Japanese Journal of Comprehensive Rehabilitation Science (2023)

Original Article

Changes in respiratory, physical, and mental conditions in moderate and severe COVID-19 cases at our convalescent rehabilitation ward

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ABSTRACT

Akimoto K, Asano S, Satoh Y, Yokogushi K. Changes in respiratory, physical, and mental conditions in moderate and severe COVID-19 cases at our convalescent rehabilitation ward. Jpn J Compr Rehabil Sci 2023; 14: 10−15.

Purpose: This study clarified the changes in respiratory condition, and physical and mental functions pertaining to them, of patients with the coronavirus disease 2019 ("COVID-19") who were admitted to our convalescent rehabilitation ward. It also examined the conditions remaining after the disease (long-COVID).

Methods: We focused on 16 moderate and severe patients with COVID-19 who were transferred to our convalescent rehabilitation ward and discharged home between March and September 2021. We evaluated the patients' respiratory, physical, and mental conditions at the time of admission, four weeks after admission, and at the time of discharge.

Results: We confirmed an improvement in the shortness of breath in those with respiratory conditions, and a significant improvement in the walking distance related to physical function before the time of discharge, but anxiety and depression remained.

Conclusion: Patients with moderate to severe COVID-19 can be discharged home after convalescent rehabilitation. Despite improved dyspnea and walking distance, the patients tend to have incomplete recovery, including physical deconditioning, mood disorders, and other long-COVID conditions at discharge.

Key words: moderate to severe COVID-19, convalescent rehabilitation, respiratory symptom, physical function, mental health

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Accepted: December 21, 2022.
Conflict of interest: The authors declare that there was no corporate involvement in this study that could represent an actual or potential conflict of interest.

Introduction

Coronavirus disease 2019 ("COVID-19") causes pneumonia and respiratory failure in the acute onset phase. However, as well as affecting respiratory symptoms it also produces physical, cognition, and mental disorders. Respiratory, cardiovascular, central nervous, renal, and digestive symptoms as well as psychosocial effects remain long-term problems [1] for patients. Concerning physical disorders, Delbressine et al. [2] reported that many patients experienced significantly decreased walking activity six months after the onset of symptoms. Regarding mental disorders, Deng et al. [3] conducted a meta-analysis and reported complication symptoms of depression in 45%, anxiety in 47%, and sleeping disorders in 34% of cases. In Japan, Yokoyama et al. [4] stated that COVID-19 patients who had higher than moderate severeness suffered from long-term symptoms such as weakened muscles and shortness of breath three months after disease onset. Fukunaga et al. [4] indicated that some prolonged symptoms decreased a patient's health-related quality of life (QOL) and that other patients developed anxiety, depression, and fear tendencies, increasing the subjective symptoms of sleeping disorders. The guidelines for medical treatment announced by the Ministry of Health, Labour and Welfare [5,6] defined post-morbid symptoms as "all symptoms that continue from the acute phase of the illness without other definite causes after contracting COVID-19 despite infectious disease, or new or previous symptoms that appear and remain during the recovery process." The guidelines indicated that the risk factors for greater severity in the elderly aged over 65 years were patients with malignant tumors, chronic obstructive pulmonary disease, chronic kidney disease, diabetes, hypertension, dyslipidemia, and obesity (body mass index 30 kg/m^2 and above). Many patients with serious conditions and

doi.org/10.11336/jjcrs.14.10

multiple symptoms require long-term hospitalization. Providing medical treatment during the COVID-19 convalescent phase is crucial.

COVID-19 patients who need admission to a convalescent rehabilitation ward are primarily moderate to severe cases who require long-term hospitalization. However, determining changes in the condition of a patient's respiratory symptoms, mental and physical health, and functionality in everyday life over time, and identifying the cause of post-morbid symptoms, remain difficult.

The purpose of this study was to clarify changes in respiratory symptoms and physical and mental functions of COVID-19 patients with moderate to severe conditions during the convalescent rehabilitation process. This study also determined the presence of post-COVID conditions.

Methods

1. Participants

This study focused on 17 unvaccinated patients (10 males, 7 females, mean age 72.2 ± 9.7 years) with COVID-19 who received treatment at an acute care hospital and were then admitted to the convalescent rehabilitation ward at our hospital from March to September 2021. At the time of admittance, these patients were mobile with wheelchairs or ambulatory equipment, and we did not observe a decrease in mental functions or consciousness level. The severity of the acute phase in a hospital is determined using the classification criteria of health care professionals appointed by the Ministry of Health, Labour and Welfare. Among the study patients, ten had respiratory failure, required oxygen administration, and had a severity classification of Moderate II, whereas seven patients had a severity classification of Severe and required a mechanical ventilator. Respiration rehabilitation and early-stage rehabilitation in joint motion range had already been performed.

Excluding one patient who had a relapse and an exacerbation of pneumonia and returned to the acute care hospital, 16 patients (9 males, 7 females, mean age 72.8 ± 9.8 years old) were ambulatory and gained the same level of daily living functions as the pre-hospitalization level; thus, they left hospital for home care (Figure 1). Underlying conditions included ten patients with diabetes, nine with hypertension, nine with dyslipidemia, five with cerebrovascular disease, five with chronic heart failure, four with angina, three with bronchial asthma, and one with depression. The median number of days from the onset of COVID-19 to transferal to the convalescent rehabilitation ward was 32.0 (20.3−57.5), and the median number of hospitalization days was 57.5 (37.0−78.3) (Table 1). This study was conducted as an observational study with no previous data for comparison, and we obtained consent from the Ethics Committee at our hospital (approval number No. 2021−013).

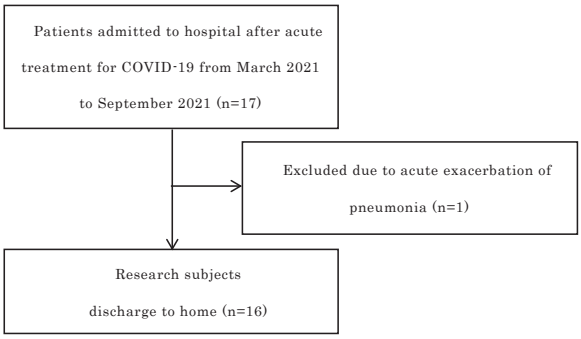

Figure 1. Flowchart of patient selection.

2. Study design and protocol

Because all patients were treated for pneumonia, we monitored the oxygen administration dosage and performed the Modified Medical Research Council Scale (mMRC) and COPD Assessment test assessed by the Global Initiative for Chronic Obstructive Lung Disease to observe changes in respiratory symptoms. We used the Short Physical Performance Battery to assess consecutive walking distance for post-pneumonia physical function, and the post-COVID-19 Functional Status Scale and Hospital Anxiety and Depression Scale to determine mental state. We also used the Functional Independence Measure™ to assess functional status during convalescent rehabilitation. Assessments were conducted at hospital admission, the middle point during hospitalization, which was four weeks after admission, and at discharge.

2.1 Oxygen administration dosage

Oxygen administration dosage was observed at rest and oxygen saturation was maintained above 95%. We used the nasal cannula method for oxygen delivery in all cases.

2.2 Modified Medical Research Council Dyspnea Scale in the GOLD 2022 edition ("mMRC Scale")

For subjective respiratory symptom assessments, we used the mMRC Scale, a self-rating questionnaire with reference to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2022 edition [7]. The scale consists of five grades: Grade 0 for minimally troubled by breathlessness to Grade 4 for extreme breathlessness that impedes everyday life.

2.3 Global Initiative for Chronic Obstructive Lung Disease COPD Assessment test ("CAT")

We also used an 8-item questionnaire related to dyspnea for subjective respiratory symptom assessment. Patients performed a self-evaluation, grading each question from 0 to 5, and calculated the total score. Whereas the mMRC Scale is an assessment method primarily focused on dyspnea, CAT assesses various subjective symptoms including dyspnea, coughing, phlegm, sleeping conditions, and mental functions [8].

Table 1. Patient characteristics.(n = 16).

Age, y, mean (SD)		72.8 (9.8)
Sex (male), *n* (%)		Male 9 (56.3)
Height, cm, mean (SD)		159.7 (8.6)
Weight, kg, mean (SD)		60.6 (13.5)
BMI, kg/m^2, mean (SD)		23.6 (4.0)
Severity Classification (Evaluation Criteria Used by Healthcare Workers), *n*		Moderate II 10, Severe 6
Convalescent ward admission from onset, days, median (IQR)		32.0 (20.3−57.5)
Number of days in the hospital, days, median (IQR)		57.5 (37.0−78.3)
Underlying conditions	Diabetes, *n* (%)	10 (62.5%)
	Hypertension, *n* (%)	9 (62.5%)
	Dyslipidemia, *n* (%)	9 (56.3%)
	Cerebrovascular disease, *n* (%)	5 (31.3%)
	Chronic heart failure, *n* (%)	5 (31.3%)
	Angina pectoris, *n* (%)	4 (25.0%)
	Bronchial asthma, *n* (%)	3 (18.8%)
	Depression, *n* (%)	1 (16.7%)

BMI, Body Mass Index.

2.4 Consecutive walking distance

We measured patients' consecutive walking distance within their capability range using a corridor with a straight-line distance of 45 meters. We instructed the patients to refrain from resting during their walk because the measuring ended when they needed to rest due to difficulty in breathing or lower limb exhaustion. Patients were allowed to use a cane or walker to secure their safety depending on their stability level. Consecutive walking distance is closely correlated with the range of daily activities and QOL in an individual's life [9], and increasing their consecutive walking distance was necessary to return to normal life functions [10]. Thus, we used this method.

2.5 Short Physical Performance Battery ("SPPB")

We used SPPB to assess the physical function and performance ability of patients. SPPB includes the balance test, gait speed test, and chair stand test, and its scores range from 0 to 12, with a higher number indicating increased physical functionality [11].

2.6 Post-COVID-19 Functional Status Scale ("PCFS")

We used PCFS as a COVID-19 functional assessment scale including mental function assessment. This assessment was originally used to ascertain the long-term outcome of illness after discharge from a hospital rather than being used on inpatients [12]. However, we proceeded with this assessment because, at the convalescent rehabilitation ward, we focused on the improvement of outdoor walking and everyday living functions. PCFS contains five grades: Grade 0 for no limitations in everyday life to Grade 4 for unable to function without nursing care or help from another person.

2.7 Hospital Anxiety and Depression Scale ("HADS")

Many cases of continuous respiratory function disparities, muscle weakness, pain, and fatigue caused by COVID-19 have been reported; therefore, we used HADS to determine the effects of COVID-19 on anxiety and mental cases [13]. HADS is a self-evaluation questionnaire that contains seven questions for anxiety and seven questions for depression, ranging in scores from 0 to 21, with a higher number indicating a stronger state of depression or anxiety.

2.8 Functional Independence Measure™ version 3.0 ("FIM")

We used FIM to assess everyday life functionality during convalescent rehabilitation. FIM is a seven-point scale ranging from 1 to 7. It measures functional independence status, assessing areas of "Self-care," "Sphincter Control," "Transfers," "Locomotion," "Communication," and "Social Cognition." FIM's scores range from a minimum of 18, which indicates a requirement of total assistance, to a maximum of 126, which indicates complete independence [14−17].

3. Rehabilitation

We provided all patients with physical, occupational, and speech-language-hearing therapies from the first day to the end of their hospitalization. Each therapy session lasted 60 minutes, for a total of 180 minutes per day. Determined by the condition of each physical function, we provided respiration rehabilitation, muscular exercise, walking practice, and daily living activity training. We also provided swallowing rehabilitation to patients with chewing and swallowing difficulties.

4. Statistical methods

This study used the Shapiro-Wilk test for normality, and we performed a one-way analysis of variance using a repeated measure to compare each condition's measured values. Mauchly's sphericity test was used to analyze the one-way analysis of variance, and if the assumption of sphericity was not met, the Greenhouse-Geisser epsilon correction was used to adjust the degrees of freedom. The Bonferroni test was performed as a post-hoc test. We used IBM SPSS Analytic Server 2.0 to analyze the data and established a significance level of 5% for each item.

Results

Figure 2 indicates the results from each index at the time of hospital admission, four weeks after admission, and discharge from the hospital. Concerning changes in respiratory conditions, six patients who needed oxygen administration upon arrival at the hospital decreased to one patient at the time of discharge. Although we did not identify a significant difference in the amount of oxygen administered, we confirmed that the number of patients who required oxygen declined. The mMRC scale identified a significant improvement in comparisons of hospital admission to four weeks after admission, and admission to discharge, but CAT did not identify a significant difference. Regarding changes in physical functions, the consecutive walking distance and SPPB were significantly improved from the time of hospital admission to discharge. To determine changes in mental functions, PCFS identified a significant improvement in the comparison at all time periods, but HADS did not identify a significant difference. FIM, which assessed functionality during convalescent rehabilitation, showed a significant improvement in the comparison between any specific time periods.

Discussion

This study determined COVID-19 patients' respiratory symptoms under the severity classifications of moderate and severe at a convalescent rehabilitation ward. It also determined the changes in physical and mental functions related to their respiratory symptoms. Each questionnaire item was assessed and compared at hospital admission, four weeks after admission, and at hospital discharge.

The mMRC scale, an indicator of respiratory conditions, detected a significant improvement compared to the time of hospital admission and discharge, and the number of patients who required oxygen administration decreased. However, CAT did not identify a significant improvement and the median

Table 2. Results at admission, 4 weeks, and discharge.

	Admission	4 weeks	Discharge	*p*-Value		
				Admission vs 4 weeks	Admission vs Discharge	4 weeks vs Discharge
Oxygen	0.8±1.5	0.3±0.8	0.1±0.3	0.167	0.118	0.331
mMRC	2.9±0.7	2.0±0.8	1.7±0.5	0.050*	0.046*	1.000
CAT	15.0±8.6	12.3±9.4	10.0±6.4	0.422	0.088	1.000
Walking distance	155.9±276.0	432.9±601.6	750.4±647.9	0.069	0.004*	0.033*
SPPB	4.4±4.4	7.5±4.0	9.1±3.4	0.024*	0.004*	0.222
PCFS	3.7±0.5	2.3±1.3	1.1±1.0	0.002*	0.000*	0.007*
HADS	11.0±7.1	11.2±6.5	8.5±8.2	1.000	0.066	1.000
FIM	82.3±28.2	100.4±25.7	110.3±19.8	0.000*	0.000*	0.024*

Mean ± SD

Oxygen, Oxygen administration dosage; mMRC, Modified Medical Research Council Dyspnea Scale; CAT, COPD Assessment Test; SPPB, Short Physical Performance Battery; PCFS, Post-COVID-19 Functional Status Scale; HADS, Hospital Anxiety and Depression Scale; FIM, Functional Independence Measure.

*: $p<0.05$

CAT score at the time of hospital discharge was 10. Daynes et al. [8] used CAT to assess patients recovering from COVID-19 who left hospital and received care at home. Similar to our results, they reported that if patients had no pre-existing respiratory disease, the presence of coughs and phlegm was difficult to identify, and symptoms such as breathlessness, sleeping disparities, and decrease of energy remained. Jones et al. [18] stated that a standard grade 2 of the mMRC scale was equivalent to a standard CAT score of 10. This study also found similar results and clarified that there was ample room for improvement at discharge.

Consecutive walking distance, one of the physical functions, and SPPB demonstrated a significant improvement at discharge compared to hospital admission. FIM was also significantly improved. The patients gained sufficient walking distance that allowed them to return home, but the SPPB score at discharge was 9.1. Liu et al. [19] reported that exercise therapy primarily focused on respiratory rehabilitation for six weeks extended patients' walking distance. However, when their follow-up progress was examined, exercise therapy was insufficient to attain a function level for daily living. Furthermore, Bellan et al. [20] conducted follow-up surveys on COVID-19 patients with severe symptoms after they were discharged from hospital, and reported that 22% had a SPPB standard score under 10. The current study also found an insufficient improvement at discharge.

Regarding mental functions, PCFS indicated a significant improvement over time, but HADS did not. Fernández et al. [21] used HADS to assess COVID-19 patients, and those after infection had scores of 8.5 whereas the standard score was above 8, and these patients reported depression and anxiety symptoms. According to a report by Yang et al. [22], COVID-19 patients often showed anxiety and mental disparities such as continuous post-traumatic stress disorder after hospital discharge. Therefore, this study also suggests the necessity of follow-up screening of patients' mental functions after discharge.

In this study, we conducted compound exercises such as muscular exercise, gait exercise, daily living activity exercise, and swallowing rehabilitation in addition to respiratory rehabilitation, and confirmed improvements in breathlessness as a respiratory symptom and daily living function as a physical function approximately 57 days after onset. One patient was transferred to an acute care hospital due to acute aggravation, but all other patients were discharged to their homes. This result indicated that a convalescent rehabilitation ward can provide effective rehabilitation to COVID-19 patients. The study also showed that patients' physical and mental recovery was insufficient and symptoms remained at discharge; therefore, it is necessary to provide medical information and after-discharge support for patients to maintain and improve their mental and life functions including exercise after they return home.

The limitations of this study included a small number of candidates and that only cases from our hospital were studied. Furthermore, results might differ based on research duration and targeted areas. Therefore, the continued evaluation of rehabilitation is of utmost importance.

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