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Onur TURAN
Can SEVİNÇ

RESEARCH

HOME NON-INVASIVE MECHANICAL VENTILATION THERAPY IN ELDERLY COPD PATIENTS

ABSTRACT

Introduction: Home non-invasive mechanical ventilation has been widely used in recent years as a treatment for chronic obstructive pulmonary disease in patients with chronic hypercapnic respiratory failure. We aimed to evaluate the use of home mechanical ventilation therapy in elderly patients.

Materials and Method: Chronic obstructive pulmonary disease patients with hypercapnic respiratory failure using home mechanical ventilation over age 65 were investigated cross-sectionally in Dokuz Eylul University Hospital between 2009-2011.

Results: The 31 patients (23 male and 8 female) had a mean age of 66.2±11.1.The most common application symptom was dyspnea; symptoms were found to regress in 63.4% of the group according to the Borg scale. Patients used mechanical ventilation for an average time of 4.6±3.9 h/day. 24 patients (77.4%) reported no problems with vehicle adherence. It was found that pH increased from 7.37 to 7.40 (p=0.07) and PaCO2 decreased from 64.3 mmHg to 50.1 mmHg (p<0.001) in a statistically significant way in arterial blood gas after mechanical ventilation therapy. Mean FEV1 value increased from 0.76 L to 0.80 L (% predicted from 31.6% to 32.2%).Emergency visits decreased from 1.6/year to 0.9/year, and a 1.3/year hospitalization rate decreased to 0.7/year after home mechanical ventilation therapy, both of which were statistically significant (p=0.044 and p=0.003, respectively).

Conclusion: Elderly chronic obstructive pulmonary disease patients on a home mechanical ventilation program were found to have good treatment adherence, reduction in dyspnea, decrease in acidosis and hypercapnia, functional improvement, and a lower number of emergency visits and hospitalizations. These results show that home mechanical ventilation treatment can provide medical benefits.

Key Words: Pulmonary Disease; Chronic Obstructive; Aged; Respiration, Artificial

ARAŞTIRMA

YAŞLI KOAH HASTALARINDA EVDE NON-İNVAZİV MEKANİK VENTİLASYON TEDAVİSİ

ÖZ

Giriş: Kronik obstruktif akciğer hastalığında kronik solunum yetmezliğinin tedavisinde evde non-invaziv mekanik ventilasyon tedavisi, son yıllarda kullanımı giderek artan önemli bir tedavi açılımıdır. Yaşlı kronik obstruktif akciğer hastalığı olanlarda ev mekanik ventilasyon tedavisi etkinliğinin değerlendirilmesi amaçlandı.

Gereç ve Yöntem: Bu çalışmada,2009-2011 yılları arasında Dokuz Eylül Üniversitesi Hastanesi'nde görülen ve kronik obstruktif akciğer hastalığına bağlı hiperkapnik solunum yetmezliği nedeniyle evde mekanik ventilasyon tedavisi düzenlediğimiz 65 yaş üstü 31 hasta kesitsel olarak incelendi.

Bulgular: Yirmi üç erkek (%74,2), 8 kadın (%25,8) toplam 31 olgunun yaş ortalaması 66,2±11,1 idi. En sık görülen semptom (tedavi öncesi) olan dispne, non-invaziv mekanik ventilasyon tedavisi sonrasında Borg skalasına göre %63,4 hastada azalmıştı. Günde ortalama cihaz kullanım süresi 4,6±3,9 saat idi. Olguların 24'ü (%77,4) tedaviye uyum sağlamakta sorun yaşamadıklarını belirtti.Tedavi öncesi ve sonrası arter kan gazı analizlerinde; pH'da 7,37'den 7,40'a yükselme (p=0,07) ve PaCO2'de 64.3 mm Hg'dan 50.1 mmHg'ya düşme (p<0,001) anlamlı olarak bulundu. Ortalama FEV1 değerinin, tedavi ile 0.76 L'den 0.80 L'ye (% beklenen: % 31.6'dan % 32.2'ye) yükseldiği gözlendi. Acil servis başvurularının evde mekanik ventilasyon tedavisi sonrası 1.6/yıl'dan 0.9/yıla, kronik obstruktif akciğer hastalığı ve solunum yetmezliğine bağlı hastaneye yatış sıklığının 1.3/yıl'dan 0.7/yıla, anlamlı olarak gerilediği belirlendi (p=0.044 ve p=0.003).

Sonuç: Yaşlı kronik obstruktif akciğer hastalığı olanlarda evde mekanik ventilasyon tedavisine hasta uyumunun iyi olduğu, dispnenin azaldığı, asidoz ve hiperkapnide düzelme olduğu, düzeylerinin gerilediği, fonksiyonel düzelme sağlandığı, acil servis başvurularının ve hastaneye yatış sıklığının azaldığı görülmüştür. Sonuç olarak, yaşlı evde non-invaziv mekanik ventilasyon tedavisiyle önemli medikal kazanımlar sağlanmaktadır.

Anahtar Sözcükler: Mekanik Ventilasyon Uyumu; Kronik Hiperkapnik Solunum Yetmezliği; Kronik Obstruktif Akciğer Hastalığı; Yaşlı Hastalar; Evde Non-invaziv Mekanik Ventilasyon.

Correspondance

Onur TURAN
Dokuz Eylul University, Faculty of Medicine,
Department of Chest Diseases İZMİR

Phone: 0505 525 28 43
e-mail: onurtura@yahoo.com

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Dokuz Eylul University, Faculty of Medicine,
Department of Chest Diseases İZMİR

Introduction

Chronic obstructive pulmonary disease (COPD) is a major health problem with high mortality and morbidity rates, despite medical and surgical therapies and long-term oxygen therapy (1). Several retrospective reports have demonstrated the efficacy of non-invasive mechanical ventilation (NIMV) in acute (2) and chronic respiratory failure (3). The use of NIMV in acute respiratory failure due to COPD exacerbation reduces the need for intubation, the length of hospitalization, and mortality, which is very important for COPD patients (2). However, the evidence on the use of NIMV in severe and stable COPD patients is inconsistent (4).

Dysfunction of the respiratory muscles, especially the diaphragm, is an important problem that occurs in patients with COPD. NIMV may improve respiratory muscle function by providing a rest for chronically tired respiratory muscles in COPD patients (5).

NIMV provides aeration of the lungs with positive airway pressure by increasing transpulmonary pressure. Airflow obstruction leads to expiratory flow limitation and an increase in airway resistance. Hyperinflation exists with the increasing end-expiratory lung volume due to an airflow limitation (6). NIMV also has great benefits in COPD by decreasing airway resistance, end-expiratory lung volume and the level of dynamic hyperinflation (7).

Home non-invasive mechanical ventilation (NIMV) has been widely used in recent years for the treatment of COPD patients with chronic hypercapnic respiratory failure. NIMV has been reported to have a positive impact on the number of hospitalizations (8) and quality of life of COPD patients (9). Home NIMV was also showed to be effective at minimising costs in COPD treatment (10). Nowadays, thousands of people in the world use home bi-level positive airway pressure (BiPAP) treatment. In the Eurovent study, which included 16 European countries, the estimated prevalence of patients performing home NIMV was found to be 6.6/100,000 (9).

Chronic obstructive pulmonary disease is a disease generally seen in older patients (11). Elderly COPD patients have a high risk of developing respiratory failure with limited pulmonary reserve, loss of muscle mass and an increased number of other comorbidities.

Although most studies in the literature have demonstrated the positive impacts of home NIMV, some have shown that long term BiPAP therapy has limited positive effects (7). On the other hand, there are only a few studies that specifically focus on home NIMV in an elderly population with COPD. The aim of our study was to demonstrate the effects of home NIMV in elderly COPD patients.

Materials and Method

Thirty-one COPD patients who had been using BiPAP machines at home because of hypercapnic respiratory failure were asked to participate in the study. The patients, who had been followed by the chest diseases department in the Medical Faculty of Dokuz Eylül University, were found using hospital database records from 2009 to 2011. Written informed consent was obtained from all of the patients, and the study was approved by the Ethics Committee of the hospital.

Chronic obstructive pulmonary disease patients who used home NIMV and met the inclusion criteria are described in Table 1. Patients with other diagnoses for alveolar hypoventilation, those who declined to join the study, or those who had a contraindication for the pulmonary function test (PFT) or arterial blood gas (ABG) analysis were excluded. Patients with an exacerbation or hospitalization phase of COPD were evaluated when they became clinically stable. 31 of 45 eligible patients agreed to join the study.

Thirty-one COPD patients aged 65 and older who had been using home BiPAP for a while were invited to our university hospital and were evaluated on the following during a single visit:

- Socio-demographic variables,
- Respiratory symptoms,
- Arterial blood gas analysis,
- Spirometric parameters,
- Questionnaire about home NIMV (ventilator and mask types, all ventilator settings, duration of home NIMV use, average ventilation time per day (hour/day), adherence to the BiPAP machine, etc.)

Table 1— NIMV Indications in COPD.

1. Symptoms (dyspnea, morning headache and general fatigue etc.)
AND
2. Physiological criteria
a. $PaCO_2$ >55 mmHg
OR
b. $PaCO_2$ 50-54 mmHg with:
Nocturnal oxygen desaturation:
O_2 saturation: <88% for 5 minutes with min. 2 L/min O_2 therapy
OR
Hospitalization min. two times/year with hypercapnic respiratory failure

- Number of emergency admissions and hospitalizations (including the periods of one year before and after home BiPAP therapy).

Patients were questioned about changes in their pulmonary symptoms after the beginning of NIMV treatment; the increases, decreases or stable position of the symptoms were recorded. Dyspnea was assessed using the Borg scale (12).

All patients underwent the standard spirometry used at our university hospital, a Vmax 22 system (Sensor Medics Pulmonary Function Analysis Instrument) following the guidelines of the American Thoracic Society (13). Flow was measured at the mouth through a mass flow sensor, and volume was obtained by numerical integration of the flow signal. Forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC) and forced expiratory volume during the first second/forced vital capacity (FEV1/FVC) were evaluated. These values were calculated from three reproducible maximal forced expiratory maneuvers. In patients with FEV1/FVC lower than 70%; FEV1 over 80% represents mild, between 50-79% represents moderate, 30-49% represents severe and lower than 30% represents very severe COPD, according to the GOLD criteria (14).

Arterial blood gas analysis for blood obtained from the radial artery was performed at rest and in a sitting position. ABG was measured at least 30 minutes after the withdrawal of oxygen or BiPAP usage.

Ventilator and mask types, and all ventilator settings including inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP) values were recorded. The total duration of home use of NIMV (determined from the mechanical ventilation device counter), average ventilation time per day (hours/day), and adherence to the BiPAP machine were investigated. Patients learned that if they had a problem with the ventilator, they could receive technical support. We also recorded all hospital and emergency department admissions, including hospitalizations one year before and after the use of home NIMV.

The values of PFT and ABG, and emergency admissions and hospitalizations because of COPD exacerbation or respiratory failure before and after BiPAP treatment were compared. The initial values of PFT and ABG, according to reports given to COPD patients using home NIMV, were used in this comparison; they were known to be the last parameters of PFT and ABG before they started to use home BiPAP (pre-BiPAP data). We ensured that patients' initial data belonged to a clinically stable period of COPD without any exacerbation. Every visit for each patient for the evaluation of home NIMV therapy and monitoring of ABG and PFT was also made during a stable period of COPD. ABG analysis was performed without oxygen.

The differences between the initial and new parameters of patients were evaluated by t-tests for dependent groups, and by paired-samples t-tests for nonparametric data. All data were analyzed using SPSS.

RESULTS

Thirty-one patients with a mean age of 66.2 11.1, including 23 males and 8 females, participated in the study.

Our sample included 5 (16.1%) moderate (these patients with respiratory acidosis had started to use home NIMV), 9 (29%) severe and 17 (54.9%) very severe COPD patients, according to COPD classification criteria (14). The most common comorbid disease was hypertension (54.8%).

Patients been diagnosed with COPD for an average of 8.97±4.72 years. The average duration of BiPAP machine use was 16.6 months. Chronic obstructive pulmonary disease patients had started using home BiPAP therapy 7.60±4.73 years after diagnosis. Patients used NIMV an average of 4.6 h/day. Average EPAP and IPAP values were 5.4±1.5 cm F H_20 (min. 4, max. 11) and 11.4±2.1 cm H_20 (min. 8, max. 16), respectively.

Twenty-seven COPD patients (87.1%) were also on long-term oxygen therapy (LTOT), while 14 patients were also using home nebulizers (45.2%).

Twenty-four patients (77.4%) reported no problems with BiPAP adherence. Twelve patients (38.7%) were having trouble with NIMV; inadaptability to the BiPAP machine was the most frequent problem (Figure 1).

Technical service for the BiPAP machines was supplied to 25.8% of patients, while 63.6% reported problems in getting help with their BiPAP machines.

Seventeen (54.8%) patients used nasal and 14 (45.2%) used oronasal masks. Only five patients (16.1%) reported trouble with the BiPAP masks.

Dyspnea was found to be the most common symptom (74.2%) in our study patients; the other symptoms were cough (45.2%) and sputum (29%).

Symptoms were said to regress in 20 (64.5%), increase in 4 (12.9%) and remain unchanged in 7 (22.6%) study patients after they used home NIMV. The Borg scale point, which had a mean of 5.0 ± 2.5 before home NIMV, decreased to 3.6±2.9 after therapy; this difference was statistically significant (p=0.001).

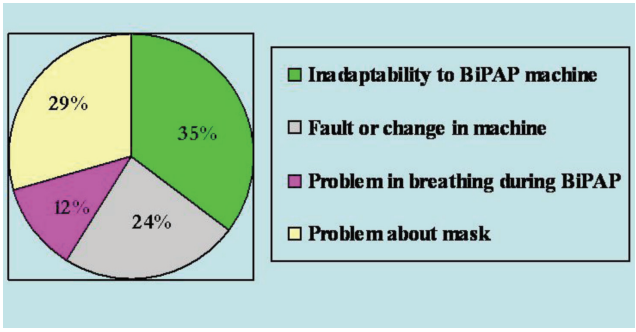

Figure 1— Problems about BiPAP adherence.

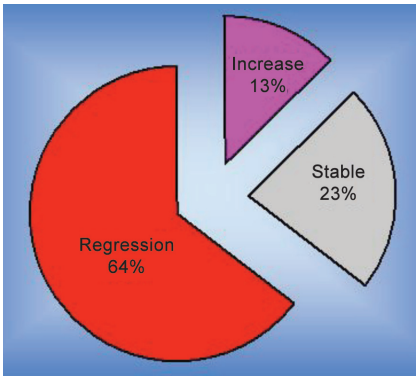

Figure 2— Comparison of ABG parameters before and after home BiPAP therapy.

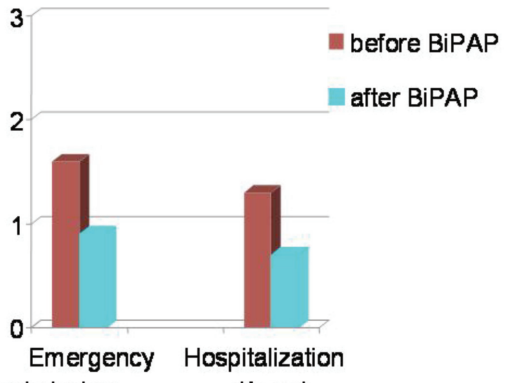

Figure 3— Emergency admissions and hospitalizations before and after home NIMV.

Arterial blood gas analysis before and after NIMV were compared (Table 2); it was found that pH increased from 7.37 to 7.40, $PaCO_2$ value decreased from 64.3 ± 8.3 mmHg to 50.1±7.2 mmHg (which was statistically significant; p=0.001), and average PaO_2 value increased from 63.9±18.4 mmHg to 69.1±15.2 mmHg (p=0.292) (Figure 2).

Spirometric parameters before and after home BiPAP therapy were also compared. Mean FEV1 value increased from 0.76 L to 0.80 L (% predicted from 31.6% to 32.2%) after the use of home NIMV. Average FEV1/FVC value increased from 53.3% to 55.3% (p=0.230).

Emergency visits decreased significantly from 1.6/year to 0.9/year with the use of home NIMV (p=0.047); in addition, the 1.3/year hospitalization rate (because of COPD exacerbation or respiratory failure) became 0.7/year after home BiPAP therapy, which was statistically significant (p=0.013) (Figure 3).

Discussion

NIMV is generally known to be an effective treatment for COPD patients with acute hypercarbic respiratory failure. NIMV may decrease the need for invasive mechanical ventilation in these patients (15). It was demonstrated that selected populations of chronic hypercapnic COPD patients may show clinical and physiologic responses with home NIMV (16). So, NIMV is also a promising method of treatment for COPD patients with chronic respiratory failure as a home ventilatory support.

To our knowledge, pulmonary symptoms, especially dyspnea, have been found to regress after the use of home NIMV

Table 2— ABG and Spirometric Parameters Before and After Home NIMV Treatment.

ABG and Spirometric Parameters	Before Home NIMV Treatment	After Home NIMV Treatment	p
$Pa0_2$, mm Hg	63.9±18.4	69.1±15.2	0.292
PaCO2, mm Hg	64.3±8.3	50.1±7.2	**0.001**
pH	7.37±0.08	7.40±0.04	0.070
FEV_1, L	0.76±0.3	0.80±0.3	0.939
FEV_1, %	31.6±12.5	32.2±14.3	0.863
FEV_1 / FVC, %	53.3±9.9	55.3±12.4	0.220

in most patients. Renston et al. demonstrated a low dyspnea score with home NIMV therapy (17). There have been some reports showing an improvement in maximal inspiratory pressure (MIP) and electromyographic activity of the diaphragm (18), which support our results of improvement in dyspnea.

The results of our study showed a positive impact on ABG levels with home BiPAP treatment. Meecham Jones et al. found significant improvements in daytime gas exchange compared with baseline ABG values in their NIMV group (19). They also suggested that patients with near normocapnia received less benefit from home NIMV treatment. The reason for this result was defined as a compensation mechanism for nocturnal hypoventilation in hypercapnic patients who responded better to nocturnal ventilation (19).

Spirometric parameters such as FEV1 value increased after the use of home NIMV in our study. Most of the previous studies reported no change in pulmonary functions after home BiPAP therapy (19). It is thought that the improvement in respiratory muscle function after NIMV therapy may be the reason for the increase in FEV1 value.

Our study demonstrated a 50% reduction in the event rate of emergency admissions after home NIMV treatment, which seems to be a remarkable result. As the rising morbidity and mortality from COPD is coupled with increasing rates of emergency admissions, the reduction in emergency visits may indicate an improvement in the life expectancy of COPD patients.

There was a reduction in the number of hospitalizations for exacerbations and respiratory failure in COPD patients after home NIMV therapy. Some studies demonstrated that there had been a reduction in the number of hospitalizations one year after home NIMV (20). The length of time COPD patients spent in hospital because of cardiac or respiratory illness may decrease after NIMV therapy. Studies on home NIMV treatment have reported an increase in quality of life with the reduction of hospitalizations (8). The cost-effectiveness of home BiPAP treatment has also been shown, related to a significant reduction in the number of hospitalizations (10). Although there are some reports showing that NIMV had no effect on exacerbations or hospital admissions after 1 year (8), with studies showing positive results in the majority, it is suggested that home NIMV therapy may be useful for COPD patients by decreasing the rate of hospitalization.

Adherence to the BiPAP machine is another important parameter for evaluating home NIMV therapy in COPD patients; patient–ventilator dyssynchrony may be a cause of suboptimal ventilation. In our study, nearly three-fourths of the patients reported no adherence problems in using home NIMV. Most patients were reported to tolerate home mechanical ventilation reasonably well in a study by Chu et al (21). It has been reported that NIMV is effective if it is set on the basis of patient comfort, with a synchrony with the patient's respiratory muscle effort and mechanics (22). We found the most frequent problem in using home NIMV was inadaptability to the BiPAP machine. We suggest that COPD patients may have more benefits from long-time NIMV therapy if clinicians observe and evaluate their adherences to home ventilators before and during NIMV treatment.

Some technical problems might cause a temporary suspension of mechanical ventilation. Karakurt et al. showed that even a brief withdrawal of NIMV in patients with chronic hypercapnic respiratory failure may lead to worsening of ABG levels and symptoms (23). Therefore, technical support and solving problems with BiPAP machines are important for COPD patients with home NIMV.

The average BiPAP usage time was found to be 4.6 hours per day in our study. It has been reported that COPD patients with chronic respiratory failure require mechanical ventilation for over 12 hours per day (23), which is much longer than our results show. We suggest that patients should be asked about their daily usage time of home NIMV for the ideal management of mechanical ventilation.

Regression in mortality rate is an important endpoint that demonstrates the success of home NIMV treatment for COPD patients. Although there is no conclusive evidence that home BiPAP treatment increases survival in COPD patients, there are hopeful studies on this subject (10). It was observed that the mean survival time in the group receiving domiciliary NIMV was significantly higher than that of the group not receiving NIMV in a study (24). Follow-up of COPD patients with home NIMV in a prospective study may contribute to our understanding of the effect of this treatment on survival rates.

Although most of the studies have shown the feasibility of home NIMV in COPD patients, some studies revealed different results. Casanova et al. (7) showed that long term NIMV had no effect on exacerbations or hospital admissions. Therefore, our study had important results that demonstrated the positive impacts of home NIMV with COPD patients. Despite the many studies on the use of home NIMV, its use with a specifically selected elderly population with COPD has rarely been studied. Balami et al. specified that elderly patients may gain similar benefits from NIMV as do younger patients with

COPD, who have a high rate of treatment success (25). Our study is one of only a few studies to examine home NIMV in elderly COPD patients.

There are some limitations of our present study. The first is the small number of elderly COPD patients with home NIMV. Our cross-sectional study design may be the reason for this. Lack of a control group is also a limitation of our study. Another limitation is the subjective reporting of the parameters of pulmonary symptoms and patient adherence to the mechanic ventilator. These data depended on the comments of the patients. An objective method for collecting these data may increase the reliability of the study. Further, larger studies of home NIMV in elderly COPD patients are required to confirm our results.

In conclusion, COPD patients on a home mechanical ventilation program were found to have a good treatment adherence, reduction in dyspnea, decrease in acidosis and hypercapnia, functional improvement, and a decrease in emergency visits and hospitalization. It is suggested that home NIMV is a promising therapeutic modality for management of chronic hypercapnic COPD patients, with medical and economic benefits. Home NIMV is as well tolerated and as successful in an older as in a younger population of COPD patients with chronic hypercapnic failure.

Conflict of Interest

No potential conflicts of interest are disclosed.

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