

Doctoral Thesis

Modification of oxygen concentrators based on questionnaire survey

(在宅酸素療法患者へのアンケート調査に基づいた酸素濃縮器の改良)

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Modification of oxygen concentrators based on questionnaire survey

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Abstract

Background: In this study, we conducted a questionnaire survey to clarify and improve problems related to oxygen concentrators.

Methods: Using a questionnaire survey of 30 patients receiving long-term oxygen therapy for chronic respiratory failure, we investigated the necessity of using a remote controller, portability, fire prevention system, built-in battery type and so on. Patients were divided into two groups according to age, sex, underlying conditions and amount of oxygen prescribed, then analyzed accordingly.

Results: Mean age was 72.3 ± 8.09 years. The mean flow rate for prescribed oxygen was 1.10 L/min at rest and 2.96 L/min under exertion. Median duration of use was 17.5 months. Built-in battery type, environmentally friendly system and voice guidance system received the most attention according to four-grade evaluations of each function. Significant differences were seen in design features in patients less than 72 years old ($P = .03$), in voice guidance system in patients who only used the equipment during exertion ($P = .01$), and in brand imaging in those using the equipment under exertion at a flow ≥ 3 L/min ($P = .04$). In questionnaire results for the three most desired features, built-in battery type was of primary concern, followed by portability and use of a remote control.

Conclusions: Overall, built-in battery type, portability, use of a remote control and an environmentally friendly system were desired features for oxygen concentrators. Desired features could vary according to age and the amount of oxygen prescribed.

KEYWORDS

chronic respiratory failure, long-term oxygen therapy, oxygen concentrator, questionnaire

1 | INTRODUCTION

Around 150 000 patients in Japan are receiving long-term oxygen therapy, and this number is increasing by approximately 3000 patients per year.¹ Around 90% of individuals on long-term oxygen therapy in Japan are using stationary oxygen concentrators.² In most cases, oxygen concentrators used at home are provided by businesses under contract to medical institutions at the direction of physicians. Although the performance of the machines offered by businesses

varies, as the number of such business is limited, patients cannot currently select a unit after considering differences between units, and only around 23% of patients are reportedly satisfied with their oxygen concentrators, with at least 20% of patients reported to be dissatisfied due to the lack of choice.³ Although long-term oxygen therapy can be expected to improve vital prognosis,^{4,5} quality of life (QOL) and exercise tolerance⁶ in cases with serious chronic obstructive pulmonary disease (COPD), patients might not be receiving the full benefits of long-term oxygen therapy if they receive

TABLE 1 Baseline characteristics

n	30
Mean age, years (range)	72.3 (52–86)
Sex: male/female	21/9
ADL	
Independent living/	27
Requiring long-term care	3
Oxygen supply, L/min	
At rest	1.1 (0–3)
Under exertion	2.96 (1–7)
Duration (months)	29.3 (1–131)
Background diseases	
COPD/old Tb/interstitial pneumonia	11/5/8
Lung cancer/bronchiectasis	4/2

machines that do not fit their lifestyles. Sufficient investigation has yet to be carried out regarding what exactly is desired from oxygen concentrators. At present, progress is being made in treatments specific to the background, state and underlying disease, of patients, but studies should conceivably be carried out for long-term oxygen therapy that takes these factors into consideration.

In this study, a questionnaire survey was undertaken regarding home oxygen concentrators for patients receiving long-term oxygen therapy.

2 | MATERIALS AND METHODS

We performed a questionnaire survey of 30 outpatients receiving long-term oxygen therapy for chronic respiratory failure to clarify functions required from an oxygen concentrator. The chief physician administered the questionnaire survey when patients made regular clinic visits. The questionnaire survey consisted of questions regarding convenience (using remote controller/portability), safety (fire prevention system and built-in battery type) and voice guidance system, environmentally friendly system, use of little electricity, design and manufacturer's brand image. We had patients evaluate the necessity of each function on a four-point scale: 'Yes, absolutely', 'Somewhat', 'Not really' and 'Not at all' (Supporting Information Figure S1). Patients were divided into two groups according to: age (above or below the mean); sex; disorder (COPD, accounting for about one-third of cases, and other disorders); prescription for oxygen at rest; prescribed oxygen flow rate during exertion (above or below the mean) and duration of use (above or below the median). Significant differences were verified using the Mann-Whitney *U* test.

We also had each patient choose the three most desired features for oxygen concentrators (Supporting Information Figure S2).

3 | RESULTS

Mean age was 72.3 ± 8.09 years and the male/female ratio was 21:9. Underlying diseases were COPD, pulmonary

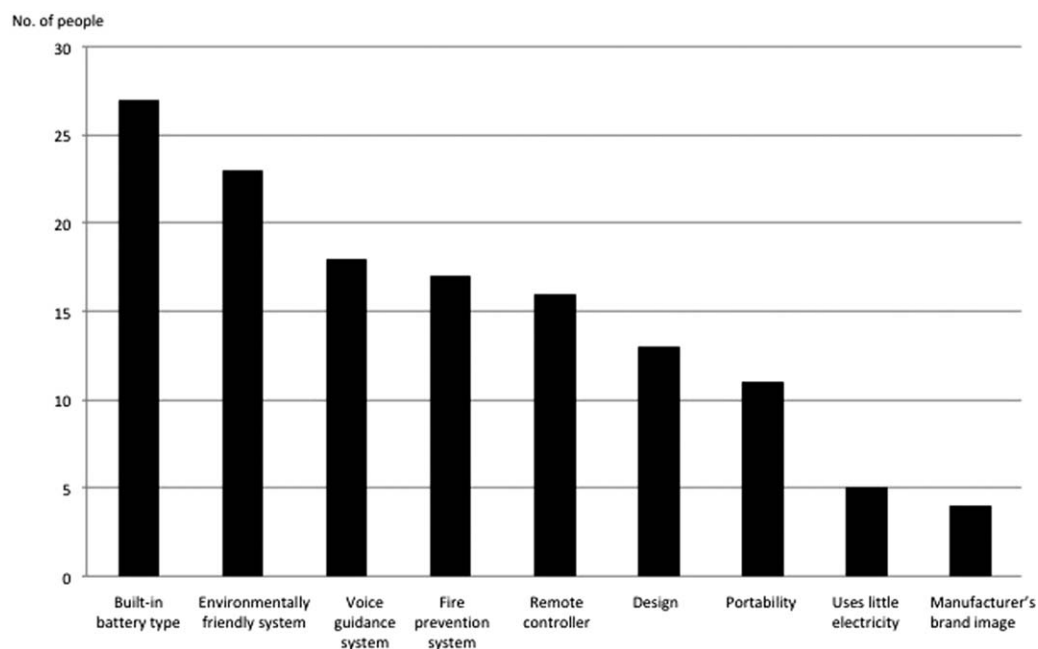


FIGURE 1 A graph showing the number of patients who answered 'Yes, absolutely' or 'Somewhat' was prepared. Battery function was the most popular feature, followed by environmental friendliness

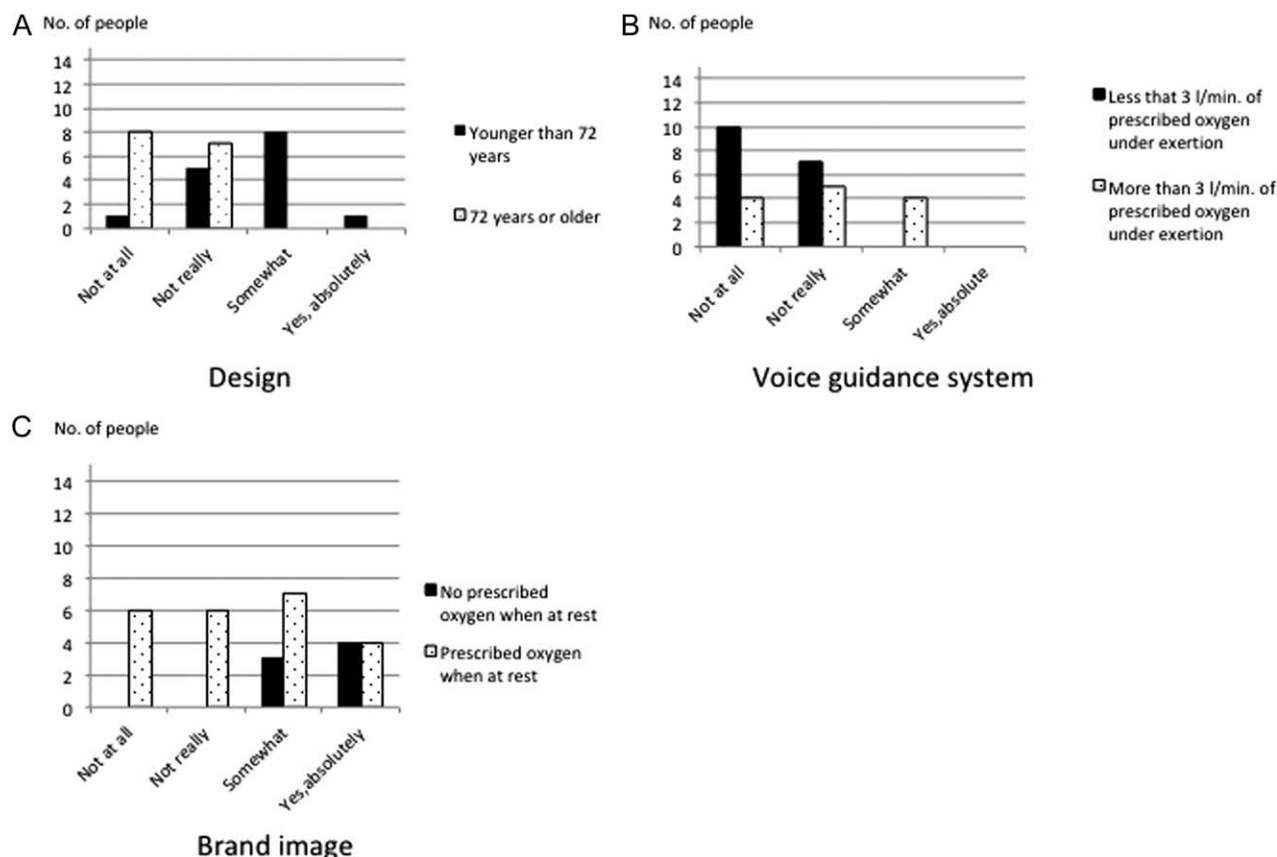


FIGURE 2 A, Questionnaire results regarding design for those under and over 72 years old. B, Questionnaire results regarding voice guidance for those with and without prescribed oxygen at rest. C, Questionnaire results regarding brand image for those prescribed less than and more than 3 L/min of oxygen under exertion

tuberculosis sequelae, interstitial pneumonia, lung cancer and bronchiectasis. In terms of activities of daily living (ADL), 27 of the 30 cases did not need nursing care during daily life. Mean flow rate of prescribed oxygen when at rest was 1.10 L/min, and the mean flow rate under exertion was 2.96 L/min. Mean duration of use was 29.3 months and the median was 17.5 months. Stationary oxygen concentrators were used in all cases (Table 1).

Results of the four-point evaluation of each function showed that in terms of functions for which patients chose 'Yes, absolutely' or 'Somewhat', the most common response was built-in battery type (90%), followed by environmentally friendly system (77%) and then voice guidance system (60%) (Figure 1).

Analyses of pairs of groups using the Mann-Whitney *U* test showed significant differences in terms of: whether design was regarded as important between those above and below the mean age; desire for a voice guidance system between those with and without oxygen prescribed at rest; and desire for brand image between those above and below the median prescribed oxygen during exertion (Table 2). A significant difference regarding design was seen for those younger than 72 years (Figure 2A), a significant difference regarding voice guidance system was seen among patients not prescribed oxygen at rest (Figure 2B) and a significant

difference regarding brand image was seen among those who receiving more than 3 L/min of prescribed oxygen during exercise (Figure 2C).

The three most desired features showed battery features to be of primary concern (82.1%), followed by portability (60.7%) and remote control (42.9%) (Supporting Information Figure S3).

4 | DISCUSSION

This study showed that patients receiving long-term oxygen therapy who took part in an evaluation of the necessity of each function on a four-point scale regarding oxygen concentrators wanted battery functionality most of all, followed by environmental friendliness. Voice guidance, fire prevention and availability of a remote control were next in places three to five, although the values were approximately the same. As pointed out in the White Paper on Home Respiratory Care,⁷ given the many natural disasters in Japan and the associated instances of power failure, patients have a heightened awareness of the need for suitable countermeasures, which appears to be why battery function featured so prominently. Demand for environmental friendliness is thought to be a response to the increasing

TABLE 2 The analysis results of pairs of groups using the Mann-Whitney U test

	<i>P</i> values	Remote controller	Portability	Fire prevention system	Built-in battery	Voice guidance system	Environmentally friendly system	Use of little electricity	Design	Brand image
≥72 years old vs <72 years old	.22	.28	.84	.91	.70	.47	.17	.03*		.19
Male/female	1.00	.31	.60	.72	.74	.45	.62	.70		.66
COPD/Other conditions	.79	.95	.77	.19	.42	.80	.74	.84		.60
With/without oxygen at rest	.74	.74	.55	.40	.01*	.13	.38	.82		.36
Prescribed oxygen under exertion ≥3 L/min vs <3 L/min	.57	.08	.96	.27	1.00	.88	.29	.26		.04*
Duration of use ≥18 months vs <18 months	.40	.22	.51	.45	.28	.53	.42	.71		.34

**P* < .05.

awareness regarding the need to protect the environment after the Great East Japan Earthquake of March 11, 2011.⁸

The results of analysis in every category emphasized design for individuals under 72 years old. Younger individuals often tend to show a greater focus on design characteristics, and similar findings were seen for the oxygen concentrator.

In terms of prescribed oxygen flow, significantly more emphasis was placed on voice guidance systems among patients not inhaling oxygen at rest than among those inhaling oxygen at rest. The field of activities is much larger for patients not prescribed oxygen at rest. Such individuals may think that not only display indications but also voice guidance is necessary for daily life apart from the oxygen concentrator.

Furthermore, a significant emphasis on brand image was seen among patients prescribed oxygen at ≥3 L/min under exertion compared with that among patients prescribed less oxygen under exertion. Because an oxygen concentrator becomes a daily necessity for a patient prescribed oxygen at a high level, we may wish to use the instrument that a reliable company produces.

No significant differences were seen according to underlying condition. A questionnaire undertaken in medical institutions in Japan regarding the proportion of underlying conditions for patients receiving long-term oxygen therapy revealed that COPD accounted for around 50%, followed by secondary pulmonary tuberculosis at 18%, and then lung cancer and interstitial pneumonia.⁹ This study showed a similar distribution of underlying conditions, with COPD accounting for 36.7%, followed by interstitial pneumonia, secondary tuberculosis and lung cancer. Demands for oxygen concentrators do not appear to vary greatly among the different disorders.

In the result for patients three most desired features, built-in battery type, portability and use of a remote control were all rated highly. Portability and use of a remote control were rated highly among the three most desired features. In the White Paper on Home Respiratory Care, points to be improved for stationary oxygen concentrators included miniaturization (51%), portability and weight (42%) and usability (12%).¹⁰ Furthermore, according to a questionnaire survey of patients with chronic respiratory disease carried out by the Japan Respiratory Disorder Information Center, points to be improved in terms of equipment as a whole included improved usability (9%) and reductions in weight and size (3%).¹¹ This study also found that the top improvements wanted by patients were portability, encompassing factors such as reductions in weight and size, as well as availability of a remote control, resulting in improved usability.

Problems associated with this study included the fact that this was a cross-sectional study with only a small number of cases, and the fact that all patients were independent in terms of ADL. To gain a clearer understanding of these issues, a larger sample of patients with issues varying from slight illness to serious conditions needs to be surveyed.

No significant differences of opinion were seen according to sex, but as the male/female ratio was not equal, this point may need reconsideration.

Our study has shown that patients who need LTOT can provide useful advice about oxygen concentrator design from a user perspective. We would encourage manufacturers to pay attention to patient's needs and suggestions when designing new concentrators.

5 | CONCLUSIONS

The results of our questionnaire survey regarding home oxygen concentrators used by patients receiving long-term oxygen therapy revealed that functions desired in an oxygen concentrator included an environmentally friendly system, a built-in battery function, remote operability and portability. As desired features may vary by age or according to the amount of oxygen prescribed, the methods of prescribing oxygen concentrators while taking patient backgrounds into account for personalized treatment need to be further investigated. Patients who receive long-term oxygen therapy should be involved in oxygen concentrator design.

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None.

CONFLICT OF INTEREST

The authors have provided suggestions to Air Water Medical Inc. The authors declare that they have no conflicts of interest with the contents of this article.

AUTHOR CONTRIBUTIONS

Masahiro Shinoda collected and analyzed the data and wrote the article. Masaharu Shinkai designed the study, collected, analyzed the data, and edited the article. Akimichi Nagashima, Kenjiro Nagai, Kei Takagi collected the data. Takeshi Kaneko finally revised the paper.

ETHICS

The study was approved by the Institutional Review Board of Yokohama City University Medical Center (approval number: D1305016).

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

Figure S1 A questionnaire survey containing 11 questions concerning convenience (remote control and portability), safety (fire prevention and battery functions), voice guidance, environmental friendliness, design and brand image was administered

Figure S2 Subjects selected the top three functions desired in oxygen concentrators

Figure S3 Questionnaire results for the three most desired features. Battery features were the most popular, at 274%. Portability was second, at 20.2%, with a remote control third

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II 副論文

なし

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