

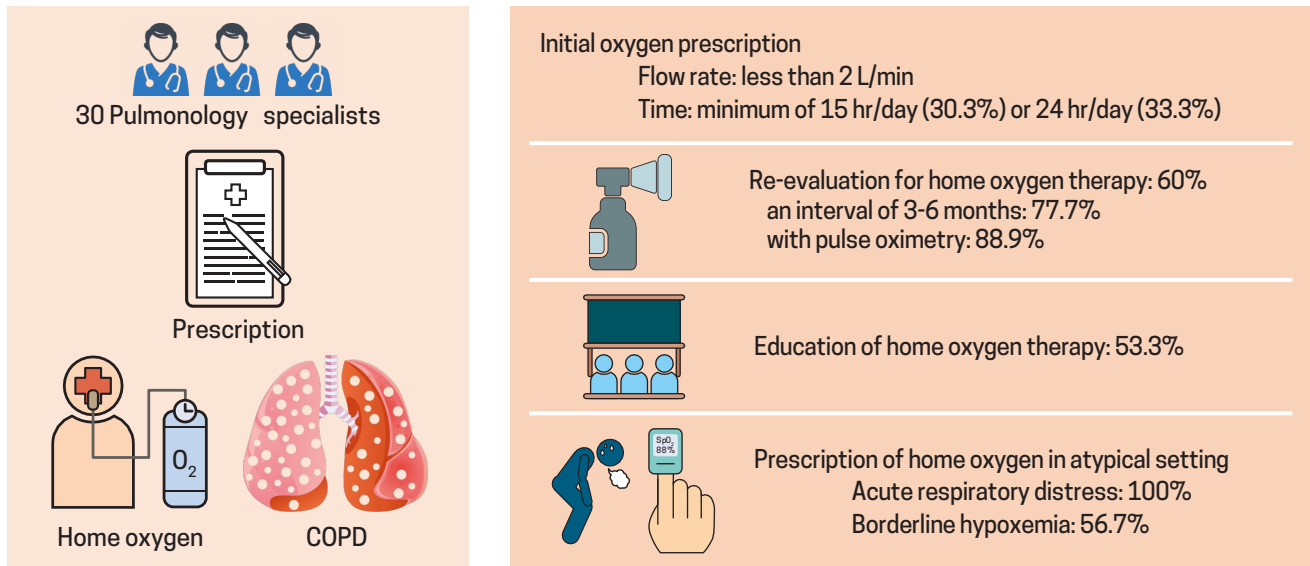


Korean physician prescription patterns for home oxygen therapy in chronic obstructive pulmonary disease patients

Youlim Kim^{1,2,*}, Hwan Il Kim^{2,3}, Ji Young Park^{2,3}, Ji Young Hong^{1,2}, Joo-Hee Kim^{2,3}, Kyung Hoon Min⁴, Chin Kook Rhee⁵, Sunghoon Park^{2,3}, Chang Youl Lee^{1,2}, Seong Yong Lim⁶, Seung Hun Jang^{2,3}, and Yong Il Hwang^{2,3}

¹Division of Pulmonary, Allergy and Critical Care Medicine, Department of Internal Medicine, Hallym University Chuncheon Sacred Heart Hospital, Chuncheon; ²Lung Research Institute of Hallym University College of Medicine, Chuncheon; ³Division of Pulmonary, Allergy and Critical Care Medicine, Department of Internal Medicine, Hallym University Sacred Heart Hospital, Anyang; ⁴Division of Respiratory and Critical Care Medicine, Department of Internal Medicine, Korea University Guro Hospital, Seoul; ⁵Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul; ⁶Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, Korea

Prescription patterns for home oxygen therapy in COPD



Received : August 28, 2020
Revised : October 14, 2020
Accepted : November 30, 2020

Correspondence to Yong Il Hwang, M.D.

Division of Pulmonary, Allergy and Critical Care Medicine, Department of Internal Medicine, Hallym University Sacred Heart Hospital, 22 Gwanpyeong-ro 170beon-gil, Dongan-gu, Anyang 14068, Korea
Tel: +82-31-380-3715, Fax: +82-31-380-3973, E-mail: hyicyk@hallym.or.kr
https://orcid.org/0000-0002-3502-5211

*Current affiliation: Division of Pulmonary, Allergy and Critical Care Medicine, Department of Internal Medicine, Konkuk University School of Medicine, Seoul, Korea

Background/Aims: Hypoxemia in chronic obstructive pulmonary disease (COPD) leads to reduced ability to exercise, decreased quality of life, and, eventually, increased mortality. Home oxygen therapy in patients with severe COPD reduces distress symptoms and mortality rates. However, there have been few studies on physicians' prescription behavior toward home oxygen therapy. Therefore, we investigated the respiratory specialists' perspective on home oxygen therapy.

Methods: In this cross-sectional, study, a questionnaire was completed by 30 pulmonary specialists who worked in tertiary hospitals and prescribed home oxygen therapy. The questionnaire consisted of 28 items, including 15 items on oxygen prescription for outpatients, four for inpatients, and nine on service improvement.

Results: All physicians were prescribing less than 2 L/min of oxygen for either 24 (n = 10, 33.3%) or 15 hours (n = 9, 30.3%). All (n = 30) used pulse oximetry, 26 (86.7%) analyzed arterial blood gas. Thirteen physicians had imposed restrictions and recommended oxygen use only during exercise or sleep. Sixteen (53.3%) physicians were educating their patients about home oxygen therapy. Furthermore, physicians prescribed home oxygen to patients that did not fit the typical criteria for long-term oxygen therapy, with 30 prescribing it for acute relief and 17 for patients with borderline hypoxemia.

Conclusions: This study identified the prescription pattern of home oxygen therapy in Korea. Respiratory physicians prescribe home oxygen therapy to hypoxemic COPD patients for at least 15 hours/day, and at a rate of less than 2 L/min. More research is needed to provide evidence for establishing policies on oxygen therapy in COPD patients.

Keywords: Pulmonary disease, chronic obstructive; Home oxygen; Prescriptions; Physicians' perspective

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a high morbidity and mortality disease in Korea and worldwide [1]. As COPD progresses, the risk of alveolar hypoxia and consequent hypoxemia increases [2], with hypoxemia leading to a decrease quality of life, reduced ability to exercise, and deteriorated skeletal muscle function. Severe hypoxemia in patients with end-stage COPD is highly associated with an increased mortality rate [3-5].

Long-term home oxygen therapy (LTOT) is recommended for patients with chronic respiratory conditions if their arterial oxygen partial pressure (PaO₂) is at least 55 mmHg or oxygen saturation (SaO₂) is less than 88%, or if PaO₂ is between 55 and 60 mmHg or SaO₂ is 89%, with pulmonary hypertension, peripheral edema from congestive heart failure, or erythrocytosis (hematocrit > 55%) [6]. If LTOT is performed for more than 15 hr/day, the survival rate is improved [7]. In addition, home oxygen therapy is essential for improving the respiratory symptoms and quality of life in patients with COPD [8]. In Korea, the expense of LTOT has been reimbursed by national health insurance since 2006 if the patients' condition meets the above criteria [9].

Despite several reports about the efficacy of oxygen

therapy to patients [7,8,10], studies about the physicians' prescription pattern of oxygen therapy in real practice are limited. One international survey conducted in 2001 on respiratory physicians who prescribed home oxygen, described the prescription pattern differences among countries [11]. To the best of our knowledge, this is the first study to provide physicians' views about home oxygen therapy in Korea. The purpose of this survey was to explore the respiratory specialists' perspectives about home oxygen therapy.

METHODS

Study designs and data collection

In this cross-sectional survey-based study, we enrolled 30 pulmonary specialists and members of the Korea Chronic Obstructive Pulmonary Disease Subgroup Study (KOCOSS) group. None were involved in the questionnaire development. The survey was carried out via a web-based questionnaire from March 22 to March 30, 2016. After requesting the selected respiratory physician to participate in the survey, the questionnaire link was sent to the consenting participants.

Questionnaire

The questionnaire used in this study was created by seven respiratory specialists participating in the KOCOSS cohort [12]. The questionnaire consisted of 28 items, including 15 items on oxygen prescription for outpatients, four items on inpatients prescription, and nine items on improving home oxygen treatment services. The questionnaire included specific physician examinations of the patients, and the time-frame of oxygen use at home during resting, exercise, or sleep. There were also questions about re-evaluation and home education after oxygen prescription. The questions on re-evaluation were mainly related to the necessity of home oxygen therapy, that is, the follow-up duration of home oxygen therapy, the diagnostic modality at follow-up, and any link with home care services. The Korean full version and English short version of questionnaire are attached in Appendices 1 and 2.

As the SaO₂ criteria [6] for long-term oxygen therapy corresponded to moderate or severe hypoxemia [13], the participants were asked about their experiences prescribing oxygen to the patients with borderline hypoxemia. The definition of "borderline hypoxemia" used in this study was a SaO₂ level that ranged between 92% to 93%. A SaO₂ level between 90% and 94%, or 89% and 93%, was defined as mild hypoxemia [13] or moderate resting desaturation [10], respectively. We chose the range of SaO₂ closest to the normal level. The full Korean version and short English version of the questionnaire are available in the supplementary section.

Ethical statement

This study was approved by the Institutional Review Board of Hallym University Sacred Hospital (IRB No. 2016-I020), Anyang, South Korea. Written informed consent was obtained from all participants

RESULTS

Oxygen prescription for outpatients

All 30 physicians confirmed they had issued more than one oxygen prescription per month on average: 19 physicians prescribed an average of 1 to 5 case/month (63.3%) and 11 prescribed 5 to 10 case/month (36.7%). All physicians included pulse oximetry when they issued oxygen prescriptions, and 26 physicians (86.7%) performed arterial blood

Table 1. Evaluation tools and numbers of trials when issuing oxygen prescriptions

Tests	No. (%)
Pulse oximetry	30 (100)
Once	11 (36.7)
Twice	14 (46.7)
Three times	3 (10.0)
Etc. ^a	2 (6.6)
Arterial blood gas analysis	26 (86.7)
Once	17 (65.4)
Twice	4 (15.4)
Three times	3 (11.5)
Etc. ^b	2 (7.7)
Six-minute-walk test	3 (10.0)
Pulmonary function test	2 (6.6)

Allowed multiple responses.

^aIncluded 'The number of trials will be different depending on the case' and 'Prescribing after 24 hours' monitoring in case of hospitalized patients.'

^bIncluded 'The number of trials will be different depending on the case' and 'Will be done after stabilization.'

gas analysis. A 6-minute walk test and pulmonary function test were used as adjunctive tests by, respectively, three (10.0%) and two (6.6%) physicians. The number of oxygen saturation measurements before oxygen prescription varied, with 11 physicians (36.7%) performing only once and 14 (46.7%) performing twice (Table 1). In terms of the initial oxygen flow, all 30 physicians prescribed less than 2 L/min, and of these physicians, 14 (46.7%) prescribed 1 L/min, and 16 (53.3%) prescribed 2 L/min. The physicians initially prescribed the oxygen use time as follows: Ten physicians (33.3%) initially prescribed for 24 hours, and nine physicians (30.3%) for 15 hours (Fig. 1). The maintenance of oxygen saturation was the primary determinant for the oxygen flow rate, and the physician prescribed the initial duration for oxygen use. However, approximately 25% of all physicians prescribed oxygen according to the patient's condition (Supplementary Table 1).

Thirteen (43.3%) of the physicians replied that they restricted the use of oxygen (Table 2). For patients during exercise, 22 physicians prescribed the same flow rate used at resting state (73.3%), and the remaining adjusted the flow rate in various ways, such as modification according to the result of the 6-minute walk test by merely increasing the

flow rate from the resting state (Table 2). In addition, 19 respiratory physicians prescribed the same flow rate as that use during sleep, seven used the reference to previous ox-

xygen saturation during the night-time, three increased the flow rate than rest, and one reduced it to less than resting state during sleep (Table 2).

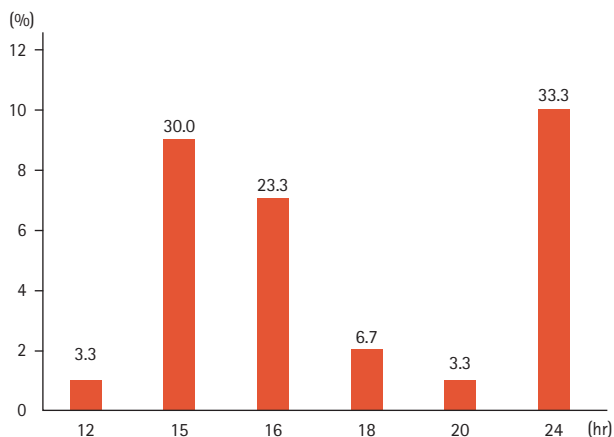


Figure 1. Initial oxygen prescription time.

Education and reevaluation about home oxygen therapy

Sixteen (53.3%) physicians educated their patients about home oxygen therapy when they issued the oxygen prescription, with eight (50.0%) having educational material about home oxygen therapy (Table 3). All eight physicians had 'leaflets provided by home oxygen therapy service providers,' and one (12.5%) had 'self-made educational materials in hospital' (Table 3). Eight physicians who did not have educational materials answered that they referred to the time usage of oxygen. Two advised to use home oxygen therapy persistently or educate their patients not to use too much oxygen (Fig. 2). Fourteen physicians answered that they did not educate about home oxygen and provided

Table 2. Oxygen prescription in specific conditions

Variable	Patients with hypoxemia ^a	Patients with borderline hypoxemia ^b
Oxygen use restriction (yes)	13 (43.3)	17 (56.7)
When to restrict oxygen use?		
During sleep	4 (30.8)	
During exercise	6 (46.1)	13 (76.5)
Use only for dyspnea	1 (7.7)	4 (23.5)
High dose at exercise and low dose as usual	1 (7.7)	
No response	1 (7.7)	
In exercise		
Same as usual	22 (73.3)	10 (58.8)
Through 6-minutes-walk test	4 (13.3)	7 (41.2)
Etc. ^c	4 (13.3)	
During sleep		
Same as usual	19 (63.3)	11 (64.7)
More than at rest	3 (10.0)	3 (17.6)
With reference to previous night saturation	7 (23.3)	2 (11.8)
Less than at rest	1 (3.3)	
No prescription		1 (5.9)

Values are presented as number (%).

^aHypoxemia was defined as an the arterial oxygen partial pressure (PaO₂) of at least 55 mmHg or oxygen saturation below 88%, or if PaO₂ is between 55 and 60 mmHg or oxygen saturation is 89%, with pulmonary hypertension, peripheral edema from congestive heart failure, or erythrocytosis (hematocrit > 55%).

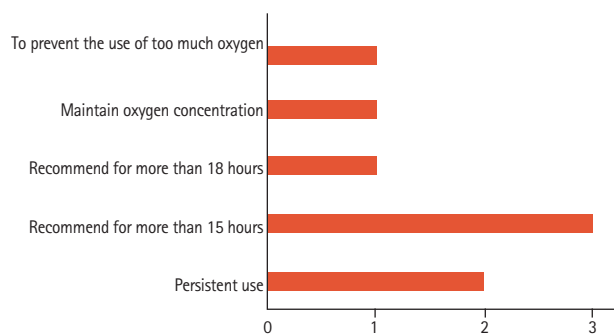
^bBorderline hypoxemia was defined as the oxygen saturation of 92% to 93%.

^cIncluded 'Increase the flow rate by 0.5 to 1.0 L/min or more from the resting state,' 'Consider hypoxemia in exercise,' or 'Check arterial blood gas analysis results after exercise.'

Table 3. Education about home oxygen therapy and available materials

Variable	No. (%)
Education about home oxygen therapy (yes)	16 (53.3)
Available education materials (yes) ^a	8 (50.0)
Leaflets from service providers of home oxygen therapy	8 (100.0)
Self-made educational materials	1 (12.5)
Education about home oxygen therapy (No)	14 (46.7)
Reasons for not doing education ^a	
Do not have time during outpatient clinic consultations	13 (43.3)
Have no one to educate	8 (26.7)
Do not have education materials	8 (26.7)
No response	1 (3.3)

^aAllowed multiple responses.

**Figure 2.** Mainly emphasized points when the doctors do not have home oxygen education.

the following explanations: 13 did not have enough time to educate during the outpatient clinic consultation (43.3%), eight answered that there was no one to educate (26.7%), and eight did not have any education material (26.7%) (Table 3).

Eighteen physicians (60.0%) re-assessed the need for home oxygen therapy for their patients. Most re-evaluated within 3 to 6 months, and the re-evaluation was confirmed using pulse oximetry (n = 16, 88.9%) or arterial blood gas analysis (n = 10, 55.6%) (Table 4).

Oxygen prescription of borderline hypoxemic state and acute respiratory distress patients at discharge

Seventeen physicians answered that they had issued an oxygen prescription for borderline hypoxemia (n = 17, 56.7%). However, generally, they recommended only to use during

Table 4. Re-evaluation of home oxygen therapy

Variable	No. (%)
Re-evaluation for home oxygen therapy (yes)	18 (60.0)
Re-evaluation interval, mo	
1	1 (3.3)
3	8 (44.4)
6	6 (33.3)
12	3 (16.7)
Re-evaluation test ^a	
Pulse oximetry	16 (88.9)
Arterial blood gas analysis	10 (55.6)
Six-minutes-walk test	1 (5.6)
Questionnaire (e.g., CAT)	2 (11.1)
Pulmonary function test	2 (11.1)

CAT, COPD Assessment Test.

^aAllowed multiple responses.

exercise (n = 13, 76.5%) or periods of dyspnea (n = 4, 23.5%) (Table 2).

The patients with borderline hypoxemia were prescribed the same flow rate at rest (n = 10, 58.8%) or the flow rate in which hypoxemia was not observed while the patients underwent the 6-minute walk exam (n = 7, 41.2%) (Table 2). Conversely, for oxygen therapy during sleep, 11 physicians prescribed the same as at rest, three prescribed higher than at resting state, and two considered the previous saturation as a reference (Table 2).

All 30 physicians had had the experience of prescribing oxygen to patients discharged from the hospital after treatment for acute respiratory distress. Furthermore, all

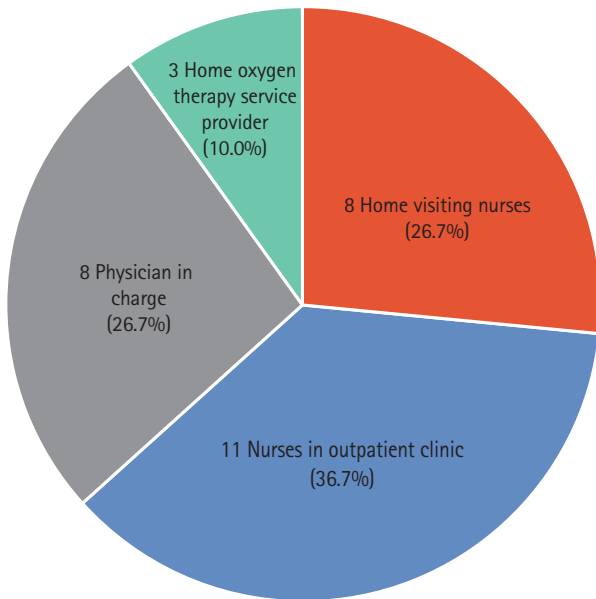


Figure 3. Appropriate training person.

the physicians prescribed home oxygen therapy to patients with chronic respiratory disease (e.g., COPD, interstitial lung disease, lung cancer, bronchiectasis), as well as congestive heart failure, palliative, and end-of-life care diseases (Supplementary Table 2). Nine physicians advised using home oxygen therapy only during exercise, sleep, or periods of dyspnea (Supplementary Table 3). Nineteen physicians (63.3%) re-evaluated the home oxygen prescribed to patients after discharge, generally, within 3 months (n = 13, 68.4%) (Supplementary Table 4), and eight (72.7%) had difficulties re-evaluating due to lack of outpatient time (Supplementary Table 4).

DISCUSSION

In this study, we explored the real-world situation of physician oxygen prescription patterns. We asked the respiratory physicians who were prescribing the home oxygen about their prescription patterns. The 30 respiratory physicians who participated in the survey recommended their patients to use home oxygen for a minimum of 15 hours/day. This prescription pattern was in line with previous reports, which concluded that continuous home oxygen for 15 hours/day improved the survival rate and the quality of life [7,14]. In terms of flow rate, which has not yet been established, we

found that most physicians prescribed less than 2 L/min initially. It had been reported that in severe COPD patients, uncontrolled oxygen administration could lead to hypercapnia [15]; therefore, physicians may have considered this when prescribing the flow rate.

All 30 physicians verified hypoxemia using pulse oximetry, and approximately 87% of physicians also performed arterial blood gas analysis when prescribing oxygen. According to the British Thoracic Society (BTS) guidelines [6], non-invasive monitoring is performed by the portable equipment used to start oxygen therapy. However, this modality may be inaccurate [16]. According to Carone et al. [17], non-invasive monitoring of oxygen saturation is inadequate for assessing arterial saturation in patients with COPD, and, when prescribing oxygen therapy, pulse oximetry should be used with a cut off limit imposed.

Inadequate understating of home oxygen therapy contributes to its underuse or misuse. Therefore, patient education, such as regular follow-ups, patient-provider communication, or well-organized programs, would help improve the outcome of home oxygen therapy [6,18]. In our study, about 50% of the physicians provided education about home oxygen therapy using the leaflets from home oxygen therapy service providers. The main reasons for not providing patient education were that physicians felt they did not have adequate time during outpatient clinics consultations and because the national insurance system does not cover the educational program. Almost all physicians (n = 29, 96.7%) were willing to provide an educational program if the health insured covered the program. Furthermore, they think that the physician in charge (n = 8, 26.7%), the nurses in outpatient clinics (n = 11, 36.7%), or the home visiting nurses (n = 8, 26.7%) should play a leading role in patient education (Fig. 3).

A total of 18 physicians (60.0%) re-evaluated the necessity of home oxygen therapy within 1 year, and the majority were re-evaluated within 3 to 6 months. Those who did not re-evaluate also responded that they did not have enough time during outpatient clinics consultations (n = 8, 66.7%). According to the previous studies on the re-evaluation of continuous oxygen therapy [19,20], there was no notable difference in the follow-up period; furthermore, a meaningful number of the patients prescribed home oxygen could discontinue the home oxygen therapy after appropriate re-evaluation. Therefore, not merely asking a "yes or no" question for determining patient compliance, the physicians

should re-assess the need for adequate oxygen treatment.

Our study also surveyed the prescription experiences regarding borderline hypoxemia or post-discharge home oxygen treatment of acute respiratory distress. Seventeen physicians responded that they prescribe oxygen to patients with 92% to 93% saturation, but they limited the oxygen use to periods of exercise or dyspnea. However, a randomized study regarding home oxygen prescription to borderline hypoxemia patients indicated, there was no increase in long-term survival [10]. A meta-analysis reported that continuous oxygen could relieve dyspnea in mild or non-hypoxemic COPD patients [21].

Several cross-over studies have suggested that short-term oxygen therapy may improve the physiological variables during a short interval [22]; however, these benefits were not demonstrated in a relatively longer clinical trial [23]. In our survey, all the respiratory physicians confirmed that they prescribed home oxygen therapy to patients discharged after hospitalization due to dyspnea. In this case, the doctors restricted the home oxygen to special conditions, such as sleep, exercise, or periods of dyspnea. Additionally, 19 physicians re-evaluated home oxygen therapy within 6 months. Short-term oxygen therapy was occasionally used to relieve acute dyspnea without hypoxemia or in patients with borderline hypoxemia, despite weak evidence to support its effectiveness in this setting [6]. However, a real-world study about the effectiveness of short-term oxygen therapy during an acute respiratory distressed state at discharge or borderline hypoxemia would be needed.

This study was conducted on pulmonary specialists who agreed voluntarily to answer the questionnaire. Therefore, the number of participants ($n = 30$) was small. Although the involvement of respiratory physicians may be a confounding factor in interpreting the results of the questionnaire, the permitted license of a physician to issue the home oxygen prescription was also limited. Notably, however, the participants have been involved with COPD research in Korea [12], and we think this study sufficiently reflects the current state of oxygen prescription by pulmonary specialists in Korea. In addition, while previous studies on home oxygen therapy that focused on the patients' perspective, this study has strength in that a questionnaire survey was completed by respiratory physicians who issued home oxygen prescriptions to assess physicians' prescription patterns.

In this study, we demonstrated the prescription pattern of home oxygen therapy in Korea. Physicians issued oxygen

prescription to patients with hypoxemic COPD for a minimum of 15 hours/day at a flow rate of less than 2 L/min. Home oxygen was also prescribed for patients at borderline hypoxemia or for relieving acute dyspnea symptoms at discharge. As patient education was not properly performed, physicians in Korea have recommended that a national policy be developed to improve the quality of home oxygen therapy, including a patient education program.

KEY MESSAGE

1. From this study, we investigated the real-world situation of physician oxygen prescription patterns in Korea.
2. Physicians issued oxygen prescription to patients with hypoxemic chronic obstructive pulmonary disease (COPD) for a minimum of 15 hr/day at a flow rate of less than 2 L/min.
3. To overcome inadequate patient education performance, physicians in Korea have requested a national policy to improve the quality of home oxygen therapy, including an educational program for patients with COPD.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

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

REFERENCES

1. Yoon HK, Park YB, Rhee CK, Lee JH, Oh YM; Committee of the Korean COPD Guideline 2014. Summary of the chronic obstructive pulmonary disease clinical practice guideline revised in 2014 by the Korean Academy of Tuberculosis and Respiratory Disease. *Tuberc Respir Dis (Seoul)* 2017;80:230-240.
2. Rabe KF, Hurd S, Anzueto A, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. *Am J Respir Crit Care Med* 2007;176:532-555.

3. 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.
4. Kim V, Benditt JO, Wise RA, Sharafkhaneh A. Oxygen therapy in chronic obstructive pulmonary disease. *Proc Am Thorac Soc* 2008;5:513-518.
5. Gulbas G, Gunen H, In E, Kilic T. Long-term follow-up of chronic obstructive pulmonary disease patients on long-term oxygen treatment. *Int J Clin Pract* 2012;66:152-157.
6. Hardinge M, Annandale J, Bourne S, et al. British Thoracic Society guidelines for home oxygen use in adults. *Thorax* 2015;70 Suppl 1:i1-i43.
7. Nocturnal Oxygen Therapy Trial Group. Continuous or nocturnal oxygen therapy in hypoxemic chronic obstructive lung disease: a clinical trial. *Ann Intern Med* 1980;93:391-398.
8. McDonald CF. Oxygen therapy for COPD. *J Thorac Dis* 2014;6:1632-1639.
9. Lee KH. Home oxygen therapy in patients with chronic obstructive pulmonary disease. *Korean J Med* 2007;73:353-360.
10. Long-Term Oxygen Treatment Trial Research Group, Albert RK, Au DH, et al. A randomized trial of long-term oxygen for COPD with moderate desaturation. *N Engl J Med* 2016;375:1617-1627.
11. Wijkstra PJ, Guyatt GH, Ambrosino N, et al. International approaches to the prescription of long-term oxygen therapy. *Eur Respir J* 2001;18:909-913.
12. Lee JY, Chon GR, Rhee CK, et al. Characteristics of patients with chronic obstructive pulmonary disease at the first visit to a pulmonary medical center in Korea: the KOrea COpd Subgroup Study Team Cohort. *J Korean Med Sci* 2016;31:553-560.
13. Shapiro BA, Peruzzi WT, Templin R. Normal ranges and interpretive guidelines. In: Shapiro BA, Peruzzi WT, ed. *Clinical Application of Blood Gases*. 5th ed. St. Louis (MO): Mosby-Year Book, 1994:57-67.
14. 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;1:681-686.
15. Abdo WF, Heunks LM. Oxygen-induced hypercapnia in COPD: myths and facts. *Crit Care* 2012;16:323.
16. Eaton T, Rudkin S, Garrett JE. The clinical utility of arterialized earlobe capillary blood in the assessment of patients for long-term oxygen therapy. *Respir Med* 2001;95:655-660.
17. Carone M, Patessio A, Appendini L, et al. Comparison of invasive and noninvasive saturation monitoring in prescribing oxygen during exercise in COPD patients. *Eur Respir J* 1997;10:446-451.
18. Peckham DG, McGibbon K, Tonkinson J, Plimbley G, Pantin C. Improvement in patient compliance with long-term oxygen therapy following formal assessment with training. *Respir Med* 1998;92:1203-1206.
19. Cottrell JJ, Openbrier D, Lave JR, Paul C, Garland JL. Home oxygen therapy: a comparison of 2- vs 6-month patient reevaluation. *Chest* 1995;107:358-361.
20. Oba Y, Salzman GA, Willsie SK. Reevaluation of continuous oxygen therapy after initial prescription in patients with chronic obstructive pulmonary disease. *Respir Care* 2000;45:401-406.
21. Uronis HE, Ekstrom MP, Currow DC, McCrory DC, Samsa GP, Abernethy AP. Oxygen for relief of dyspnoea in people with chronic obstructive pulmonary disease who would not qualify for home oxygen: a systematic review and meta-analysis. *Thorax* 2015;70:492-494.
22. Bradley JM, O'Neill B. Short term ambulatory oxygen for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev* 2005;2:CD004356.
23. Moore RP, Berlowitz DJ, Denehy L, et al. A randomised trial of domiciliary, ambulatory oxygen in patients with COPD and dyspnoea but without resting hypoxaemia. *Thorax* 2011;66:32-37.

Supplementary Table 1. Considerations when issuing oxygen prescription

Variables for prescription criteria	No. (%)
Following the patient's condition (severity)	7 (23.3)
To maintain oxygen saturation	13 (43.3)
Following the arterial blood gas analysis	3 (10.0)
Following the oxygen saturation and arterial blood gas analysis	3 (10.0)
Etc. ^a	4 (13.3)

^aIncluded 'Consider sleeping and resting time,' 'Prescribe at the flow rate used during hospitalization,' or 'Decide more than 15 L/day within the range that hypercapnia is not observed.'

Supplementary Table 2. Diseases prescribed home oxygen therapy

Disease	No. (%)
Chronic respiratory diseases ^a (e.g., COPD, ILD, lung cancer, bronchiectasis)	30 (100)
Congestive heart failure	7 (23.3)
Patients with palliative and end-of-care disease	13 (43.3)

COPD, chronic obstructive pulmonary disease; ILD, interstitial lung disease.

^aAllowed multiple responses.

Supplementary Table 3. Oxygen use restrictions in patients with acute dyspnea at discharge

Variable	No. (%)
Oxygen use restriction (yes)	9 (30.0)
When to restrict oxygen use in patients? (n = 9)	
During sleep	2 (22.2)
During exercise	6 (66.7)
Use only for dyspnea	1 (11.1)

Supplementary Table 4. Re-evaluation of patients with the acute respiratory distress for home oxygen therapy after discharge

Variable	No. (%)
Re-evaluation for home oxygen therapy (yes)	18 (60.0)
Timing of re-evaluation	
1 Month later	3 (16.7)
3 Months later	13 (72.2)
6 Months later	2 (11.1)
Re-evaluation tests ^a	
Pulse oximetry	18 (100.0)
Arterial blood gas analysis	11 (61.1)
Six-minute-walk test	2 (11.1)
Questionnaire (e.g., CAT)	3 (16.7)
Pulmonary function test	1 (5.6)
Reasons for not re-evaluating the patients ^a	
Do not have time during outpatient clinic consultations	8 (66.7)
Do not need to re-evaluate	2 (16.7)
Patients refuse the follow-up test	3 (25.0)
No response	2 (16.7)

CAT, COPD Assessment Test.

^aAllowed multiple responses.

APPENDIX 1. The questionnaire: simple English version

Questions about overall home oxygen prescription

- 1) Have you ever issued a home oxygen therapy prescription?
- 2) Do you know the criteria for issuing an oxygen prescription?
- 3) How many oxygen prescriptions do you issue per month (including both outpatient and inpatient)?

Questions about the prescription in outpatients

- 1) Have you ever issued an oxygen prescription to patients with chronic obstructive pulmonary disease?
- 2) Have you ever restricted the use of oxygen to patients with an oxygen prescription? When?
- 3) Which tests do you perform when issuing oxygen prescriptions?
- 4) How do you usually prescribe the initial oxygen prescription flow rate and time when issuing an oxygen prescription?
- 5) How do you prescribe oxygen in case of sleep or exercise?

Questions for improving home oxygen therapy services

- 1) Do you re-evaluate your need for home oxygen treatment if you have issued an oxygen prescription? How often do you?
- 2) Do you provide any training materials on home oxygen treatment when issuing oxygen prescriptions? Which training materials do you have?
- 3) Why do you not prescribe home oxygen therapy? If a new policy about home oxygen treatment is developed, are you interested in oxygen therapy?
- 4) Do you think it is necessary to re-assess the need for home oxygen treatment after issuing an oxygen prescription? If you need a re-evaluation, how often do you think you should?
- 5) Do you think that a link with "home nurse service" or changes in the payment standard for home oxygen care will be necessary to activate home oxygen therapy services?

Questions about prescription of borderline hypoxemic state

- 1) Have you ever issued oxygen prescriptions to patients with borderline hypoxemia (oxygen saturation 92 to 93%) who do not meet the criteria for issuing oxygen prescriptions? In what cases did you decide to use oxygen?
- 2) Do you re-evaluate the need for home oxygen therapy if you are issued an oxygen prescription to patients with borderline hypoxemia?

Questions about prescribing home oxygen therapy to patients with acute respiratory distress at discharge

- 1) Have you ever issued an oxygen prescription when an inpatient was discharged? In what cases?
- 2) Have you ever restricted the use of oxygen for discharge patients when issuing oxygen prescriptions? In what case, mainly?
- 3) Do you re-evaluate the need for home oxygen treatment after issuing an oxygen prescription?

APPENDIX 2. The questionnaire: full Korean version

1. 가정산소치료 서비스 처방전 (산소처방전)을 발행해 보신 적이 있으십니까?
 - 1) 예
 - 2) 아니오
2. 산소처방전 발행 기준을 알고 계십니까?
 - 1) 예
 - 2) 아니오
3. 한달에 평균 몇 건 정도 산소처방전을 발행하십니까? (외래, 입원 환자 모두 포함)
 - 1) 1~5건
 - 2) 5~10건
 - 3) 10건 이상

외래 환자 산소 처방: 다음 질문들은 외래에서 산소처방전 발행에 대한 질문입니다.

4. 외래에서 만성폐쇄성폐질환(COPD) 환자들에게 산소처방전을 발행해 보신 적이 있으십니까?
 - 1) 예
 - 2) 아니오
5. 산소처방전 발급 대상 환자들에게 산소처방전 발행 시 산소의 용도를 제한한 적이 있으십니까?
 - 1) 예 (5-1 로 이동)
 - 2) 아니오
- 5-1 주로 어떤 경우에 산소를 사용하도록 하셨습니까?
 - 1) 수면 시에만 사용,
 - 2) 운동(이동) 시에만 사용
 - 3) 숨찰 때만 사용
 - 4) 기타_____
6. 산소처방전 발행 시 어떤 검사를 시행하십니까? (복수응답 가능)
 - 1) 산소 포화도 측정
 - 2) 동맥혈 가스 검사
 - 3) 운동 부하 검사 (6분 보행 검사)
 - 4) 안한다
 - 5) 기타_____
7. 산소처방전 발행을 위해 질문 6번의 검사를 몇 번 시행 후 산소처방전을 발행하십니까?
 - 1) 1번만 시행 후 처방전을 발행한다.
 - 2) 2번 시행 후 처방전을 발행한다.
 - 3) 기타_____

8. 산소처방전 발행 시 최초 산소 처방 유량과 시간은 보통 어떻게 처방하십니까? (주관식)

- 1) 시간: _____시간/일
- 2) 유량: _____L/분
- 3) 1),2)를 정하는 기준 _____

9. 운동 시 산소처방은 어떻게 정하십니까?

- 1) 운동 부하 검사를 통해서 저산소혈증이 생기는 않는 최소 산소 양을 정한다
- 2) 안정 시에 사용하는 용량을 기준으로 하여 정한다

3) 기타 _____

10. 수면 시 산소처방은 어떻게 정하십니까?

- 1) 특별한 상태 변화가 없으면 안정 시와 동일하게 사용하도록 한다.
- 2) 안정시 보다는 산소량을 늘려서 사용하도록 한다.
- 3) 과거 야간(수면 중) 산소 포화도를 참고해서 처방한다
- 4) 기타 _____

11. 산소처방전을 발행한 경우 다시 가정산소치료의 필요성에 대해 재평가를 하십니까?

- 1) 예 (11-1,2 로 이동)
- 2) 아니오 (11-3 로 이동)

11-1. 가정산소치료의 필요성에 대해 재평가를 하는 간격은 어느 정도 입니까?

- 1) 1개월
- 2) 2개월
- 3) 3개월
- 4) 기타 _____

11-2. 가정산소치료의 필요성에 대해 재평가를 할 때 어떤 방법을 이용하십니까? (복수응답 가능)

- 1) 산소 포화도 측정
- 2) 동맥혈 가스 검사
- 3) 운동 부하 검사 (6분 보행 검사)
- 4) 문진 또는 설문지 (예, CAT)
- 5) 기타 _____

11-3. 가정산소치료의 필요성에 대해 재평가를 하지 않는 이유는 무엇입니까? (복수 응답가능)

- 1) 환자들이 이미 산소 사용을 안하고 있어서
- 2) 외래 중에 재평가를 할 시간이 없어서
- 3) 환자들이 추가 검사를 거부해서
- 4) 처음 처방 시 정확한 평가를 해서 재평가가 필요 없어서
- 5) 기타 _____

12. 가정산소치료를 잘 사용하는지 환자에게 어떻게 확인하십니까?

- 1) 외래 진료 시 잘 사용하고 있는지 정도만 물어 본다
- 2) 외래 진료 시 구체적으로 물어 본다 (하루에 몇 L/분으로 몇 시간 사용하는지)
- 3) 가정산소치료 서비스 회사에 확인한다
- 4) 기타_____

13. 산소처방전 발행 시 가정산소치료에 대한 교육을 하십니까?

- 1) 예 (13-1,2,3로 이동)
- 2) 아니오 (13-4,5,6로 이동)

13-1. 가정산소치료에 대한 교육 자료를 비치하고 계십니까?

- 1) 예
- 2) 아니오

13-2. 어떤 교육 자료를 가지고 계십니까?

- 1) 가정산소치료 서비스회사에서 제공한 리플렛
- 2) 병원에서 자체 제작한 교육 자료
- 3) 기타_____

13-3. 교육 내용 중 가장 강조하는 내용 한가지만 기술해 주십시오(주관식)

13-4. 가정산소치료 교육을 시행하지 않는다면 이유는 무엇입니까?

- 1) 외래에서 교육할 시간이 없어서
- 2) 교육을 시킬 사람이 없어서
- 3) 교육 자료가 없어서
- 4) 기타

13-5 가정산소치료 교육비가 신설되면 산소치료 교육을 할 의향이 있으십니까?

- 1) 예
- 2) 아니오

13-6 산소치료 교육을 시행한다면 교육 담당자는 누가 적당하다고 생각하십니까?

- 1) 진료 담당의사
- 2) 외래 간호사
- 3) 가정산소치료 서비스 회사
- 4) 가정 방문 간호사
- 5) 기타_____

14. 산소처방전 발행 시 이동용 산소 사용에 대해서도 권고를 하십니까?

- 1) 예
- 2) 아니오 (14-1로 이동)

14-1. 이동용 산소 사용을 권고하지 않는 이유가 무엇입니까? (복수 응답 가능)

- 1) 이동용 산소의 필요성을 적어서
- 2) 이동용 산소의 가격이 비싸고 보험 급여가 되지 않아서
- 3) 이동용 산소 기구가 무겁고 불편해서
- 4) 외래에서 권고할 시간이 없어서
- 5) 기타_____

15. 산소처방전 발행 기준에 해당되지 않는 borderline hypoxemia (SaO₂ 92-93%) 환자들에게 산소처방전을 발급해 본적이 있으십니까?

- 1) 예 (15-1,2,3,4,5 로 이동)
- 2) 아니오

15-1. 주로 어떤 경우에 산소를 사용하도록 하셨습니다습니까?

- 1) 수면 시에 사용하도록 한다
- 2) 운동(이동) 시에 사용하도록 한다
- 3) 숨찰 때만 사용하도록 한다
- 4) 기타_____

15-2. borderline hypoxemia 환자들에게 산소처방전 발행 시 어떤 검사를 시행하십니까? (복수응답 가능)

- 1) 산소 포화도 측정
- 2) 동맥혈 가스 검사
- 3) 운동 부하 검사 (6분 보행 검사)
- 4) 안한다
- 5) 기타_____

15-3. borderline hypoxemia 환자들의 운동 시 산소처방량은 어떻게 정하십니까?

- 1) 운동 부하 검사를 통해서 저산소혈증이 생기는 않는 최소 산소 양을 정한다
- 2) 안정 시에 사용하는 용량을 기준으로 하여 정한다
- 3) 기타 _____

15-4. borderline hypoxemia 환자들의 수면 시 산소처방량은 어떻게 정하십니까?

- 1) 특별한 상태 변화가 없으면 안정 시와 동일하게 사용하도록 한다.
- 2) 안정시 보다는 1L/분 정도 산소량을 늘려서 사용하도록 한다.
- 3) 과거 야간(수면 중) 산소 포화도를 참고해서 처방한다
- 4) 기타_____

15-5. borderline hypoxemia 환자들에게 산소처방전을 발행한 경우 다시 가정산소치료의 필요성에 대해 재검사를 하십니까?

- 1) 예 (15-5-1로 이동)
- 2) 아니오 (15-5-2로 이동)

15-5-1. 가정산소치료의 필요성에 대해 재평가를 하신다면 얼마 간격으로 검사하십니까?

- 1) 1개월
- 2) 2개월
- 3) 3개월
- 4) 기타 _____

15-5-2. 가정산소치료의 필요성에 대해 재평가를 하지 않는 이유는 무엇입니까? (복수 응답가능)

- 1) 환자들이 이미 산소 사용을 안하고 있어서
- 2) 외래 중에 재평가를 할 시간이 없어서
- 3) 환자들이 추가 검사를 거부해서
- 4) 처음 처방 시 정확한 평가를 해서 재평가가 필요 없어서
- 5) 기타 _____

입원 환자 산소 처방: 다음 질문들은 입원 환자 산소처방전 발행에 대한 질문입니다.

16. 입원 환자가 퇴원할 때 산소처방전을 발행해 보신 적이 있습니까?

- 1) 예
- 2) 아니오

17. 주로 어떤 환자들에게 발행하십니까? (복수 응답 가능)

- 1) 만성 호흡기 질환 환자 (COPD, ILD, lung cancer, bronchiectasis 등)
- 2) 심부전 환자
- 3) 임종 전 환자 (palliative and end-of-life care)

17-1. 기존에 90일간 적절한 내과적인 치료를 받지 않던 환자가 급성악화로 산소처방전을 받은 경우에는 보험급여가 되지 않습니다.

이 사실을 알고 계십니까?

- 1) 예
- 2) 아니오

17-2. 17-1 의 경우에 해당되는 환자의 경우 산소처방전 발행을 급여화 해야 된다고 생각하십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다

18. 퇴원 환자들에게 산소처방전 발행 시 산소의 용도를 제한한 적이 있으십니까?

- 1) 예 (18-1 로 이동)
- 2) 아니오

18-1 주로 어떤 경우에 산소를 사용하도록 하십니까?

- 1) 수면 시에만 사용,
- 2) 운동(이동) 시에만 사용
- 3) 숨차 할 때만 사용
- 4) 기타 _____

19. 산소처방전을 발행 후 다시 가정산소치료의 필요성에 대해 재평가를 하십니까?

- 1) 예 (19-1,2로 이동)
- 2) 아니오 (19-3으로 이동)

19-1. 가정산소치료의 필요성에 대해 보통 재평가는 언제 하십니까?

- 1) 퇴원 1개월 후
- 2) 퇴원 2개월 후
- 3) 퇴원 3개월 후
- 4) 기타 _____

19-2. 가정산소치료의 필요성에 대한 재평가 시 어떤 검사를 시행하십니까? (복수응답 가능)

- 1) 산소 포화도 측정
- 2) 동맥혈 가스 검사
- 3) 운동 부하 검사 (6분 보행 검사)
- 4) 문진 또는 설문지 (예, CAT)
- 5) 기타 _____

19-3. 가정산소치료의 필요성에 대해 재평가를 하지 않는 이유는 무엇입니까? (복수 응답가능)

- 1) 환자들이 이미 산소 사용을 안하고 있어서
- 2) 외래 중에 재평가를 할 시간이 없어서
- 3) 환자들이 추가 검사를 거부해서
- 4) 처음 처방 시 정확한 평가를 해서 재평가가 필요 없어서
- 5) 기타 _____

보다 나은 가정산소치료 서비스를 위한 질문

20. 산소처방전 발행 후 가정산소치료의 필요성에 대한 재평가가 필요하다고 생각하십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다

21. 가정산소치료의 필요성에 대해서 재평가가 필요하다면 얼마 간격이 적당하다고 생각하십니까? (안정 상태에서)

- 1) 1개월
- 2) 2개월
- 3) 3개월
- 4) 6개월
- 5) 기타 _____ 개월

22. 가정산소치료의 필요성에 대해서 재평가가 시 어떤 검사가 적절하다고 생각하십니까? (복수응답 가능)

- 1) 산소 포화도
- 2) 동맥혈 가스 검사
- 3) 운동 부하 검사 (6분 보행 검사)
- 4) 문진 또는 설문지 (예, CAT)
- 5) 폐기능검사
- 6) 기타 _____

23. 다음은 현재 가정산소치료 서비스의 문제점들을 나열한 것입니다. 우선적 개선이 필요하다고 생각하시는 것 2가지만 선택해 주십시오.

- 1) 이동용 산소치료에 대한 보험 급여가 필요하다
- 2) 환자가 산소치료를 제대로 받고 있는지 확인할 방법이 부족하다.
- 3) 가정산소치료 서비스에 대한 인식이 부족하다
- 4) 도서 지역에는 가정산소 치료 이용이 어렵다
- 5) 가정산소치료 서비스 회사간의 차별이 없고 환자가 어느 회사를 이용하는지 알 수 없다.

24. 가정산소치료 서비스 회사를 통하여 환자의 가정산소치료 실태가 정기적으로 피드백이 제공된다면 정보를 제공받을 의향이 있으십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다

25. 가정산소치료 서비스 회사로부터 산소치료에 대한 피드백을 받을 경우 어떤 내용이 포함되었으면 하시는지요? (복수 응답 가능)

- 1) 환자의 산소 포화도
- 2) 환자의 실제 산소 사용 시간
- 3) 환자의 실제 산소 사용 용량
- 4) 산소처방전대로 사용하지 않는 이유
- 5) 회사의 환자 방문 주기
- 6) 기타_____

26. 가정산소치료 서비스의 활성화를 위해서 '가정 간호사 서비스'와의 연계가 필요하다고 생각하십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다

26-1. 가정간호사 서비스와 연계 시 '가정간호 전문간호사' 제도의 도입이 필요하다고 보십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다

26-2. 가정간호사 서비스와 연계 시 추가적인 수가 인정이 필요하다고 보십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다

27. 현재 산소처방전 발행 시 가정산소치료 서비스 관련 상병 명이 있으면 요양급여를 인정하고 있는데 ‘호흡 부전’의 경우는 직접 상병이 없으면 요양 급여가 인정되지 않고 있습니다. 이 사실을 알고 계십니까?

- 1) 예
- 2) 아니오

27-1. ‘호흡부전’ 코드 만 입력하여도 요양급여가 인정되도록 해야 된다고 생각하십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다

28. 현재 가정산소 요양비 지급 기준이 "환자가 집에서 산소발생기를 대여받고 있는 기간 동안" 으로 되어 있습니다. 가정산소치료 서비스를 받는 환자가 입원을 할 경우에는 가정산소치료 서비스 회사들이 요양비를 공단에 반환을 해야 된다고 합니다. 이 사실을 알고 계셨습니까?

- 1) 예
- 2) 아니오

28-1. 가정산소 요양비 지급 기준을 "산소발생기를 대여하고 있는 동안"으로 변경해야 된다고 생각하십니까?

- 1) 매우 그렇다
- 2) 그렇다
- 3) 보통이다
- 4) 그렇지 않다
- 5) 전혀 그렇지 않다
- 6) 잘 모르겠다