

## Original Article

## Does Home Oxygen Therapy Slow Down the Progression of Chronic Obstructive Pulmonary Diseases?

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**Purpose:** As the National Health Insurance Service (NHIS) began to cover home oxygen therapy (HOT) services from 2006, it is expected that the new services have contributed to overall positive outcome of patients with chronic obstructive pulmonary disease (COPD). We examined whether the usage of HOT has helped slow down the progression of COPD. **Methods:** We examined hospital claim data (N=10,798) of COPD inpatients who were treated in 2007~2012. We performed  $\chi^2$  tests to analyze the differences in the changes to respiratory impairment grades. Multiple logistic regression analysis was used to identify factors that are associated with the use of HOT. Finally, a generalized linear mixed model was used to examine association between the HOT treatment and changes to respiratory impairment grades. **Results:** A total of 2,490 patients had grade 1 respiratory impairment, and patients with grades 2 or 3 totaled 8,308. The OR for use of HOT was lower in grade 3 patients than others (OR: 0.33, 95% CI: 0.30~0.37). The maintenance/mitigation in all grades, those who used HOT had a higher OR than non-users (OR: 1.41, 95% CI: 1.23~1.61). **Conclusion:** HOT was effective in maintaining or mitigating the respiratory impairment in COPD patients.

**Key Words:** Chronic obstructive pulmonary disease, Oxygen inhalation therapy, Home care services, Respiratory mechanics

## INTRODUCTION

Chronic obstructive pulmonary disease (COPD) causes closure of the airway without lung/heart disease as a particular cause. It causes continuous aggravation of lung function, which can lead to death (1-3). According to the 2011 World Health Organization (WHO), 6,400 million people worldwide suffer from COPD, and COPD was ranked fourth among all causes of death (4). Thus, COPD has a substantial impact on

the health of the world's population. According to the National Health Insurance Service (NHIS), the number of COPD patients who visit medical institutions has increased to more than 200,000 in one year during the 21<sup>st</sup> century (5). Patients with COPD show gradual deterioration, and could have respiratory impairment or live with poor quality of life (6-9).

Although there is no cure for COPD, some treatments and life style changes, such as taking bronchodilators and quitting smoking, can help the patients feel better and keep the

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disease from getting worse (10). In severe cases, however, other types of treatment, such as oxygen therapy and surgery, may also be required (11). Particularly, those who need long-term oxygen therapy may need to get the service at home.

Prior studies suggest the following positive effects of using home oxygen therapy (HOT): improvement in survival and prognosis of patients with respiratory disease, decrease of polycythemia, prevention of occurrence of pulmonary hypertension, and enhancement of neuropsychological health (12-21).

While HOT can be expensive, it had not been covered by the National Health Insurance (NHI) scheme in Korea, which, therefore, caused significant financial barriers for COPD patients accessing the service. As policies aimed to expand overall health insurance benefits were introduced in Korea in the mid-2000s, the NHIS finally started covering HOT service in 2006. Thus, patients who are determined as Grade 1 or Grade 2 of respiratory impairment and patients that meet the coverage criteria through arterial blood gas test or examination of oxygen saturation have been entitled to use the HOT, by paying for 20 percent of the monthly charge. This appears to contribute to overall increase in the number of patients with respiratory impairment who use HOT service. According to the statistics, the percentage of those who use HOT increased from 34.1% in 2008 to 53.4% in 2011 (22).

While it is expected that this newly covered service has contributed to overall positive outcome of the COPD patients, there is limited empirical evidence on whether this really has been the case. Therefore, we examined whether the usage of HOT services has helped slow down the progression of COPD.

## MATERIALS AND METHODS

### 1. Study population

In order to examine the effect of using a HOT service, we used hospital claim data on COPD inpatients during 2007~2012. Among them, we selected COPD patients with respiratory impairment grades 1, 2, and 3, and followed up on the changes in their grades. We excluded variables with missing values, Medical-Aid beneficiaries, and participants who died during the study period, which leaves 10,798 cases in the final analysis.

### 2. Variables

The outcome variables in this study were the changes of respiratory impairment grade. Changes of respiratory impairment grade were divided into two groups by grade: Grade 1; 1) maintenance/deterioration and 2) mitigation, Grade 2/3; 1) deterioration and 2) maintenance/mitigation.

The independent variable of main interest in relation to the change of respiratory impairment grade was the usage of HOT by the patients. Other independent variables considered in the analysis as potential confounding variables were the grade of respiratory impairment, sex, age, type of medical institution, length of stay, experience of care in intensive care unit (ICU), experience of ventilator care, and years.

The grades of respiratory impairment were classified according to three stages. Judgment of grade was implemented according to the following criteria. Grade 1/2/3 was defined as chronic function failure in lung or bronchus requiring oxygen therapy, even at rest/while moving in home/while walking, as well as patients with a pulmonary function lower than 25%/35%/40% of normal value or who had partial pressure of arterial blood gas less than 55 mmHg/60 mmHg/65 mmHg. By using this variable, it could be reflect severity of patients with COPD as indirectly (23). Age groups were divided as follows: younger than 49 years, 50~59 years, 60~69 years, and older than 70 years. Types of medical institution were defined as "General hospital" or "Hospital, Clinic" by patient visits as COPD. It could consider structural characteristics of each hospital (24). Length of stay was defined as the number of hospitalization days per inpatient. These were classified according to four groups: "Within 10 days", "10~29 days", and "More than 30 days". Experience of care in ICU or ventilator care was used to consider severity of COPD patients. Therefore, it could be possible to analyze reflecting patient's mix (25).

### 3. Statistical analysis

We examined the distribution of each categorical variable according to frequency and percentages and performed  $\chi^2$  tests to examine the differences in each variable according to the changes of respiratory impairment grade and usage of oxygen therapy. We used the multiple logistic regression analysis to examine the factors that are associated with the

use of HOT. In addition, a generalized linear mixed model was used to incorporate repeated-measures variables and to examine the association between usage of HOT service and changes of respiratory impairment grade, while controlling for potential confounding variables, including the grade of respiratory impairment, sex, age, type of medical institution, length of stay, experience of care in ICU, experience of ventilator care, and years. All statistical analyses were performed using SAS statistical software (Cary, NC) version 9.2. All reported p-values are two-sided and considered significant when  $P < 0.05$ .

## RESULTS

The data used in this analysis consisted of 10,798 patients. Among them, 4,371 patients who had used HOT and 6,427 patients who not used HOT. Among users for HOT, male was more slow down for progression of COPD (Male: 74.8%, Female: 67.9%) than female. Furthermore, number of mitigated or maintained patients were lower in older groups than younger (Less than 49: 77.7%, 50~59: 72.8%, 60~69: 67.8%, More than 70: 55.4%), higher for people who used the hospital or clinic (Hospital, Clinic: 81.6%, General hospital: 71.9%), and higher for patients with longer length of stay (Within 10days: 70.6%, 10~29days: 73.5%, More than 30 days: 85.7%). Among non-users for HOT, number of maintenance and mitigated patients by sex was contrast with results in users (Male: 66.3%, Female: 72.9%). On the other hand, we founded similar results in users by age-groups (Less than 49: 73.5%, 50~59: 63.2%, 60~69: 61.2%, More than 70: 47.1%), hospitalized in hospital or clinic (Hospital, Clinic: 79.4%, General hospital: 62.4%), and patients with longer length of stay (Within 10days: 62.0%, 10~29 days: 69.2%, More than 30 days: 91.1%). Finally people who experienced ICU care were less frequent than non-experienced group ("Yes": 50.0%, "No": 67.9%) (Table 1).

Table 2 shows the results of the multiple logistic regression analysis on the factors associated with using HOT. The odds ratio (OR) for use of HOT was lower in grade 3 than grade 1 and 2 (OR: 0.33, 95% Confidence Intervals; 95% CI: 0.30~0.37). And, female patients had lower odds ratio than male patients (OR: 0.86, 95% CI: 0.77~0.95). By the age-group, older groups were more likely to use HOT than younger

groups. We also found that participants who stayed longer than 30 days had a significantly higher odds ratio for maintenance/mitigation (OR: 1.25, 95% CI: 1.09~1.45). Also, people who did not receive the ventilator care had lower odds ratio than those who did (OR: 0.37, 95% CI: 0.30~0.45) (Table 2).

Table 3 shows the results of the analysis using the generalized linear mixed model. As expected, for the maintenance/mitigation in all grades, those who used HOT had a higher odds ratio, compared to those who did not use (OR: 1.41, 95% CI: 1.23~1.61). By age-group, a lower odds ratio was observed for older age groups compared with lower age groups. The highest odds ratio was observed for participants who had a length of stay more than 30 days (OR: 2.54, 95% CI: 2.00~3.22) (Table 3).

## DISCUSSION

In our study, we investigated the association of usage of HOT with the change of respiratory impairment grade among COPD patients after the NHI scheme began to cover the service in November 2006.

The results of the study show that use of a HOT service was effective in maintaining or mitigating the grade of respiratory impairment of COPD patients. Since COPD is a chronic disease, its symptoms tend to get worse with time. Therefore, preventing the loss of quality of life through ongoing management of the patient is necessary (26). According to prior studies, providing HOT as a means for management of COPD can prevent the loss of quality of life of the patients (27-29). Regarding any alternatives to prevent for progression of COPD patients were lacked, positive roles of usage HOT would be effective alternative in managing severe patients with other disease such as lung cancer, and etc. In addition, it is expected that usage of HOT would be positive effect to management for terminally-ill patients in other arena such as home hospice care.

The finding that COPD patients with grade 3 were much less likely than those with grade 1 and 2 to use HOT suggests that the payer should consider expanding insurance coverage for the service to those with grade 3. Given that using HOT helps slow down the progression of the disease, it would be beneficial for the patients who are less severe to

**Table 1.** Demographic Characteristics by Usage of Home Oxygen Therapy (frequency, %).

	HOT											
	Use						Non-use					
	Total	Deterioration		Maintenance or Mitigation		P-value	Total	Deterioration		Maintenance or Mitigation		P-value
	N	N	%	N	%		N	N	%	N	%	
The grade of respiratory impairment												
Grade 1	1,418	370	26.1	1,048	73.9	0.5479	1,072	301	28.1	771	71.9	<0.0001
Grade 2	1,516	393	25.9	1,123	74.1		1,928	579	30.0	1,349	70.0	
Grade 3	1,437	396	27.6	1,041	72.4		3,427	1,200	35.0	2,227	65.0	
Sex												
Male	3,552	896	25.2	2,656	74.8	<0.0001	5,137	1,731	33.7	3,406	66.3	<0.0001
Female	819	263	32.1	556	67.9		1,290	349	27.1	941	72.9	
Age (years)												
~49	1,841	411	22.3	1,430	77.7	<0.0001	3,182	844	26.5	2,338	73.5	<0.0001
50~59	1,715	466	27.2	1,249	72.8		2,223	818	36.8	1,405	63.2	
60~69	658	212	32.2	446	67.8		869	337	38.8	532	61.2	
70~	157	70	44.6	87	55.4		153	81	52.9	72	47.1	
Types of medical institution												
General hospital	3,638	1,024	28.1	2,614	71.9	<0.0001	4,453	1,674	37.6	2,779	62.4	<0.0001
Hospital, Clinic	733	135	18.4	598	81.6		1,974	406	20.6	1,568	79.4	
Length of stay												
Within 10 days	2,154	634	29.4	1,520	70.6	<0.0001	3,490	1,325	38.0	2,165	62.0	<0.0001
10~29 days	1,712	453	26.5	1,259	73.5		2,253	694	30.8	1,559	69.2	
More than 30 days	505	72	14.3	433	85.7		684	61	8.9	623	91.1	
Experience of care in ICU												
Yes	94	42	44.7	52	55.3	<0.0001	82	41	50.0	41	50.0	0.0006
No	4,277	1,117	26.1	3,160	73.9		6,345	2,039	32.1	4,306	67.9	
Experience of ventilator care												
Yes	389	94	24.2	295	75.8	0.2711	167	57	34.1	110	65.9	0.6207
No	3,982	1,065	26.7	2,917	73.3		6,260	2,023	32.3	4,237	67.7	
Years												
2007	243	151	62.1	92	37.9	<0.0001	506	333	65.8	173	34.2	<0.0001
2008	377	151	40.1	226	59.9		653	283	43.3	370	56.7	
2009	566	191	33.7	375	66.3		895	328	36.6	567	63.4	
2010	765	210	27.5	555	72.5		1,143	370	32.4	773	67.6	
2011	1,022	222	21.7	800	78.3		1,401	350	25.0	1,051	75.0	
2012	1,398	234	16.7	1,164	83.3		1,829	416	22.7	1,413	77.3	
Total	4,371	1,159	26.5	3,212	73.5		6,427	2,080	32.4	4,347	67.6	

HOT: Home Oxygen Therapy, ICU: Intensive Care Unit. \*P-values are for results of  $\chi^2$  tests for categorical variables.

start using the service earlier, once they also are entitled to be covered.

The finding that patients who were hospitalized in general hospitals were more likely to use HOT than those who were stayed in hospitals or clinics may indicate that the former were either more severe or better informed about the service. A recent report suggests that many respiratory patients are

either unaware of the fact that HOT service is covered by the NHIS scheme or unsure about the effectiveness, efficacy, and safety of using the service (30).

However, this study has some limitations. First, it would have been ideal had we been able to used information including all respiratory diseases. But, the data used in this study included only COPD patients who have experienced

Table 2. Factors Associated with the Use of HOT.

	Usage of HOT		
	OR	95% CI	
The grade of respiratory impairment			
Grade 1	1.00	-	-
Grade 2	0.60*	0.54	0.67
Grade 3	0.33*	0.30	0.37
Sex			
Male	1.00	-	-
Female	0.86*	0.77	0.95
Age (years)			
~49	1.00	-	-
50~59	1.18*	1.08	1.30
60~69	1.15*	1.02	1.30
70~	1.38*	1.07	1.77
Types of medical institution			
Hospital, Clinic	1.00	-	-
General hospital	2.13*	1.92	2.37
Length of stay			
Within 10 days	1.00	-	-
10~29 days	1.15*	1.06	1.26
More than 30 days	1.25*	1.09	1.45
Experience of care in ICU			
Yes	1.00	-	-
No	0.98	0.70	1.38
Experience of ventilator care			
Yes	1.00	-	-
No	0.37*	0.30	0.45
Years			
2007	1.00	-	-
2008	1.26*	1.02	1.55
2009	1.38*	1.13	1.67
2010	1.50*	1.24	1.81
2011	1.65*	1.37	1.98
2012	1.68*	1.40	2.01

HOT: Home Oxygen Therapy, ICU: Intensive Care Unit, OR: Odds Ratio, CI: Confidence Interval. \*The results were statistically significant, †OR and 95% CI for results by multiple logistic regression analysis.

hospitalization corresponding to Grades 1, 2, and 3 of respiratory impairment. Therefore, we were not able to consider any respiratory disorders such as polycythemia, pulmonary hypertension, and neuropsychological symptoms related to COPD. The results of this study cannot be applied to both respiratory disorders and patients with COPD. Second, this study did not consider the aspects of cost when analyzing the effect of HOT. Given that cost is an important factor in treatment and management of disease, this will limit establishment of measures for COPD. Finally, there is also limitation in that only HOT, and no other treatment for

COPD, was considered.

Despite these limitations, this study examined the effect of utilizing treatment after enforcement of insurance coverage of HOT in 2006. In particular, the strength of this study is that the effect of HOT was indirectly examined through change in the grade of impairment. The results of this study would be helpful in development of a policy for management of COPD. In addition, it must be able to provide support for treatment of physical, emotional symptoms of COPD patients through other studies.

**Table 3.** Factors Associated with Slow Down the Progression of COPD.

	OR	Total	
		95% CI	
HOT			
Non-use	1.00	-	-
Use	1.41*	1.23	1.61
The grade of respiratory impairment			
Level 1	1.00	-	-
Level 2	1.04	0.87	1.24
Level 3	0.89	0.75	1.05
Sex			
Male	1.00	-	-
Female	0.94	0.80	1.10
Age (years)			
~49	1.00	-	-
50~59	0.86*	0.75	0.98
60~69	0.73*	0.61	0.88
70~	0.53*	0.38	0.74
Types of Medical institution			
Hospital, Clinic	1.00	-	-
General hospital	0.59*	0.51	0.68
Length of stay			
Within 10 days	1.00	-	-
10~29 days	1.23*	1.10	1.37
More than 30 days	2.54*	2.00	3.22
Experience of care in ICU			
Yes	1.00	-	-
No	1.17	0.79	1.74
Experience of ventilator care			
Yes	1.00	-	-
No	0.98	0.76	1.26
Years			
2007	1.00	-	-
2008	3.36*	2.67	4.23
2009	4.48*	3.58	5.61
2010	6.79*	5.45	8.47
2011	10.67*	8.57	13.28
2012	16.51*	13.30	20.48

Chronic obstructive pulmonary disease, HOT: Home Oxygen Therapy, ICU: Intensive Care Unit, OR: Odds Ratio, CI: Confidence Interval. \*The results were statistically significant, †OR and 95% CI for results by generalized linear mixed model.

### AUTHORS' CONTRIBUTION

K.T.H. designed the study, researched data, performed statistical analyses, and wrote the manuscript. S.J.K, E.C.P, K.B.Y., J.A.K., and T.H.K. contributed to the discussion and reviewed and edited the manuscript. All authors have read and approved submission of the manuscript and the

manuscript has not been published and is not being considered for publication elsewhere in whole or part in any language except as an abstract.

### 요 약

**목적:** 2006년부터 가정산소치료 서비스에 대해 보장을 시작함에 따라, 기준에 부합하는 사람들은 가정산소

서비스이용에 대해 20%의 본인부담만을 지출하게 되었다. 이 같은 제도의 도입은 환자의 가정산소치료 서비스에 대한 부담을 경감시키게 됨에 따라 주요 이용자인 만성 폐쇄성 폐질환 환자들에게 긍정적인 효과를 미쳤을 것으로 예상된다. 하지만, 제도 도입 후 가정산소치료 서비스 제도의 효과에 대한 연구가 많지 않았고, 실증적 근거자료 또한 부족한 실정이다. 따라서, 본 연구는 제도 도입 후, 가정산소치료 서비스가 만성 폐쇄성 폐질환 환자의 상태에 긍정적 영향을 미쳤는지를 알아보려고 한다.

**방법:** 만성폐쇄성 폐질환으로 2007년부터 2012년까지 병원을 방문한 사람(N=10,798)의 청구데이터를 분석에 이용하였으며, 가정산소치료 서비스 제도 적용의 기준인 호흡기장애등급에 따라 분포의 차이를 설명하기 위해  $\chi^2$  test을 하였다. 또한, 가정산소치료 서비스 이용에 대한 요인을 알아보려고 Multiple Logistic Regression Analysis을 하였으며, 가정산소치료 서비스 이용이 호흡기장애등급의 변화에 어떠한 영향을 주었는지 알아보려고 Generalized Linear Mixed Model 분석을 하였다.

**결과:** 분석대상 중 호흡기장애등급 1등급에 속하는 대상은 2,490명이었으며, 2/3등급에 속하는 대상은 8,308명이었다. 가정산소치료 서비스 이용에 대해서는 호흡기 장애등급 3등급이 1 또는 2등급에 비해 적게 이용하였다(OR: 0.33, 95% CI: 0.30~0.37). 또한, 가정산소치료를 이용함에 따라 환자의 상태의 변화에 대해 분석한 결과, 가정산소치료 이용자는 미이용자에 비해 상태의 완화 또는 유지에 대해 높은 값을 보였다(OR: 1.41, 95% CI: 1.23~1.61).

**결론:** 가정산소치료 서비스 이용은 만성 폐쇄성 폐질환 환자의 상태 악화방지에 대해서 긍정적인 영향을 준다.

**중심단어:** 만성폐쇄성 폐질환, 산소흡입치료, 가정치료, 호흡역학

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