



Case Study

## Twenty-four-hour ambulatory oximetry monitoring in a patient with idiopathic pulmonary fibrosis for assisting in the discharge instruction on activities of daily living: a case report

KIYOKAZU SEKIKAWA, RPT, PhD<sup>1)\*</sup>, FUMIYA AIZAWA, RPT<sup>2)</sup>, NORIKO SEKIKAWA, RPT<sup>2)</sup>, MAYUKO EGAMI, RPT<sup>2)</sup>, NAOTO KANDA, RPT<sup>2)</sup>, KANON ABE, RPT<sup>2)</sup>, YOUSUKE MATSUMURA, RPT<sup>2)</sup>, YASUTAKA UMAHARA, RPT, PhD<sup>3)</sup>, TOSHIHIRO KAWAE, RPT, MS<sup>4)</sup>

<sup>1)</sup> Institute of Biomedical and Health Sciences, Hiroshima University: 1-2-3 Kasumi, Minami-ku, Hiroshima 734-8553, Japan

<sup>2)</sup> Department of Rehabilitation Medicine, Yoshijima Hospital, Japan

<sup>3)</sup> Department of Rehabilitation, Faculty of Health Science, Hiroshima Cosmopolitan University, Japan

<sup>4)</sup> Department of Physical Therapy, Faculty of Makuhari Human Care, Tohto University, Japan

**Abstract.** [Purpose] Patients with idiopathic pulmonary fibrosis (IPF) often develop remarkable exercise-induced hypoxemia and are hospitalized for management. The pre-discharge management of activities of daily living (ADL) should determine the amount of exercise-induced hypoxemia permitted during daily activities and inform concrete instructions based on these results. This clinical report aimed to promote 24-hour ambulatory oximetry monitoring in a patient with IPF to guide the pre-discharge management of ADL. [Participant and Methods] Our patient was a 67-year-old male with IPF. He was hospitalized and scheduled to be discharged after introduction of home oxygen therapy. Prior to discharge, we conducted a 24-hour ambulatory oximetry monitoring in the patient's home. We administered instructions on ADL based on these results. Furthermore, 1 day after discharge, we monitored his oxygen saturation level during ADL in his home. [Results] During the pre-discharge monitoring, the patient experienced hypoxemia during bathing, with a minimum oxygen saturation (SpO<sub>2</sub>) level of 87% and SpO<sub>2</sub> level of <90% for 14.3% of the time. The patient was instructed on bathing by a physical therapist before discharge; this led to decreased desaturation, as the patient's SpO<sub>2</sub> was <90% for 7.7% of the time. [Conclusion] Twenty-four-hour ambulatory oximetry monitoring is effective in guiding the pre-discharge management of ADL in the home with home oxygen therapy for patients with IPF.

**Key words:** Idiopathic pulmonary fibrosis, Pulse oximetry, Discharge instruction

(This article was submitted May 14, 2020, and was accepted Aug. 4, 2020)

### INTRODUCTION

Patients with idiopathic pulmonary fibrosis (IPF) exhibit exercise-induced hypoxemia (EIH)<sup>1)</sup>, which affects their quality of life<sup>1, 2)</sup>. The presence of EIH is confirmed by the six-minute walking test<sup>3, 4)</sup>, which is also performed to indicate the need for supplemental long-term oxygen therapy. In addition, since IPF is a progressive disease, supportive treatment to ensure the best quality of life is extremely important<sup>5)</sup>. Treatments for IPF include oxygen therapy and pulmonary rehabilitation. It is also important to ensure that discharge instructions are given to IPF patients. These instructions include self-care concerning use of supplemental oxygen during pulmonary rehabilitation<sup>5)</sup>. However, we have found no previous case study that considers factors affecting the onset of hypoxemia in everyday life and then makes treatment proposals regarding the activities of

\*Corresponding author. Kiyokazu Sekikawa (E-mail: sekikawa@hiroshima-u.ac.jp)

©2020 The Society of Physical Therapy Science. Published by IPEC Inc.



This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License. (CC-BY-NC-ND 4.0: <https://creativecommons.org/licenses/by-nc-nd/4.0/>)

daily living (ADL).

The objective of this clinical report was to promote 24-hour ambulatory oximetry monitoring in IPF patients to guide the pre-discharge management of ADL.

## PARTICIPANT AND METHODS

Our patient was a 67-year-old Japanese male (63 kg, 163 cm, BMI 23.7 kg/m<sup>2</sup>) with IPF, which was grade I both in the IPF disease severity and in the modified Medical Research Council dyspnea scale. He had no history of documented cardiac or pulmonary compromise or of diabetes mellitus.

He was admitted to our hospital for the purpose of adjusting pharmacotherapy, introducing home oxygen therapy (HOT), and conducting pulmonary rehabilitation. Pulmonary function analysis on admission showed the following: Vital capacity (VC) 2.77 L, %VC 77.8%, forced expiratory volume in one second 2.34 L, FEV<sub>1.0%</sub> 84.5%, pulmonary diffusing capacity (DLCO) 8.86 mL/min/mmHg, %DLco 36.5%.

On admission, we initially conducted the six-minute walking test (6MWT) without oxygen therapy; the walking distance was 340 m, and his oxygen saturation decreased to 82% (Table 1). His oxygen inhalation on admission was 4.0 L/min at rest, and 5.0 L/min on exertion. The Barthel Index of ADL score was 100 points.

Pulmonary rehabilitation, such as breathing exercises, supervised muscle and endurance exercise, and educating the patient about HOT, was provided from the second day after hospitalization. The patient's rehabilitation progressed smoothly without exacerbation of the IPF or of physical conditions. The patient had a 6MWT while hospitalized (Table 1), and was discharged home 66 days after hospitalization.

Before (day 53) and one day after discharge, we obtained a 24-hour recording of the patient's oxygen saturation (SpO<sub>2</sub>) profile, during which his activities were noted. The SpO<sub>2</sub> profile was obtained in his home, using a waterproof pulse oximeter (Anypal Wal ATP-W03, FUKUDA DENSHI, Japan). The probe was placed on the patient's left index finger.

The patient was also instructed on how to record his basic activities of eating, sleeping, house working, toileting, bathing, and outings and their duration. He was supplied with a table listing the basic activities.

The SpO<sub>2</sub> data was recorded every second and was extracted using software (Fukuda home-care management viewer ver.1, FUKUDA DENSHI, Japan) and graphed. Data points associated with a sudden pulse rate decrease to less than 25 bpm were considered outliers and were excluded from the analysis<sup>6</sup>.

The results from the pulse oximeter were matched with the basic activities and their duration, as described in the table listing.

All procedures were performed in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

**Table 1.** Results of six-minute walking test

|                       |       | 1PAD | 52PAD | 65PAD |
|-----------------------|-------|------|-------|-------|
| Oxygen flow           | L/min |      |       |       |
| resting               |       | N.A. | 1.0   | 0.0   |
| with 6MWT             |       | N.A. | 2.5   | 2.5   |
| Walking distance      | m     | 340  | 435   | 420   |
| Pulse rate            |       |      |       |       |
| (Resting)             | bpm   | 78   | 82    | 76    |
| (end 6MWT)            | bpm   | 96   | 103   | 115   |
| SpO <sub>2</sub>      |       |      |       |       |
| (Resting)             | %     | 98   | 97    | 97    |
| (end 6MWT)            | %     | 82   | 89    | 89    |
| Dyspnea (mBorg scale) |       |      |       |       |
| (Resting)             |       | 0    | 2     | 2     |
| (end 6MWT)            |       | 4    | 5     | 5     |
| Fatigue (mBorg scale) |       |      |       |       |
| (Resting)             |       | 0    | 2     | 2     |
| (end 6MWT)            |       | 5    | 4     | 4     |

PAD: post admission day; N.A.: not applicable; 6MWT: 6-minute walking test; mBorg: modified Borg.

## RESULTS

In the hospital, the patient showed a tendency to become hypoxemic during a series of bathing activities (changing his clothes, moving in the bathroom, entering the bathtub and washing the body) (Fig. 1). During the bathing activities, the minimum SpO<sub>2</sub> was 89% and the proportion of time that his SpO<sub>2</sub> was less than 90% was 14.3% (Fig. 2). The patient did not report dyspnea during his bathing activities. From these results, we decided that the patient needed to learn how to conduct his bathing activities differently so that SpO<sub>2</sub> did not decrease to less than 90%. He received instructions on breathing techniques and movements associated with his activities at home.

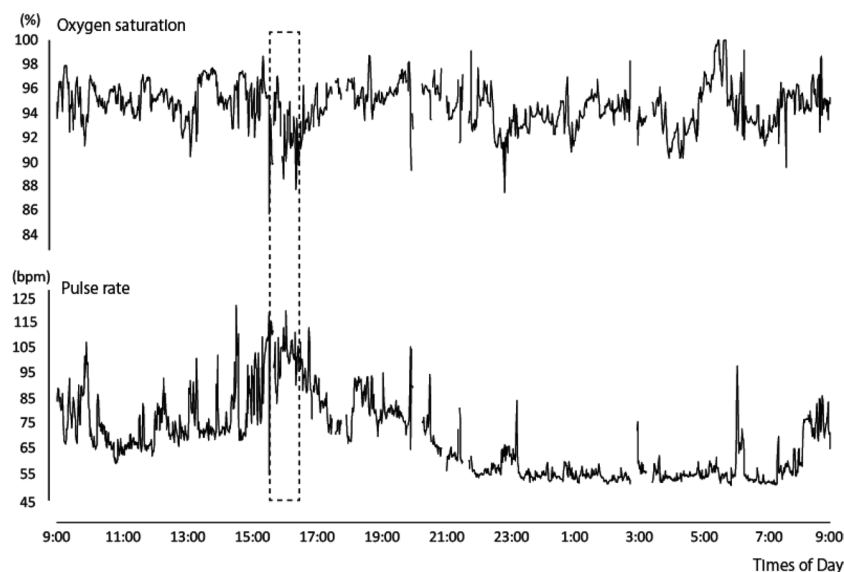
Instructions given by the physical therapist regarding his bathing activities were as follows: “be in a seated position as much as possible”, “breathe and control the movement”, “take enough time to rest between movements”, “minimize disconnecting the cannula when dressing jackets”, “use a long towel or a brush for washing the body”, “shampoo using only one hand”.

On the day after discharge, while bathing at home his minimum SpO<sub>2</sub> was 89%, and the proportion of time that his SpO<sub>2</sub> was less than 90% was 7.7%. The patient’s data shows that he experienced less activity-induced hypoxemia after instruction on his ADL routines (Fig. 3).

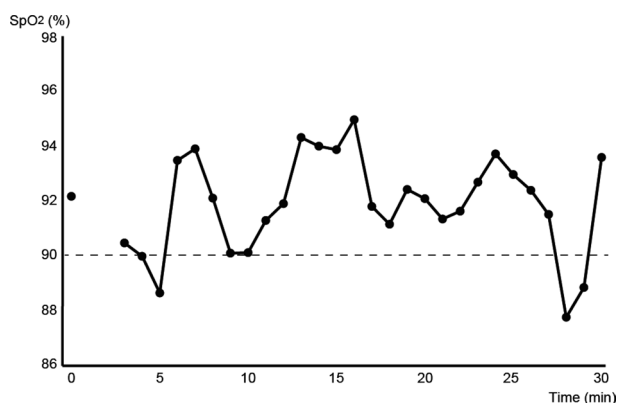
## DISCUSSION

Remarkable desaturation in patients with IPF is frequently shown, particularly during both maximal and submaximal exercise<sup>7</sup>. In patients with mild IPF, it has been reported that the proportion of time in a day in which they could be considered to be hypoxemic was 17.1%<sup>8</sup>, and it is necessary to consider that even daily activities can produce hypoxemia. Basic ADL consist of daily self-care tasks including bathing as well as ambulation, toileting, eating and dressing. In this case study, we were able to test oxygen saturation in all basic ADLs in daily life, including bathing activity, using a water proof pulse oximeter. In this case, oxygen desaturation occurred during bathing activity but without awareness of breathlessness. We analyzed the results of the twenty-four-hour ambulatory oximetry monitoring in the hospital before the patient was discharged, and confirmed the onset of hypoxia with the bathing activities. We were able to advise the patient that hypoxemia was present even though he had not yet experienced dyspnea. As IPF progresses, patients experience frequent episodes of shortness of breath and develop hypoxemia with activity. Bathing, in particular, becomes an increasingly difficult chore. It is important that physical therapists manage ADL activities before hypoxemia in IPF is aggravated. To achieve this, it is useful to instruct the patient on breathing techniques, i.e., breathing control during activities, and ensure the patient stays calm and breathes slowly.

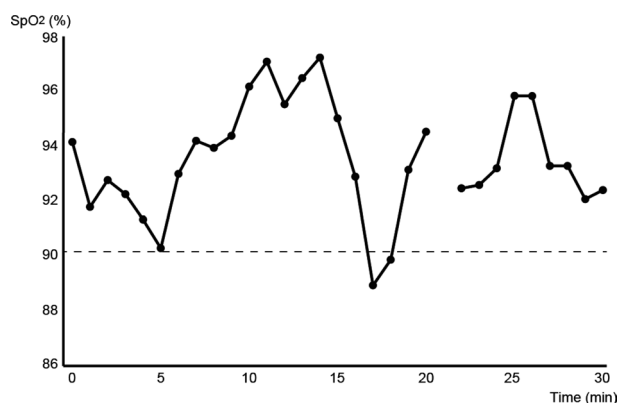
The daily physical activity level in IPF patients is approximately 35% lower than that in healthy sedentary controls, because IPF patients are highly sedentary<sup>9</sup>. Physical activity and EIH are associated with mortality in IPF<sup>10</sup>. Therefore, in patients with IPF, exercise therapy that promotes physical activity and self-management to prevent EIH in everyday life is



**Fig. 1.** Results of twenty-four-hour ambulatory oximetry monitoring at home (53 days after hospitalization). The dotted frame represents a series of bathing activities including changing clothes, moving around in the bathroom, entering the bathtub and washing the body.



**Fig. 2.** Oxygen saturation during bathing activities in hospital before the pre-discharge instructions. The dashed line represents SpO<sub>2</sub> 90%. The patient's inhalational oxygen flow was 4 L/min. The minimum SpO<sub>2</sub> was 88.6%; the proportion of time that the SpO<sub>2</sub> was <90% was 14.3%. The dot plot is based on the values obtained every minute, and missing values during measurement are not connected by lines.



**Fig. 3.** Oxygen saturation during bathing activities at home after the ADL instructions. The dashed line represents SpO<sub>2</sub> 90%. The patient's inhalational oxygen flow was 4 L/min. The minimum SpO<sub>2</sub> was 89%; the proportion of time that the SpO<sub>2</sub> was <90% was 7.7%. The dot plot is based on the values obtained every minute, and missing values during measurement are not connected by lines.

important.

In conclusion, 24-hour pulse oximetry monitoring can identify activities that may cause hypoxemia in daily life, and pre-discharge instructions using the results may be effective in supporting self-management to prevent hypoxemia in everyday life.

### Funding

There was no funding provided for this study.

### Conflict of interest

The authors declare that there is no conflict of interest.

## REFERENCES

- 1) Kusakisako K, Galay RL, Umemiya-Shirafuji R, et al.: 2-Cys peroxiredoxin is required in successful blood-feeding, reproduction, and antioxidant response in the hard tick *Haemaphysalis longicornis*. *Parasit Vectors*, 2016, 9: 457. [Medline] [CrossRef]
- 2) Ohno S, Nakazawa S, Kobayashi A, et al.: Reassessment of the classification of the severity in idiopathic pulmonary fibrosis using SF-36 questionnaire. *Intern Med*, 2005, 44: 196–199. [Medline] [CrossRef]
- 3) Brown AW, Nathan SD: The value and application of the 6-Minute-Walk Test in idiopathic pulmonary fibrosis. *Ann Am Thorac Soc*, 2018, 15: 3–10. [Medline] [CrossRef]
- 4) Lancaster LH: Utility of the six-minute walk test in patients with idiopathic pulmonary fibrosis. *Multidiscip Respir Med*, 2018, 13: 45. [Medline] [CrossRef]
- 5) Duck A, Pigram L, Errhalt P, et al.: IPF Care: a support program for patients with idiopathic pulmonary fibrosis treated with pirfenidone in Europe. *Adv Ther*, 2015, 32: 87–107. [Medline] [CrossRef]
- 6) Casanova C, Hernández MC, Sánchez A, et al.: Twenty-four-hour ambulatory oximetry monitoring in COPD patients with moderate hypoxemia. *Respir Care*, 2006, 51: 1416–1423. [Medline]
- 7) Lama VN, Flaherty KR, Toews GB, et al.: Prognostic value of desaturation during a 6-minute walk test in idiopathic interstitial pneumonia. *Am J Respir Crit Care Med*, 2003, 168: 1084–1090. [Medline] [CrossRef]
- 8) Rodrigues MP, Vissoci CM, Rosa SP, et al.: 24-hour hypoxia and pulmonary hypertension in patients with idiopathic pulmonary fibrosis. *Open Respir Med J*, 2017, 11: 10–16. [Medline] [CrossRef]
- 9) Wallaert B, Monge E, Le Rouzic O, et al.: Physical activity in daily life of patients with fibrotic idiopathic interstitial pneumonia. *Chest*, 2013, 144: 1652–1658. [Medline] [CrossRef]
- 10) Vainshelboim B, Kramer MR, Izhakian S, et al.: Physical activity and exertional desaturation are associated with mortality in idiopathic pulmonary fibrosis. *J Clin Med*, 2016, 5: 5. [Medline] [CrossRef]