive pulmonary disease: determinants for success and failure. *Crit Care Med* 1994; 27: 417–34.
29. Confalonieri M, Gorini M, Ambrosino N, Mollica C, Corrado A. Respiratory intensive care units in Italy: a national census and prospective cohort study. *Thorax* 2001; 56: 373–8.
30. Kaya A, Çiledağ A, Çaylı İ, Önen ZP, Şen E, Gülbay B. Associated factors with noninvasive mechanical ventilation failure in acute hypercapnic respiratory failure. *Tub Toraks J* 2010; 58: 128–34.