

Original Article
Respiratory Diseases



Current Situation of Home Oxygen Therapy for Chronic Obstructive Pulmonary Disease Patients in Korea

OPEN ACCESS

Received: Oct 8, 2019

Accepted: Dec 20, 2019

Address for Correspondence:

Yong Il Hwang, MD

Division of Pulmonary, Allergy and Critical Care Medicine, Department of Internal Medicine, Hallym University Sacred Heart Hospital, 22 Gwanpyeong-ro 170-beon-gil, Dongan-gu, Anyang 14068, Republic of Korea.
E-mail: hyicyk@hallym.or.kr

© 2020 The Korean Academy of Medical Sciences.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ORCID iDs

Joo Kyung Kim <https://orcid.org/0000-0003-0080-9785>
Seung Hun Jang <https://orcid.org/0000-0001-5457-5780>
Sunghoon Park <https://orcid.org/0000-0001-7004-6985>
Joo-Hee Kim <https://orcid.org/0000-0002-1572-5149>
Ji-Young Park <https://orcid.org/0000-0002-6533-4656>
Kwang Ha Yoo <https://orcid.org/0000-0001-9969-2657>
Young Sam Kim <https://orcid.org/0000-0001-9656-8482>
Seong Yong Lim <https://orcid.org/0000-0001-8098-3622>
Yong Il Hwang <https://orcid.org/0000-0002-3502-5211>

Joo Kyung Kim ^{1,2} Seung Hun Jang ^{1,2} Sunghoon Park ^{1,2} Joo-Hee Kim ^{1,2} Ji-Young Park ^{1,2} Kwang Ha Yoo ³ Young Sam Kim ⁴ Seong Yong Lim ⁵ and Yong Il Hwang ^{1,2}

¹Division of Pulmonary, Allergy and Critical Care Medicine, Department of Internal Medicine, Hallym University Sacred Heart Hospital, Anyang, Korea

²Lung Research Institute, Hallym University College of Medicine, Anyang, Korea

³Division of Pulmonary, Allergy and Critical Care Medicine, Department of Internal Medicine, Konkuk University School of Medicine, Seoul, Korea

⁴Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

⁵Division of Pulmonary and Critical Care Medicine, Department of Medicine, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, Korea

ABSTRACT

Background: Long-term oxygen therapy provides various benefits, including prolonged survival for severely hypoxic chronic obstructive pulmonary disease (COPD) patients. However, adequate management strategies for home oxygen therapy are not well established in Korea. This study aimed to explore the current situation of home oxygen therapy to provide basic data for developing a strategy for COPD patients on home oxygen therapy.

Methods: In this cross-sectional study, we enrolled COPD patients using home oxygen therapy for at least 1 month. Face-to-face interviews were conducted, guided by a structured questionnaire about home oxygen therapy.

Results: A total of 195 patients were enrolled. The mean age was 72.6 ± 9.7 years, and 76.4% of patients were men. The mean modified Medical Research Council, COPD Assessment Test, and EuroQoL-5D index scores were 3.4 ± 0.8 , 29.7 ± 6.8 , and 0.35 ± 0.44 , respectively. At rest, patients were prescribed oxygen for 12.5 ± 7.3 hr/day and used 12.9 ± 8.5 hr/day on average. During exercise, the mean duration of prescribed oxygen was 6.6 ± 4.3 hr/day, and the actual use was 1.1 ± 2.9 hr/day. A total of 25.6% of patients used ambulatory oxygen; with financial burden the main reason for nonuse. The mean number of hospitalizations and emergency room visits were 2.5 and 2.6, respectively.

Conclusion: This study revealed low adherence to home oxygen therapy, poor health-related quality of life, frequent hospitalizations, and a high financial burden among COPD patients using home oxygen therapy. The study highlights the need for adequate strategies to improve the quality of home oxygen therapy.

Keywords: COPD; Home Oxygen Therapy; Health Care Utilization

Funding

This study was supported by grants from the Korea Centers for Disease Control and Prevention and the study code was 2015-E330011-00.

Disclosure

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Yoo KH, Kim YS, Lim SY, Hwang YI. Data curation: Kim JK, Lim SY, Hwang YI. Formal analysis: Kim JK, Jang SH, Yoo KH, Kim YS, Lim SY, Hwang YI. Funding acquisition: Hwang YI. Investigation: Jang SH, Yoo KH, Kim YS, Lim SY, Hwang YI. Supervision: Yoo KH, Kim YS, Lim SY, Hwang YI. Writing - original draft: Kim JK. Writing - review & editing: Kim JK, Jang SH, Park S, Kim JH, Park JY, Hwang YI.

INTRODUCTION

Hypoxemia is occasionally observed in patients with chronic obstructive pulmonary disease (COPD), and it generally worsens as the disease progresses.¹ Oxygen therapy is crucial to hypoxic COPD patients. Long-term oxygen therapy (LTOT), defined as supplemental oxygen use for over 15 hr/day, prolongs survival in COPD patients with severe resting hypoxemia.^{2,3} LTOT also improves exercise capacity,⁴ neuropsychiatric function,⁵ health-related quality of life (HRQoL),⁶ and pulmonary hemodynamics.⁷

As home oxygen therapy has become more common, many countries have developed strategies to facilitate its appropriate utilization to maximize its benefits. In the United Kingdom, the British Thoracic Society released guidelines for home oxygen therapy, which contains the indications or restrictions on various modalities of home oxygen therapy as well as guiding the follow-up of patients on oxygen therapy.⁸ Oxygen registries have been established in Sweden and Denmark for improving the overall quality of LTOT. Since 1987, Swedish LTOT users have been registered in the Swedish National Register of Respiratory Failure, which provides prospective clinical and research data. Using this registry, the national structure for the prescription and management of LTOT have been evaluated.⁹ Establishment of the Danish Oxygen Register improved survival as well as adherence to LTOT guidelines. It also helped equip more patients with an oxygen concentrator and mobile oxygen, facilitating continuous oxygen use.¹⁰ The French government recommended oxygen prescriptions to meet the patient's needs rather than providing oxygen therapy uniformly. This led to increased use of portable oxygen concentrators and decreased use of liquid oxygen tanks, leading to reduced costs for the health care system.¹¹

Despite these efforts, patients still feel that the lack of a patient-centered approach is one of the barriers to optimal oxygen therapy administration. Therefore, strategies must be developed for prescribing appropriate home oxygen therapy to meet individual patients' clinical and lifestyle needs.^{12,13}

In Korea, home oxygen therapy has been covered by national health care insurance since 2006. However, adequate management strategies for home oxygen therapy are not well established. This study aimed to explore the current situation of home oxygen therapy and to provide basic data for developing appropriate strategies for managing COPD patients using home oxygen therapy in Korea.

METHODS**Patients and procedures**

In this cross-sectional study, we targeted COPD patients using home oxygen therapy. The inclusion criteria were as follows: 1) age > 18 years, 2) diagnosis of COPD according to Global Initiative for Chronic Obstructive Lung Disease guideline,¹⁴ 3) using home oxygen therapy for at least 1 month, and 4) meeting the indication of home oxygen therapy in Korea (arterial partial oxygen pressure [PaO₂] ≤ 55 mmHg or PaO₂ ≤ 59 mmHg in the presence of cor pulmonale and/or secondary polycythemia). The exclusion criteria were as follows: 1) disagree with enrollment, 2) using home oxygen therapy for other respiratory diseases mimicking COPD such as bronchiectasis, asthma, and tuberculosis-destroyed lungs, and 3) patients who

were in exacerbation state. After patients provided informed consent, face-to-face interviews were conducted by a well-trained interviewer administering a structured questionnaire.

Questionnaire

The questionnaire consisted of four parts. The first part assessed clinical characteristics and HRQoL; it queried gender, age, height, weight, smoking history, comorbidities, grade of respiratory impairment,¹⁵ and supportive care from family or other people. The severity of dyspnea was assessed using the modified Medical Research Council (mMRC) scale. HRQoL was evaluated by both the COPD Assessment Test (CAT) score and the EuroQol-5D (EQ-5D), with three levels of severity for each of the five dimensions. The EQ-5D index is a continuous variable wherein 1 represents the best health status, and 0 represent death.¹⁶ Severity of respiratory impairment is categorized into three group according to airway limitation. The FEV₁ of grade 1 was $\leq 25\%$, grade 2 was $\leq 30\%$, and grade 3 was 40% of predicted value, respectively.¹⁵ The second part assessed socioeconomic characteristics, including family structure, family function assessed by the family Adaptation, Partnership, Growth, Affection, Resolve (APGAR) score,¹⁷ marital status, level of education, monthly income, and financial support. The family APGAR score consists of five closed-ended questions about adaptation, partnership, growth, affection, and resolve. Respondents should select one of three options for each question, which are each scored differently. Total scores of 7 to 10, 4 to 6, and 0 to 3 suggest a highly functional family, a moderately dysfunctional family, and a severely dysfunctional family, respectively.¹⁷ The third part of the questionnaire evaluated patterns of home oxygen use; it queried oxygen flow rate, duration of oxygen use, and ambulatory oxygen use. The fourth section evaluated health care utilization, with items querying hospital visit and admission frequency, frequency of emergency room visits, and health care expenditures.

Statistical analyses

All data herein are expressed as arithmetic mean \pm standard deviation (SD), where appropriate. Data analysis and descriptive statistics were conducted using SPSS Statistics, version 22.0 (IBM Corp., Armonk, NY, USA). Student's *t*-test was used to compare continuous variables such as clinical characteristics according to gender. Also, it was used to compare the number of health care utilization and the mean values of variables that might be associated with exercise according to whether the patients use oxygen during exercise or not. Pearson's χ^2 test was used for categorical data. It was used in comparison of the number of patients who used health care utilization. Kolmogorov-Smirnov test was used to evaluate the normality of distribution and Mann-Whitney test was used to compare the median values in two groups that were not normally distributed. EQ-5D index was calculated using a formula that used time trade-off method and was proposed for Korean population.¹⁶ Results were considered statistically significant if $P < 0.05$.

Ethics statement

This study was approved by the Institutional Review Board (IRB) of Hallym University Sacred Hospital (IRB No.: 2016-I020), Anyang, Korea. All patients provided written informed consent before enrollment.

RESULTS

Patient characteristics and HRQoL

Although we first asked for consent from 224 patients to enroll in this study, 27 patients refused to answer the questionnaire and 2 patients were excluded because they used home oxygen therapy less than one month. Finally, a total of 195 patients were enrolled in this study, and the demographic and clinical characteristics of the study patients are provided in **Table 1**. The mean age was 72.6 ± 9.7 years, and 76.4% were men. The age distribution was as follows: 18 patients (9.2%) were under 60 years old, 50 patients (25.6%) were in their sixties, 78 (40.0%) were in their seventies, and 49 (25.1%) were at least 80 years old. 73.8% of patients had history of smoking and all of them were ex-smokers. In terms of comorbidities, essential hypertension (41.0%) was the most common disease, followed by benign prostate hyperplasia (27.2%) and diabetes mellitus without complications (10.8%). Respiratory

Table 1. Clinical and sociodemographic characteristics and health-related quality of life

Variables	All patients (n = 195)	Men (n = 149)	Women (n = 46)
Age, yr	72.6 ± 9.7	73.6 ± 8.9	69.3 ± 11.4
Age group, yr			
< 60	18 (9.2)	9 (6)	9 (19.6)
60–70	50 (25.6)	36 (24.2)	14 (30.4)
70–80	78 (40.0)	62 (41.6)	16 (34.8)
≥ 80	49 (25.1)	42 (28.2)	7 (15.2)
BMI, kg/m ²	20.9 ± 5.0	20.4 ± 4.8	22.6 ± 5.2
No. of smokers ^a	144 (73.8)	134 (89.9)	10 (21.7)
Amount of smoking, ^b pack-year	44.9 ± 32.8	46.4 ± 33.0	24.7 ± 24.2
Comorbidities			
Essential hypertension	80 (41.0)	60 (40.3)	20 (43.5)
Benign prostate hyperplasia	53 (27.2)	53 (35.6)	-
Diabetes mellitus without complication	21 (10.8)	14 (9.4)	7 (15.2)
Grade of respiratory impairment ^c			
Grade 1	48 (24.6)	38 (25.5)	10 (21.7)
Grade 2	46 (23.6)	32 (21.5)	14 (30.4)
Grade 3	43 (22.1)	35 (23.5)	8 (17.4)
Not graded or do not know	58 (29.7)	44 (29.5)	14 (30.4)
No. of patients with a caregiver	171 (87.7)	135 (90.6)	36 (78.3)
Family APGAR score			
7–10	141 (82.5)	113 (83.7)	28 (77.8)
4–6	19 (11.1)	15 (11.1)	4 (11.1)
0–3	11 (6.4)	7 (5.2)	4 (11.1)
mMRC	3.4 ± 0.8	3.4 ± 0.8	3.2 ± 0.9
mMRC ≥ 2	190 (97.4)	147 (98.7)	43 (93.5)
CAT score	29.7 ± 6.8	29.8 ± 6.7	29.4 ± 7.1
CAT score ≥ 10	193 (99.0)	148 (99.3)	45 (97.8)
EQ-5D index	0.35 ± 0.44	0.37 ± 0.43	0.27 ± 0.46
Income, USD			
None	10 (5.1)	7 (4.7)	3 (6.5)
< 900	105 (53.8)	84 (56.4)	21 (45.7)
900–2,700	52 (26.7)	40 (26.8)	12 (26.1)
2,700–4,400	21 (10.8)	13 (8.7)	8 (17.4)
≥ 4,400	6 (3.1)	4 (2.7)	2 (4.3)
Do not know	1 (0.5)	1 (0.7)	0 (0)

Data are presented as mean ± standard deviation or number (%).

BMI = body mass index, APGAR = adaptation, partnership, growth, affection, resolve, mMRC = modified medical research council, CAT = chronic obstructive pulmonary disease assessment test, EQ-5D = EuroQol-5D, USD = United States dollar.

^aIncludes ex-smokers and current smokers; a smoker is defined as a person who has smoked at least 100 cigarettes in his or her lifetime; ^bCalculated among ex-smokers and current smokers; ^cRespiratory impairment grading according to The Act on Welfare of Persons with Disabilities.¹⁵

impairment was diagnosed in 70.3% of the patients.¹⁵ The number of grade 1 respiratory impairment was 48 (24.6%), grade 2 was 46 (23.6%), and grade 3 was 43 (22.1%).

The mean mMRC was 3.4 ± 0.8 , and more than half of the patients (54.4%) had an mMRC score of 4. The mean CAT score was 29.7 ± 6.8 . According to the mMRC and CAT, respectively, 97.4% and 99.0% of the COPD patients were dyspneic and symptomatic.¹⁴ The overall mean EQ-5D index score was $0.35 \pm 0.44 - 0.37 \pm 0.43$ for men and 0.27 ± 0.46 for women. Less than 10% of the participants were capable of walking (8.7%) and usual activity (7.2%).

Socioeconomic characteristics

The most common family structure was a two-member household shared by a couple (43.6%), and 72.3% of patients were married. 87.7% of the patients had caregivers. Family function was assessed by family APGAR score, and 82.5% of patients' families had family APGAR scores of 7 or more, indicating a highly functional family.¹⁷ In terms of education, 52.3% of the patients received junior high school education only. Regarding salary, over half of the patients' (59.0%) monthly income was less than USD 900. However, only 39.5% of patients received financial support from their children or relatives.

Patterns of home oxygen therapy usage

Table 2 summarizes the characteristics of home oxygen therapy. The mean duration of home oxygen therapy was 45.9 months. Patients were prescribed oxygen for means of 12.5 hr/day, 6.6 hr/day, and 8.2 hr/day at rest, during exercise, and during sleep, respectively. The mean values reflecting actual daily hours of oxygen use at rest, during exercise, and during sleep were 12.9, 1.1, and 6.6, respectively. The mean prescribed amounts of oxygen were 1.7 L/min, 2.0 L/min, and 1.7 L/min at rest, during exercise, and during sleep, respectively. The mean amounts of oxygen in actual use were 1.8 L/min, 0.7 L/min, and 1.7 L/min at rest, during exercise, and during sleep, respectively.

Fig. 1 shows the prescription details regarding oxygen duration and real use at rest and during exercise. Although both mean values were similar, there was a difference in distribution between daily hours of prescription and actual use at rest. Only 32.3% of the patients were prescribed more than 15 hr/day of oxygen, and 54.3% of patients used home oxygen for less than 15 hr/day.

Table 2. Patterns of home oxygen therapy usage

Variables	Prescription (n = 195)	Real use (n = 195)	P value
Hours of home oxygen therapy			
At rest	8 (8-18)	12 (5-24)	0.970
During exercise	8 (3-8)	0 (0-0.5)	< 0.001
During sleep	8 (8-8)	8 (5-8)	< 0.001
At rest	12.5 ± 7.3	12.9 ± 8.5	0.581
During exercise	6.6 ± 4.3	1.1 ± 2.9	< 0.001
During sleep	8.2 ± 4.5	6.6 ± 3.8	< 0.001
Flow rate of home oxygen therapy, L/min			
At rest	2 (1-2)	2 (1-2)	0.614
During exercise	2 (1.5-2)	0 (0-1.5)	< 0.001
During sleep	2 (1-2)	2 (1-2)	0.469
At rest	1.7 ± 0.6	1.8 ± 0.9	0.289
During exercise	2.0 ± 0.8	0.7 ± 1.0	< 0.001
During sleep	1.7 ± 0.8	1.7 ± 1.0	0.378

Data are presented as median (interquartile range) or mean \pm standard deviation.

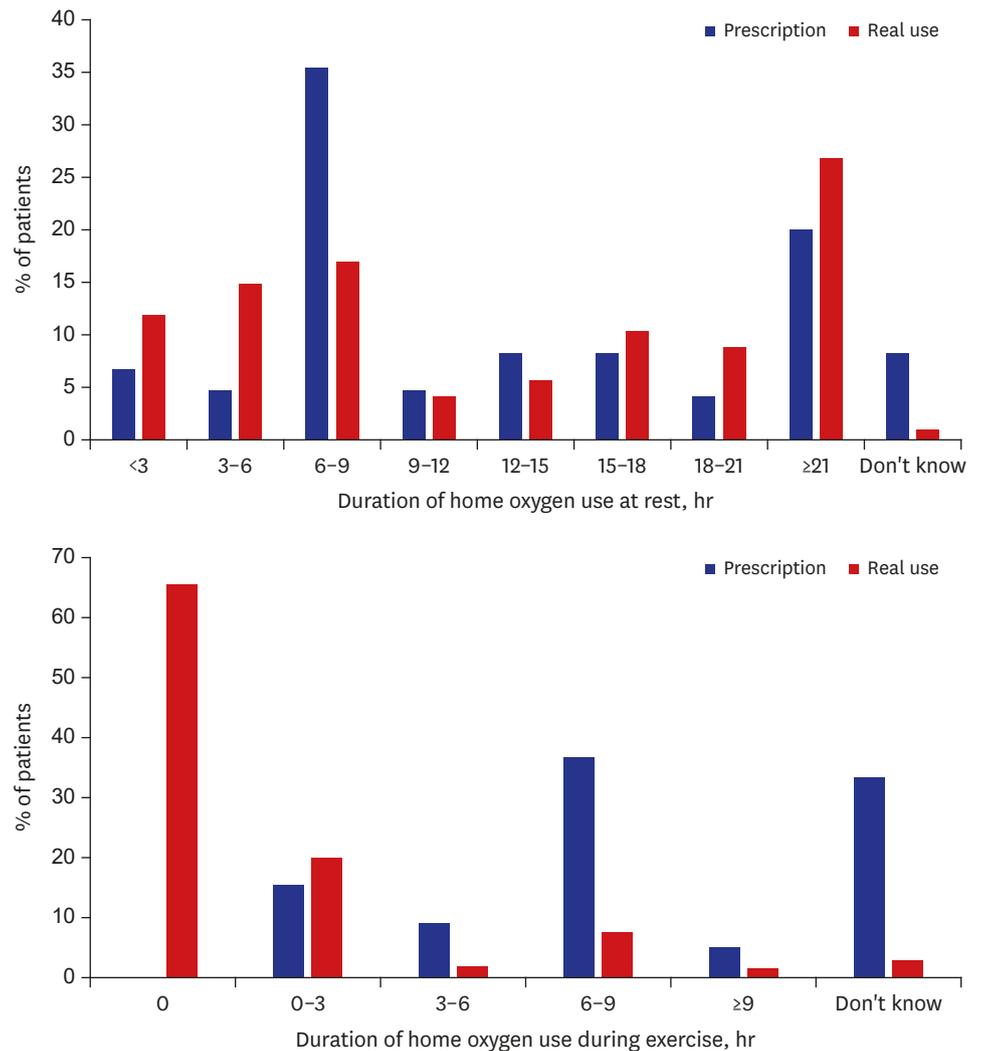


Fig. 1. Distribution of hours of oxygen use.

During exercise, 65.6% of patients did not use oxygen at all. mMRC and CAT scores were higher in patients who did not use oxygen during exercise. Additionally, the mean EQ-5D index was higher among patients who used oxygen during exercise (Table 3). After home oxygen therapy, 57.9% of patients felt that their health status improved.

We also asked the patients whether they used ambulatory oxygen or not. 25.6% of patients responded in the affirmative. The main reason for not using ambulatory oxygen

Table 3. Comparison of respiratory symptoms and health-related quality of life according to oxygen use during exercise

Variables	Patients who used oxygen during exercise (n = 120)	Patients who did not use oxygen during exercise (n = 75)	P value
mMRC	3.2 ± 0.8	3.5 ± 0.8	0.024
CAT score	28.0 ± 6.0	30.9 ± 6.7	0.004
EQ-5D index	0.51 ± 0.35	0.25 ± 0.45	< 0.001

Data are presented as mean ± standard deviation.

mMRC = modified medical research council, CAT = chronic obstructive pulmonary disease assessment test, EQ-5D = EuroQol-5D.

Table 4. Health care utilization during the previous year

Variables	All patients (n = 195)	Men (n = 149)	Women (n = 46)	P value
No. of patients with unscheduled visits	122 (62.6)	91 (61.1)	31 (67.4)	0.439
No. of patients with hospitalizations	118 (60.5)	91 (61.1)	27 (58.7)	0.773
No. of patients with ER visits	107 (54.9)	82 (55.0)	25 (54.3)	0.935
No. of unscheduled visits, per yr	2.9 ± 3.5	3.1 ± 3.9	2.4 ± 1.7	0.152
No. of hospitalizations, per yr	2.5 ± 2.9	2.6 ± 3.2	2.2 ± 1.4	0.466
No. of ER visits, per yr	2.6 ± 3.3	2.7 ± 3.6	2.2 ± 1.4	0.564
Medical cost spent during the past year, USD ^a /mon	169.12 ± 379.04	175.43 ± 414.26	148.62 ± 231.66	0.679

Data are presented as number (%) or mean ± standard deviation.

ER = emergency room.

^a1 USD = 1,160 KRW.

was insufficient finances (57.9%). The majority of patients (81.0%) were willing to use ambulatory oxygen therapy if it could be covered by health insurance.

Health care utilization

A total of 62.6% of patients had unscheduled hospital visits due to exacerbations of respiratory symptoms in the previous year (Table 4). The mean number of unscheduled visits was 2.9. Moreover, almost all the patients with unscheduled visits (118/122) experienced hospitalization. The mean number of hospitalizations and emergency room visits were 2.5 and 2.6, respectively. The mean medical cost for COPD was about USD 170/mon/patient.

DISCUSSION

This study showed the patterns of home oxygen use among Korean COPD patients on LTOT as well as their clinical and socioeconomic characteristics.

In this study, the proportion of men was about three fold more than that of women. Although the difference of prevalence according to gender is diminishing, prevalence of COPD was still higher in men at the time we collected the data.¹⁸ Difference of prevalence could be reflected in this study.

We evaluated the HRQoL of patients using the EQ-5D index. The mean EQ-5D index was 0.35, and this figure was worse than that of the general population in Korea whose EQ-5D index was 0.94.¹⁹ Few studies have evaluated HRQoL assessed by the EQ-5D targeting COPD patients on home oxygen therapy. Respiratory impairment was present in 70.3% of patients in this study which required FEV₁ would be ≤ 40% of predicted at least.¹⁴ Thus, we compared the results of this study with those of other studies on severe and very severe COPD. We found that the overall HRQoL in the present study was worse than that reported by other studies, which found EQ-5D index ranging between 0.5 and 0.8.²⁰⁻²⁴ Similarly, the mean CAT score in our study was worse than that of other investigations of severe COPD patients.^{21,22} These results provide insights into the severity of symptoms and HRQoL among COPD patients on home oxygen therapy.

The family APGAR score was used to evaluate family functioning when the family was involved in patient care. In this study, 82.5% of patients' families had family APGAR scores of 7 or more, meaning that they had highly functional families. Taking care of COPD patients has been reported as a moderate burden for family caregivers in Korea, and this was similar

to the burden on the family imposed by stroke patients.²⁵ However, overall, family function is relatively stable, and this may have a positive effect on the care received by COPD patients on home oxygen therapy.

There was a discrepancy between the prescribed and actual durations of oxygen therapy use. If we defined compliant as a patient who used oxygen within 1 hour of the prescribed duration of home oxygen therapy,²⁶ 35% of patients could be classified as compliant. This figure was not different from that of previously reported compliance rates derived after using a similar definition, ranging from 23% to 60%.^{26,27} Like previous studies, we found that adherence to home oxygen therapy was suboptimal.

During exercise, 65.6% of patients did not use oxygen at all. Patients who did not use oxygen during exercise had more symptoms and worse HRQoL than those who used oxygen during exercise (**Table 3**). The severe respiratory symptoms and poor HRQoL were probably due to reduced physical activity.²⁷ As exercise capacity could be improved by providing home oxygen therapy,⁴ we should encourage COPD patients with home oxygen to use oxygen more continuously. Ambulatory oxygen therapy can facilitate patients using oxygen continuously—even during exercise. However, in this study, only 25.6% of patients used ambulatory oxygen. The high cost was a major reason that the patients did not use ambulatory oxygen. Over half of the patients responded that they could not use ambulatory oxygen because of the cost. This finding was consistent with that of a previous study.²⁸ As ambulatory oxygen therapy has recently been covered by health insurance, more patients are expected to use ambulatory oxygen services just like in Denmark, where ambulatory oxygen therapy is fully covered by insurance.^{10,29}

LTOT has been known to confer a survival benefit if patients use supplemental oxygen for more than 15 hr/day.^{2,3} It is important not only for patients to adhere to their prescriptions but also for physicians to prescribe appropriately. Our study showed that only 32.3% of patients were prescribed more than 15 hr/day, and 45.7% of patients used oxygen more than 15 hr/day. These figures were much lower than that of previous studies conducted in Korea and Western countries, with previous values ranging from 68.2% to 98%.^{9,28,30,31} Previous reports have 40% to 70% of patients using more than 15 hr/day.³² In Korea, when pulmonologists prescribe home oxygen therapy, they usually only give patients a verbal explanation regarding how to use oxygen, and the spaces on the prescription pad designated for duration and flow of oxygen are often left blank. For that reason, despite most pulmonologists prescribing more than 15 hr/day of oxygen, our patients reported low rates of appropriate oxygen duration prescriptions.

We also evaluated the health care utilization and medical costs among COPD patients using home oxygen therapy. It is well known that advanced COPD is associated with high costs, much of which can be attributed to hospitalizations.³³ In our study, 60.5% of patients reported being hospitalized, and the mean frequency of hospitalization was 2.5 per year. This figure was similar to or larger than corresponding values reported by previous studies.³⁴⁻³⁶ The patients enrolled in this study were spending about USD 300/month for COPD, which was a high cost considering that over half of patients the earned less than USD 900/month. The appropriate use of home oxygen can reduce hospitalizations and mitigate the economic burden imposed on COPD patients.³⁴

This study had several limitations. First, we only relied on patient self-reporting. In terms of oxygen use, we did not ascertain oxygen concentrator clock counter values. Therefore, the

findings may be affected by recall bias. In most recent studies, researchers have collected oxygen use data by checking the clock counter available on most concentrators,³⁷ and this is necessary to obtain objective data. Second, there was no spirometry data. As the purpose of the study was to provide basic data regarding home oxygen therapy in Korea, accurate spirometry values were not necessary to obtain this information. Respiratory impairment was present in 70.3% of patients, among whom the required FEV₁ would be \leq 40% of predicted at least.¹⁴ This meant that at least 2/3 of patients had severe COPD in our study. Third, after we surveyed the questionnaire, health insurance began covering ambulatory oxygen therapy. Thus, the results of this study could be different from the current situation, especially financial problems.

In conclusion, Korean COPD patients on home oxygen therapy in our study had low adherence to home oxygen therapy, poor HRQoL, frequent hospitalizations, and a high financial burden. This study provided basic data to inform adequate management strategies to improve the quality of home oxygen therapy. Based on these results, a pilot study using education materials and home oxygen note, is in progress.

REFERENCES

1. Kent BD, Mitchell PD, McNicholas WT. Hypoxemia in patients with COPD: cause, effects, and disease progression. *Int J Chron Obstruct Pulmon Dis* 2011;6:199-208.
[PUBMED](#)
2. Medical Research Council Working Party. Long term domiciliary oxygen therapy in chronic hypoxic cor pulmonale complicating chronic bronchitis and emphysema. Report of the Medical Research Council Working Party. *Lancet* 1981;(8222):681-6.
[PUBMED](#)
3. Nocturnal Oxygen Therapy Trial Group. Continuous or nocturnal oxygen therapy in hypoxemic chronic obstructive lung disease: a clinical trial. *Ann Intern Med* 1980;93(3):391-8.
[PUBMED](#) | [CROSSREF](#)
4. Morrison DA, Stovall JR. Increased exercise capacity in hypoxemic patients after long-term oxygen therapy. *Chest* 1992;102(2):542-50.
[PUBMED](#) | [CROSSREF](#)
5. Wedzicha JA. Effects of long-term oxygen therapy on neuropsychiatric function and quality of life. *Respir Care* 2000;45(1):119-24.
[PUBMED](#)
6. Eaton T, Lewis C, Young P, Kennedy Y, Garrett JE, Kolbe J. Long-term oxygen therapy improves health-related quality of life. *Respir Med* 2004;98(4):285-93.
[PUBMED](#) | [CROSSREF](#)
7. Zieliński J, Tobiasz M, Hawrylkiewicz I, Sliwiński P, Palasiewicz G. Effects of long-term oxygen therapy on pulmonary hemodynamics in COPD patients: a 6-year prospective study. *Chest* 1998;113(1):65-70.
[PUBMED](#) | [CROSSREF](#)
8. Hardinge M, Annandale J, Bourne S, Cooper B, Evans A, Freeman D, et al. British Thoracic Society guidelines for home oxygen use in adults. *Thorax* 2015;70 Suppl 1:i1-43.
[PUBMED](#) | [CROSSREF](#)
9. Ekström M, Ahmadi Z, Larsson H, Nilsson T, Wahlberg J, Ström KE, et al. A nationwide structure for valid long-term oxygen therapy: 29-year prospective data in Sweden. *Int J Chron Obstruct Pulmon Dis* 2017;12:3159-69.
[PUBMED](#) | [CROSSREF](#)
10. Ringbaek TJ, Lange P. The impact of the Danish Oxygen Register on adherence to guidelines for long-term oxygen therapy in COPD patients. *Respir Med* 2006;100(2):218-25.
[PUBMED](#) | [CROSSREF](#)
11. Clini E, Veale D, Winck JC, Muir JF, Kampelmacher M, Vivodtzev I, et al. Advances in ambulatory oxygen workshop and long-term oxygen therapy in real-life practice. *Eur Med J* 2015;3(2):63-70.
12. Doherty DE, Petty TL, Bailey W, Carlin B, Cassaburi R, Christopher K, et al. Recommendations of the 6th long-term oxygen therapy consensus conference. *Respir Care* 2006;51(5):519-25.
[PUBMED](#)

13. Jacobs SS, Lederer DJ, Garvey CM, Hernandez C, Lindell KO, McLaughlin S, et al. Optimizing home oxygen therapy. An official American Thoracic Society workshop report. *Ann Am Thorac Soc* 2018;15(12):1369-81.
[PUBMED](#) | [CROSSREF](#)
14. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for prevention, diagnosis and management of COPD (2019 Report). <http://www.goldcopd.org>. Accessed April 8, 2019.
15. Ministry of Government Legislation. National Law Information Center. Enforcement Rule of The Act on Welfare of Persons with Disabilities. <http://www.law.go.kr/lsInfoP.do?lsiSeq=206271&efYd=20190101#0000>. Accessed April 22, 2019.
16. Jo MW, Yun SC, Lee SI. Estimating quality weights for EQ-5D health states with the time trade-off method in South Korea. *Value Health* 2008;11(7):1186-9.
[PUBMED](#) | [CROSSREF](#)
17. Smilkstein G. The family APGAR: a proposal for a family function test and its use by physicians. *J Fam Pract* 1978;6(6):1231-9.
[PUBMED](#)
18. Hwang YI, Park YB, Yoo KH. Recent trends in the prevalence of chronic obstructive pulmonary disease in Korea. *Tuberc Respir Dis (Seoul)* 2017;80(3):226-9.
[PUBMED](#) | [CROSSREF](#)
19. Jeong YH. A report on the health related quality of life in Korea. *Health Welf Policy Forum* 2011;182:6-14.
20. Ståhl E, Lindberg A, Jansson SA, Rönmark E, Svensson K, Andersson F, et al. Health-related quality of life is related to COPD disease severity. *Health Qual Life Outcomes* 2005;3(1):56.
[PUBMED](#) | [CROSSREF](#)
21. Sundh J, Johansson G, Larsson K, Lindén A, Löfdahl CG, Janson C, et al. Comorbidity and health-related quality of life in patients with severe chronic obstructive pulmonary disease attending Swedish secondary care units. *Int J Chron Obstruct Pulmon Dis* 2015;10:173-83.
[PUBMED](#) | [CROSSREF](#)
22. Wacker ME, Jörres RA, Karch A, Wilke S, Heinrich J, Karrasch S, et al. Assessing health-related quality of life in COPD: comparing generic and disease-specific instruments with focus on comorbidities. *BMC Pulm Med* 2016;16(1):70.
[PUBMED](#) | [CROSSREF](#)
23. Rutten-van Mólken MP, Oostenbrink JB, Tashkin DP, Burkhart D, Monz BU. Does quality of life of COPD patients as measured by the generic EuroQol five-dimension questionnaire differentiate between COPD severity stages? *Chest* 2006;130(4):1117-28.
[PUBMED](#) | [CROSSREF](#)
24. Punekar YS, Rodriguez-Roisin R, Sculpher M, Jones P, Spencer M. Implications of chronic obstructive pulmonary disease (COPD) on patients' health status: a western view. *Respir Med* 2007;101(3):661-9.
[PUBMED](#) | [CROSSREF](#)
25. Kim JH, Kim EK, Park SH, Lee KA, Hwang YI, Kim EJ, et al. Burden of COPD among family caregivers. *Tuberc Respir Dis (Seoul)* 2010;69(6):434-41.
[CROSSREF](#)
26. Pépin JL, Barjhoux CE, Deschaux C, Brambilla C. Long-term oxygen therapy at home. Compliance with medical prescription and effective use of therapy. ANTADIR Working Group on Oxygen Therapy. Association Nationale de Traitement à Domicile des Insuffisants Respiratoires. *Chest* 1996;109(5):1144-50.
[PUBMED](#)
27. Esteban C, Quintana JM, Aburto M, Moraza J, Egurrola M, Pérez-Izquierdo J, et al. Impact of changes in physical activity on health-related quality of life among patients with COPD. *Eur Respir J* 2010;36(2):292-300.
[PUBMED](#) | [CROSSREF](#)
28. Park MJ, Yoo JH, Choi CW, Kim YK, Yoon HK, Kang KH, et al. Long-term oxygen therapy for chronic respiratory insufficiency: the situation in Korea after the health insurance coverage: a multi-center Korean survey. *Tuberc Respir Dis (Seoul)* 2009;67(2):88-94.
[CROSSREF](#)
29. Ringbaek TJ, Lange P, Viskum K. Are patients on long-term oxygen therapy followed up properly? Data from the Danish Oxygen Register. *J Intern Med* 2001;250(2):131-6.
[PUBMED](#) | [CROSSREF](#)
30. Ringbaek TJ, Lange P. Trends in long-term oxygen therapy for COPD in Denmark from 2001 to 2010. *Respir Med* 2014;108(3):511-6.
[PUBMED](#) | [CROSSREF](#)
31. Restrick LJ, Paul EA, Braid GM, Cullinan P, Moore-Gillon J, Wedzicha JA. Assessment and follow up of patients prescribed long term oxygen treatment. *Thorax* 1993;48(7):708-13.
[PUBMED](#) | [CROSSREF](#)

32. Ringbaek TJ, Lange P, Viskum K. Geographic variation in long-term oxygen therapy in Denmark: factors related to adherence to guidelines for long-term oxygen therapy. *Chest* 2001;119(6):1711-6.
[PUBMED](#) | [CROSSREF](#)
33. Guarascio AJ, Ray SM, Finch CK, Self TH. The clinical and economic burden of chronic obstructive pulmonary disease in the USA. *Clinicoecon Outcomes Res* 2013;5:235-45.
[PUBMED](#)
34. Ringbaek TJ, Viskum K, Lange P. Does long-term oxygen therapy reduce hospitalisation in hypoxaemic chronic obstructive pulmonary disease? *Eur Respir J* 2002;20(1):38-42.
[PUBMED](#) | [CROSSREF](#)
35. Farrero E, Escarrabill J, Prats E, Maderal M, Manresa F. Impact of a hospital-based home-care program on the management of COPD patients receiving long-term oxygen therapy. *Chest* 2001;119(2):364-9.
[PUBMED](#) | [CROSSREF](#)
36. Turner AM, Sen S, Steeley C, Khan Y, Sweeney P, Richards Y, et al. Evaluation of oxygen prescription in relation to hospital admission rate in patients with chronic obstructive pulmonary disease. *BMC Pulm Med* 2014;14(1):127.
[PUBMED](#) | [CROSSREF](#)
37. Gauthier A, Bernard S, Bernard E, Simard S, Maltais F, Lacasse Y. Adherence to long-term oxygen therapy in patients with chronic obstructive pulmonary disease. *Chron Respir Dis* 2019;16:1-9.
[PUBMED](#) | [CROSSREF](#)