



Original Article

Effect of short-duration, limited rehabilitation on maintenance of the activities of daily living in patients with acute phase of COVID-19

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Abstract. [Purpose] To determine whether short-duration, limited rehabilitation is effective in patients with COVID-19. [Participants and Methods] Single-center, retrospective, observational study. Thirty-six inpatients were classified into the three groups: a close contact (CC) group with a negative polymerase chain reaction (PCR) test (n=14); a PCR-positive (PP) group (n=15); and a PCR-positive and transfer (PT) group with severe COVID-19 patients who were transferred to an acute care hospital for treatment and then returned to our hospital (n=7). Short-duration, limited rehabilitation was provided to the CC and PP groups in isolated rooms by a therapist wearing full personal protective equipment, and we assessed the changes in their activities of daily living. [Results] The patients' clinical characteristics at baseline were similar among the three groups. Functional Independence Measure scores in the CC, PP, and PT groups were not different at baseline (69 ± 29 , 53 ± 26 , and 63 ± 32), but differed after control of COVID-19 (63 ± 25 , 47 ± 24 , and 32 ± 19). Multivariate regression analysis showed that the implementation of a customized self-exercise program and the Mini Nutritional Assessment Short-Form at baseline were independently associated with Functional Independence Measure score after control of COVID-19. [Conclusion] These results suggest that even short-duration, limited rehabilitation may be effective for preventing decreases in activities of daily living in patients with COVID-19.

Key words: COVID-19, Rehabilitation, Activities of daily living

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INTRODUCTION

The first outbreak of novel pneumonia cases, later designated coronavirus disease of 2019 (COVID-19), was reported in Wuhan, China in late December 2019¹⁾. This infection then quickly spread from Wuhan to various regions in China and to other parts of the world, including Japan, Europe, and the United States. The World Health Organization (WHO) declared it a pandemic on March 11, 2020. Patients with COVID-19 are treated in isolation to prevent exposure to others, which puts them at higher risk of disuse syndrome, a negative factor that reduces their activities of daily living (ADL)²⁻⁵⁾. Moreover, the reductions in physical inactivity associated with isolation reportedly leads to negative effects on cardiovascular health⁶⁾. These findings suggest that COVID-19 infection in patients admitted to a convalescent rehabilitation ward due to stroke, fracture, or disuse syndrome may experience significant declines in ADL. Recent studies have reported the efficacy of

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cardiopulmonary rehabilitation for patients infected with COVID-19^{7, 8)}, and rehabilitation is thought to be effective even in acute phase COVID-19 patients^{9, 10)}. However, little is known about the efficacy of rehabilitation for acute phase COVID-19 patients hospitalized in a convalescent rehabilitation ward, and it remains unclear what kind of rehabilitation should be provided or for how long each day rehabilitation should be provided to maintain ADL.

In the present study, we performed short-duration, limited rehabilitation with the goals of preventing deterioration of ADL while also preventing the spread of COVID-19 infection. To accomplish this, during the first two weeks after COVID-19 infection was diagnosed, about 20 minutes of rehabilitation were provided to isolated patients without COVID-19 symptoms. Then after 2 weeks or until the infection was controlled, the rehabilitation performed depended on the patient's activity level. Once the COVID-19 infection was controlled, we used the Functional Independence Measure (FIM) and Barthel Index to compare ADL among patient groups to determine whether short-duration, limited rehabilitation is effective for COVID-19 patients.

PARTICIPANTS AND METHODS

This study was approved by the ethics committee of Wakakusa-Tatsuma Rehabilitation Hospital (approved number 19100761). All participants or their legal representatives provided written informed consent. The study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

Our hospital has 4 convalescent wards (168 beds) and 7 chronic care wards (332 beds). One nurse in one convalescent ward had a fever and had a positive polymerase chain reaction (PCR) test of a nasopharyngeal sample for SARS-CoV-2 on December 09, 2020. The following day (December 10, 2020), we performed PCR tests for SARS-CoV-2 in 11 patients who had a fever of 37.5°C or higher within the previous 2 weeks, and 10 patients were found to be positive for SARS-CoV-2 on December 11, 2020. Because these results showed the spread of the infection, that same day PCR tests were conducted on the remaining 27 patients, and 10 additional patients were confirmed to be positive for SARS-CoV-2 on December 12, confirming that the 20 of the 38 patients were PCR positive. Moreover, we performed additional PCR tests in 18 patients whose first test was negative on December 18, and four more patients were found to be positive for SARS-CoV-2 on December 19.

We also administered PCR tests to the 58 medical staff working in this ward (10 doctors, 15 nurses, 9 caregivers, and 24 therapists) on December 11, and two nurses and three physical therapists with less than two years of clinical experience were found to be positive for SARS-CoV-2 on December 12. The nurses and caregivers were retested on December 18, and 1 nurse and 1 caregiver were found to be positive. In addition, one physical therapist who experienced a partial loss of the sense of smell had a positive PCR test on December 23, 2020. Eventually, 24 of the 38 inpatients and 8 of the 58 members of the medical staff tested positive for SARS-CoV-2, and 9 of the 24 infected inpatients were transferred to an acute care hospital.

In response to the outbreak, the ward was zoned so that the rooms with PCR-positive patients were separated from the rooms of PCR-negative patients such that they did not intersect. Chest computed tomography was performed on all 24 PCR-positive patients, and pneumonia were detected in 23 of them. Blood tests, including C-reactive protein (CRP) were also performed. Every day the patients were checked for fever, shortness of breath, general fatigue, oxygen saturation, anorexia, and pneumonia by four doctors, and whether there was an indication for steroid use or for patient transfer to a specialized COVID-19 treatment hospital were determined in a case conference. At that time, the number of COVID-19-infected patients in Osaka was increasing rapidly, and the hospital specializing in COVID-19 treatment hospital was nearly full. Consequently, only one case transfer per day from our hospital to the specialized COVID-19 treatment hospital could be allowed. Ultimately, 9 patients diagnosed with severe COVID-19 were transferred to the specialized COVID-19 hospital for treatment. The mean duration from the positive PCR test to the transfer was 5.6 ± 4.0 days. Seven of these 9 patients were readmitted to our hospital after recovery; one died at the acute care hospital, and the other developed renal impairment and was transferred to another specialized hospital after treatment for COVID-19 (Fig. 1). The mean length of stay in the specialized COVID-19 hospital was 16.7 ± 12.1 days.

The patients were classified into three groups: a close contact (CC) group who were suspected of COVID-19 but whose PCR test was negative ($n=14$, 75 ± 16 years); a PCR positive (PP) group who were suspected of COVID-19 and whose PCR test was positive ($n=15$, 70 ± 22 years); and a PT group composed of PCR-positive patients with severe COVID-19 who were transferred to an acute care hospital for treatment and then returned to our hospital after recovery ($n=7$, 87 ± 6 years) (Fig. 1).

Demographic data, including age, gender, body weight, height, and body mass index (BMI) was collected from electronic medical records. Clinical data such as ADL measurements, tests of swallowing function, and blood tests were also collected. ADL was evaluated using the Functional Independence Measure (FIM) and Barthel Index¹¹⁻¹⁴⁾. Swallowing function was evaluated using the functional oral intake scale (FOIS). Scores ranged from 1 to 7, with higher scores indicating better swallowing function¹⁵⁾. Levels 1-3 relate to varying degrees of non-oral feeding, while levels 4-7 relate to varying degrees of oral feeding without non-oral supplementation. Nutritional status was evaluated using the Mini Nutritional Assessment Short Form (MNA-SF), which is a nutritional screening tool that provides subscores for 6 domains: loss of appetite (0 to 2 points), weight loss (0 to 3 points), mobility (0 to 2 points), stress/acute disease (0 or 2 points), neuropsychological impairment (0 to 2 points) and body mass index (BMI) (0 to 3 points)¹⁶⁾.

Because the spread of the SARS-Cov-2 infection was confirmed on December 11-12, 2020, all therapists were ordered by the hospital director to stay home on December 13. Therapists started work again on December 14. On December 14 and 15,

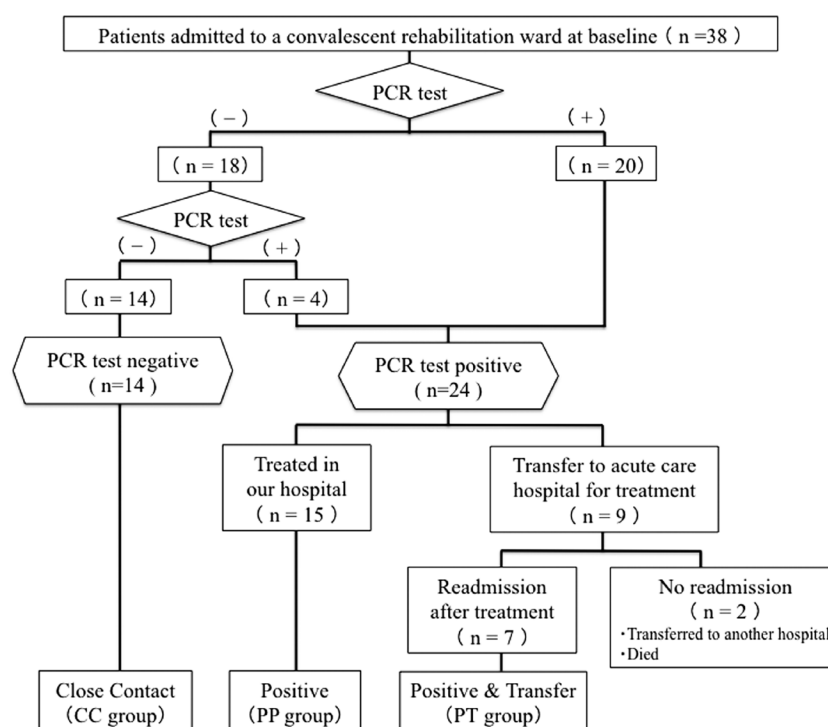


Fig. 1. Flowchart determining patient classification.

PCR: polymerase chain reaction; CC: close contact; PP: PCR-positive; PT: PCR-positive and transfer.

The first PCR test was performed on December 10–11, 2020, and the second PCR test was performed on December 18, 2020.

they cleaned the ward while wearing personal protective equipment (PPE). Patient rehabilitation restarted on December 16.

Every morning the heads of physical therapy, occupational therapy, and speech therapy had a conference where each patient's condition (fever, cough, sputum, appetite, fatigue, etc.) was evaluated from electronic medical records to determine whether the patient could participate in a rehabilitation program. All rehabilitation for patients in the CC and PP groups was conducted in the zoned area. Rehabilitation was not performed with the PT group due to the severity of their COVID-19 symptoms. Therapists wore PPE when performed rehabilitation, and the PPE was changed for every single patient. Although the CC group had a negative PCR test, because they had close contact with COVID-19 patients, rehabilitation was performed under the same infection control measures as in the PP group.

Rehabilitation during the period of infection control was divided into two stages. The first stage extended until December 23, 2020, during which the therapists providing rehabilitation were required to have at least 3 years of clinical experience and to attend a lecture on infection control at our hospital. During the first stage, the area where rehabilitation was performed was restricted to the bedside. The rehabilitation programs included range of motion (ROM), changing positions, and sitting and standing, and were mainly aimed at preventing joint contracture and pressure ulcers. Rehabilitation of severely immobile patients was performed in pairs because the therapist needed to minimize contact with the patients to reduce the risk of infection. For example, ROM exercises were performed by one therapist, while sitting exercises and position adjustment exercises were performed by a pair of therapists.

During the second stage, which extended from December 24 until the COVID-19 outbreak was controlled, all therapists, regardless of years of experience, performed rehabilitation. Therapists who had not yet received an infection control lecture were required to receive it before they performed rehabilitation. The rehabilitation area was expanded from the bedside to a room inside the ward, but access to the rehabilitation room was still prohibited. The rehabilitation program during the second stage was designed to maintain physical activity and prevent disuse syndrome, depending on the individual patient's activity level. The rehabilitation intervention focused on 4 physical domains: ROM, muscle strengthening, balance, and walking. The intensity of the muscle strengthening exercises was defined individually and included one or two sets of 10 repetitions. Balance exercises included 360° turns, sitting and standing, functional reaching, and stepping in various directions.

In all patients, oxygen saturation (SpO₂) and heart rate were monitored using an SpO₂ oximeter placed on their finger during rehabilitation, irrespective of the patient's condition or physical performance. Additionally, all patients were instructed to perform individualized self-training for themselves outside of rehabilitation time after the therapist confirmed that they could do it safely.

Continuous data are presented as means \pm standard deviation, while non-parametric data are presented as the median (interquartile range 25–75 percentile). Differences among groups were evaluated using one-way analysis of variance (ANOVA) with post-hoc Fisher's PLSD tests, and differences in FIM scores among groups were evaluated using analysis of covariance (ANCONA) adjusted for age. Categorical data are expressed as incidences and percentages, and comparisons were made using the χ^2 -test. Univariate analysis was performed to evaluate the factors associated with FIM scores after control of COVID-19. Multiple regression analysis was performed with FIM scores after control of COVID-19 as the dependent variable. Age, gender, MNA-SF as an indicator of nutrition status, rehabilitation time per day and implementation of customized self-training as indicators of rehabilitation, and the presence of COVID-19 infection were the independent variables. Values of $p < 0.05$ were considered statistically significant. Statistical analyses were performed using STATVIEW version 5 (Abacus Concepts, Berkeley, CA, USA).

RESULTS

There were no newly infected COVID-19 patients after December 18, 2020. The COVID-19 outbreak was considered to be fully controlled January 4, 2021.

The demographic and clinical characteristics and the ADL scores of the CC, PP, and PT groups at baseline, just before the COVID-19 outbreak, are shown in Table 1. There were no differences in age, gender, oxygen inhalation, CRP, and independence of their ADL before admission, among the three groups. Body weights at baseline were significantly lower in the PT group than in the PP group; however, there was no difference in BMI among the three groups. Regarding causative disease, the proportion with hip fractures was higher in the PT group than other two groups. As for comorbidities, the prevalence of hypertension in was higher in the CC group than the other two groups. However, there were no differences in the prevalence of diabetes, dyslipidemia, and chronic heart failure. Computed tomography showed the finding of pneumonia in almost all patients in the CC and PT group: however; the PT group had more severe finding than the CC group had. There was also no difference in the motor-FIM, cognitive-FIM, total-FIM, Barthel Index, FOIS or MNA-SF among the three groups at baseline.

The lengths of the first and second rehabilitation stages and the ADL in the CC and PP groups are shown in Table 2. Despite negative PCR tests, 4 patients in the CC group had symptoms of fever and/or chest congestions (CC2, 11–13). Consequently, rehabilitation was not provided to 1 (CC13) of those patients, and sufficient rehabilitation was not provided to the other 3 patients (CC2, 11–12). Since one patient (CC6) had a mild dyspnea due to interstitial pneumonia, rehabilitation was performed monitoring for his condition. During the second stage, all patients except for 1 (CC14) who refused rehabilitation were able to perform rehabilitation almost every day, and the rehabilitation times were increased compared to the first stage. Five patients in the PP group were unable to perform rehabilitation during the first stage due to symptoms of fever or chest congestion (PP11–15). Even in the second stage, 2 of those 5 patients (PP14–15) could not perform sufficient rehabilitation due to symptoms of fever or chest congestions. Among the 13 patients, excluding the two (PP14–15) in the PP group, 10 were able to perform rehabilitation every day in the second stage (PP1, 3–5, 7, 8, 10–13), and the rehabilitation time was increased compared to the first stage. However, because two patients (PP2, 6) had a mild fever in second stage, they were not provided with sufficient rehabilitation. Customized self-training was instructed and encouraged to be performed in one patient (PP9) with independent in ADLs. Although there were some patients with fever in the second stage, no severe adverse events were observed in the CC or PP group.

The physical status, ADL, and rehabilitation outcomes in the CC, PP, and PT groups after COVID-19 was brought under control are shown in Table 3. Body weights and BMIs were significantly lower in the PT group than other two groups. Motor-FIM scores and total-FIM scores were significantly lower in the PT group than in the CC group. Barthel Index scores were significantly lower in the PT group than in the CC or PP group, while there was no difference between the CC and PP groups. FOIS was significantly lower in the PT group than in the CC group, whereas there was no difference between the CC and PP group. MNA-SF was significantly lower in the PT group than in the CC or PP group, and was significantly lower in the PP group than in the CC group. The reduction in total FIM in the PT group was significantly larger than in the CC or PP group ($p < 0.01$). Similarly, the reduction in the Barthel Index in the PT group was significantly larger than in the CC or PP groups ($p < 0.01$). However, there was no ADL difference between the CC and PP groups.

Univariate analysis showed that MNA-SF at baseline ($r = 0.593$, $p < 0.001$), rehabilitation time per day ($r = 0.422$, $p < 0.05$), implementation of customized self-training ($r = 0.592$, $p < 0.01$), and presence of COVID-19 infection ($r = -0.385$, $p < 0.05$) were significantly associated with FIM scores after control of COVID-19. Multivariate analysis of factors associated with FIM scores after control of COVID-19 using age, gender, MNA-SF at baseline, rehabilitation time per day, implementation of customized self-training, and presence of COVID-19 infection as independent factors showed that MNA-SF at baseline and implementation of customized self-training were independently associated with FIM score after control of COVID-19 (Table 4).

DISCUSSION

In the present study, we showed that minimal rehabilitation during their isolation period significantly attenuated the reduction of ADL indices in patients with COVID-19 and those in close contact with them, who were also quarantined. On

Table 1. Demographics, characteristics and clinical indicators at baseline

	Overall	CC group	PP group	PT group
Number, n	36	14	15	7
Age, years	75 ± 16	75 ± 11	70 ± 22	87 ± 6
Male, n (%)	19 (52.7)	8 (57.1)	7 (46.7)	4 (57.1)
Height, cm	157 ± 9	156 ± 10	159 ± 10	155 ± 6
Body weight, kg	52.6 ± 9.5	52.7 ± 10.4	56.3 ± 8.6	44.7 ± 3.8 [†]
BMI, kg/m ²	21.3 ± 3.2	21.5 ± 3.5	22.3 ± 2.8	18.8 ± 2.4
Causative disease				
Stroke, n (%)	21 (58.3)	9 (64.3)	9 (60.0)	3 (42.9)
Fracture, n (%)	7 (19.4)	2 (14.3)	1 (6.7)	4 (57.1) [†]
Disuse syndrome, n (%)	8 (22.2)	3 (21.4)	2 (26.6)	0 (0)
Comorbidity				
Hypertension, n (%)	26 (72.2)	13 (92.9)	11 (73.3)	2 (28.6)**
Diabetes, n (%)	9 (25.0)	5 (35.7)	2 (13.3)	2 (28.6)
Dyslipidemia, n (%)	7 (19.4)	3 (21.4)	2 (13.3)	2 (28.6)
Atrial fibrillation, n (%)	9 (25.0)	4 (28.5)	5 (33.3)	0 (0)
Oxygen inhalation, n (%)	1 (2.7)	1 (7.1)	0 (0)	0 (0)
CRP, mg/dL	0.7 ± 0.8	0.7 ± 0.6	0.8 ± 1.0	0.5 ± 0.5
CT findings				
Distribution, n (%)				
Bilateral	15 (68.2)	n.d.	8 (53.3)	7 (100) [†]
Unilateral	6 (27.3)	n.d.	6 (40.0)	0 (0) [†]
None	1 (4.5)	n.d.	1 (6.7)	0 (0)
Consolidation, n (%)				
++	2 (9.1)	n.d.	0 (0)	2 (28.6) [†]
+	12 (54.5)	n.d.	7 (46.7)	5 (71.4)
-	8 (36.4)	n.d.	8 (53.3)	0 (0) [†]
Ground glass opacity, n (%)				
++	8 (36.4)	n.d.	3 (20.0)	5 (71.4) [†]
+	11 (50.0)	n.d.	9 (60.0)	2 (28.6)
-	3 (13.6)	n.d.	3 (20.0)	0 (0)
Degree of pneumonia, n (%)				
Up to 1/3	15 (68.2)	n.d.	12 (80.0)	3 (42.9)
1/3 to 2/3	6 (27.3)	n.d.	3 (20.0)	3 (42.9)
2/3 or more	1 (4.5)	n.d.	0	1 (14.2)
ADL before admission				
Independence, n (%)	34 (94.4)	13 (92.9)	15 (100)	6 (85.7)
Dependence, n (%)	2 (5.6)	1 (7.1)	0 (0)	1 (14.3)
FIM, score				
Motor	44 ± 22	51 ± 23	37 ± 20	46 ± 24
Cognitive	17 ± 7	18 ± 7	16 ± 7	17 ± 9
Total	62 ± 29	69 ± 29	53 ± 26	63 ± 32
Barthel Index	59 ± 33	65 ± 35	53 ± 33	57 ± 29
FOIS	5.3 ± 2.3	5.4 ± 2.5	5.1 ± 2.3	5.1 ± 2.0
MNA-SF	5.3 ± 2.3	5.9 ± 2.8	5.9 ± 1.9	3.7 ± 2.2

CC: Close contact; PP: PCR-positive; PT: PCR-positive and transfer; ADL: activities of daily living; BMI: body mass index; CRP: C-reactive protein; FIM: functional independence measure; FOIS: functional oral intake scale; MNA-SF: Mini Nutritional Assessment-Short Form; n.d.: not done.

*p<0.05 vs. CC group, **p<0.01. vs. CC group, †p<0.05, vs. PP group.

Data are presented as the mean ± standard deviation or median (IQT).

Table 2. Rehabilitation under COVID-19 infection in the CC and PP groups

Case	Gender	Age, years	Rehabilitation, day		Rehabilitation time, min/day		Self training	Total FIM, score		Barthel Index, score		Note
			First stage (12 days)	Second stage (12 days)	First stage (12 days)	Second stage (12 days)		Baseline	Control of COVID-19	Baseline	Control of COVID-19	
CC1	F	84	7	12	20 ± 0	85 ± 40	+	95	92	95	95	
CC2	M	80	3	11	20 ± 0	89 ± 41	-	82	68	75	75	Fever of 37.0°C or higher (Max 37.2°C) (1st stage)
CC3	F	51	8	12	23 ± 7	142 ± 45	+	56	53	50	45	
CC4	M	81	8	12	23 ± 7	133 ± 50	+	96	96	90	90	
CC5	F	78	6	12	23 ± 8	130 ± 49	+	71	73	85	85	
CC6	M	68	3	12	33 ± 23	145 ± 19	-	64	64	75	75	Inhaling oxygen 3L Underlying disease of interstitial pneumonia
CC7	M	55	9	12	44 ± 14	90 ± 31	+	31	21	30	20	
CC8	F	83	6	11	20 ± 0	124 ± 50	+	102	79	100	100	
CC9	M	71	7	12	29 ± 9	148 ± 22	+	61	61	40	40	
CC10	M	77	6	12	20 ± 0	143 ± 21	+	70	87	90	95	
CC11	F	79	3	10	20 ± 0	88 ± 36	-	112	65	90	85	Fever of 37.5°C or higher (Max 37.9°C) (1st stage)
CC12	M	76	2	12	20 ± 0	87 ± 25	-	22	22	0	0	A lot of sputum retention (1st stage)
CC13	F	88	0	12	0	78 ± 49	-	21	21	0	0	Fever of 37.5°C or higher (Max 37.5°C) (1st stage) Sputum retention and wheezing
CC14	M	83	0	0	0	0	-	87	77	90	90	Refusal of rehabilitation
PP1	F	52	7	12	40 ± 23	158 ± 6	+	76	66	80	75	
PP2	M	70	7	7	49 ± 25	77 ± 53	-	49	13	40	15	Fever of 37.0°C or higher (Max 37.3°C) (2nd stage)
PP3	F	58	6	12	30 ± 17	73 ± 57	+	49	40	25	25	
PP4	F	60	7	12	40 ± 20	155 ± 12	+	45	44	55	45	
PP5	F	70	6	12	23 ± 8	150 ± 18	+	103	94	90	90	
PP6	M	91	9	6	29 ± 10	57 ± 27	-	21	37	25	10	Fever of 37.0°C or higher (Max 37.4°C) (2nd stage)
PP7	M	67	5	12	32 ± 16	123 ± 52	+	78	66	85	85	
PP8	M	79	7	12	20 ± 8	132 ± 30	+	64	64	80	85	
PP9	M	51	3	1	27 ± 12	80	+	89	85	100	100	Independent of ADL. Encourage customized self-training.
PP10	F	85	5	12	20 ± 0	32 ± 13	-	37	37	35	35	
PP11	F	86	0	12	0	72 ± 50	-	18	18	0	0	Fever of 37.5°C or higher (Max 37.9°C) (1st stage) Wheezing
PP12	F	92	0	12	0	47 ± 31	-	37	37	40	35	Marked increase in amylase levels
PP13	F	84	0	12	0	53 ± 48	-	34	31	55	30	Fever of 37.5°C or higher (Max 37.7°C) (1st stage) Sputum retention and cough
PP14	M	84	0	5	0	76 ± 26	-	78	60	90	60	Fever of 38.0°C or higher (Max 38.6°C) (1st and 2nd stage)
PP15	M	77	0	4	0	40 ± 0	-	24	20	0	0	Fever of 38.7°C ten days before the outbreak. A lot of sputum retention. (1st and 2nd stage)

CC: Close contact; PP: PCR positive; F: Female; M: Male; FIM: Functional Independence measure. Patient numbers are shown in order of admission date.

Table 3. Physical status, ADL, and rehabilitation outcomes after control of COVID-19

	Overall	CC group	PP group	PT group
Body weight, kg	50.5 ± 9.8	52.3 ± 10.5	53.4 ± 8.3	40.7 ± 2.9 ^{***†}
BMI, kg/m ²	20.5 ± 3.6	21.4 ± 3.5	21.2 ± 3.2	17.1 ± 2.9 ^{***†}
FIM, score				
Motor	35 ± 20	45 ± 20	32 ± 17	20 ± 12 ^{**}
Cognitive	16 ± 7	18 ± 6	16 ± 7	13 ± 8
Total	51 ± 26	63 ± 25	47 ± 24	33 ± 19 ^{**}
Barthel Index, score	47 ± 36	64 ± 35	46 ± 34	15 ± 20 ^{***†}
FOIS	4.6 ± 2.6	5.6 ± 2.5	4.5 ± 2.7	2.6 ± 1.5 [*]
MNA-SF	6.6 ± 3.5	8.9 ± 2.4	6.5 ± 2.5 [*]	2.0 ± 2.0 [†]
Change in body weight, kg	-2.1 ± 3.5	-0.4 ± 2.2	-2.8 ± 4.1	-4.0 ± 3.2 [*]
Changes in FIM, score				
Motor	-10 ± 16	-6 ± 13	-5 ± 8	-27 ± 24 ^{***‡}
Cognitive	-1 ± 3	-1 ± 3	-0 ± 2	-4 ± 5 [†]
Total	-11 ± 19	-7 ± 15	-6 ± 11	-31 ± 27 ^{***‡}
Change in Barthel index, score	-12 ± 21	-1 ± 4	-8 ± 11	-42 ± 31 ^{***‡}
Changes in MNA-SF	1.1 ± 2.4	3.0 ± 2.1	0.5 ± 1.4	-1.5 ± 1.5 [†]
Length of hospital stay, day	140 ± 61	128 ± 57	148 ± 73	146 ± 42
Discharge destination, n (%)				
Home	18 (50.0)	9 (69.3)	7 (46.7)	2 (28.6)
Facility	15 (41.7)	5 (35.7)	8 (53.3)	2 (28.6)
Death	3 (8.3)	0 (0)	0 (0)	3 (42.8)

CC: Close contact; PP: PCR-positive; PT: PCR-positive and transfer; ADL: activities of daily living; BMI: body mass index; FIM: functional independence measure; FOIS: functional oral intake scale; MNA-SF: Mini Nutritional Assessment-Short Form.

*p<0.05 vs. CC group, **p<0.01 vs. CC group, †p<0.05 vs. PP group, ‡p<0.01 vs. PP group.

Data are presented as the mean ± standard deviation.

Table 4. Multiple linear regression analysis of FIM after control of COVID-19 using demographic, clinical, and rehabilitation data

	β	95% CI		p
		Lower	Higher	
(Constant)	-44.593	-123.504	34.317	
Age	0.331	-0.086	1.611	
Male	0.094	-9.031	18.608	
PCR positive	-0.166	-23.496	6.405	
MNA-SF at baseline	0.382	0.756	7.115	*
Rehabilitation time/day	0.270	-0.136	0.584	
Implementation of self-training	0.375	1.937	37.884	*

FIM: functional independence measure; MNA-SF: Mini Nutritional Assessment-Short Form; PCR: polymerase chain reaction.

*p<0.05.

the other hand, in patients who were transferred to an acute care hospital, where rehabilitation was not performed, the ADL index had decreased significantly by the time they were readmitted to our hospital. These results suggest that even a short period of limited rehabilitation in an isolated room may be effective for preventing a decrease in ADL in patients, irrespective of whether their PCR test for SARS-CoV-2 was positive or negative.

Since December 2019, COVID-19 has been a world-wide pandemic¹⁷). Patients with moderate or severe COVID-19 primarily develop lung dysfunction, which may be fatal¹⁸). However, increasing evidence suggests that SARS-CoV-2 infections may also affect the nervous system and cardiovascular function¹⁹⁻²¹). It also has been shown that many patients develop mental health problems that must be addressed through rehabilitation programs²²). Thus, COVID-19 rehabilitation needs to deal with many conditions. The Global Health Alliance recommends that rehabilitation for COVID-19 should start from acute and early post-acute care and needs to be continued in the post-acute and long-term rehabilitation phases²³).

To the best of our knowledge, however, there are no guidelines for how to conduct rehabilitation of COVID-19 patients during the acute phase of the disease. A systematic review and meta-analysis by Cevik et al.²⁴⁾ reported that the mean duration of SARS-CoV-2 shedding from the upper airway is 17.0 days, with the peak occurring approximately 1 week after infection. Therefore, after zoning of the ward²⁵⁾, we began providing short-duration (about 20 minutes) rehabilitation in day 4 to patients without a cough or chest congestions under a protocol of infection control. Fortunately, most COVID-19-positive patients in the PP group showed ground glass images on chest CT, but none exhibited severe dyspnea or hypoxemia. Moreover, we also checked for fever, fatigue, loss of appetite, and chest congestions every day in the CC and PP groups and, if there were no symptoms, the rehabilitation program was conducted. As a result, there were no new COVID-19 patients from the CC group. Therefore, 2 weeks after the COVID-19 outbreak, we were able to increase rehabilitation times, though we continued the infection control measures such as wearing PPE. We then reassessed ADL in the CC and PP groups just after the COVID-19 outbreak was contained, and in the PT group at the time of their readmission to our hospital. We found that the reductions in ADL were much smaller in the CC and PP groups than in the PT group, and there were no differences in FIM or Barthel Index between the CC and PP groups. These results are consistent with several earlier reports, which showed that early rehabilitation during the acute phase of COVID-19 is effective for maintaining ADL^{26–28)}.

There are still concerns about the rehabilitation of COVID-19 patients; however, some consensus has been achieved for the adoption of breath training in a prone or semi-recumbent bed position, moderate head elevation, limb mobilization, and bed and bedside sitting and standing²⁹⁾. From the present study, we also believe that early rehabilitation, even if it is short-duration and limited, contributes to the maintenance of ADL. Notably, a marked decrease in ADL was observed in the PT group. One of the reasons for this may be that COVID-19 was more severe in the PT group than in the CC or PP group³⁰⁾. In addition, about 2 weeks of bed rest and immobilization likely led to a decrease in skeletal muscle mass and exacerbated skeletal muscle wasting^{31, 32)}. Multiple regression analysis with FIM as the dependent variable showed that baseline MNA-SF and self-training were significantly associated with FIM. This indicates that both daily rehabilitation and nutrition contribute to the maintenance of ADL. It is widely known that nutrition is useful for rehabilitation and important for improving ADL^{33, 34)}, and we recently showed that nutrition is important for improving ADL in hip fracture patients³⁵⁾. In addition, another recent study on the nutritional status of COVID-19 patients showed that malnutrition increases the incidence of mortality³⁶⁾.

The present study has several limitations. First, it was a single-center investigation carried out with a limited number of patients. Therefore, our findings should be confirmed in a multicenter study with a larger number of patients. Second, the PT group had only 7 patients. Because there are few clusters in convalescent rehabilitation hospitals, it is difficult to evaluate ADL before and after treatment in COVID-19 patients in the real world. Nonetheless, because all 7 members of the PT group exhibited a large decrease in FIM, it is speculated that the results would not be changed if the number were increased.

In summary, the results of the present study suggest that even short-duration, limited rehabilitation in an isolated room may be an effective means of preventing a decrease in ADL in COVID-19 patients while also preventing spread of the disease.

Funding and Conflicts of interest

All authors declare no conflict of interest.

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