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## Case Report

# The successful rehabilitation of a 75-year-old female with debilitating long COVID: A case report

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**Abstract** A 75-year-old previously healthy female became severely ill, functionally dependent, and required long-term home oxygen therapy, after recovery from coronavirus disease 2019 (COVID-19) with acute respiratory failure and extensive pulmonary fibrosis. After two months of respiratory muscle training and a comprehensive cardiopulmonary rehabilitation program, her dyspnea, physical performance, pulmonary function parameters, and activities of daily living rapidly improved. This Case highlights the importance of a timely active rehabilitation program for COVID-19 survivors experiencing the long-term effects of coronavirus (long COVID).

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## Introduction

The 2019 novel coronavirus (COVID-19) pandemic has continued to spread worldwide. COVID-19 ranges in severity from asymptomatic infection to severe, critical illness.<sup>1–3</sup> In addition to the physical and pulmonary consequences, hospitalization with a COVID-19 infection can also lead to psychological complications,<sup>1–5</sup> and there are increasing reports of persistent and prolonged effects after acute

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COVID-19.<sup>6–8</sup> The Centers for Disease Control and Prevention (CDC) used the term “Post-Covid Conditions” to describe people who continue to experience symptoms that last four or more weeks from the onset of acute symptoms of COVID-19.<sup>9</sup> In Britain, the National Health Service (NHS) commonly used the term “long COVID” to describe these symptoms in this group of people; the ongoing symptoms of long COVID may last longer than 12 weeks and cannot be explained by any other condition.<sup>10</sup> “Post-COVID Conditions” or “long COVID” can present differently and with different combinations of other health problems for different lengths of time,<sup>9</sup> thus, interdisciplinary cooperation is needed to provide comprehensive care for these patients in the outpatient setting.<sup>8</sup>

Rehabilitation is important for admitted and discharged patients regarding the treatment of the disease,<sup>2,4,5,7</sup> and preliminary evidence suggests that personalized rehabilitation training may also help certain patients with long COVID.<sup>11–14</sup> Herein, we report the feasibility of outpatient rehabilitation for one patient recovering from COVID-19, we also used a comprehensive evaluation to present the pulmonary, physical, and functional recovery of this patient with long COVID.

## Case report

**Admission history.** A 75-year-old woman who complained of general weakness, nausea and diarrhea was diagnosed with COVID-19 on June 1, 2021 (day 1). Apart from a history of a cholecystectomy and hypothyroidism with regular follow-up, she was functionally independent prior to hospital admission. On day 1, the vital sign of the patient included a body temperature (BT) of 38.2 °C and an oxygen saturation (SPO<sub>2</sub>) of 70% under room air, and she was initially admitted to the general ward. Unfortunately, she developed acute respiratory failure, and mechanical ventilation with the placement of an endotracheal tube was performed on day 6. She was transferred to the medical intensive care unit (MICU) for further care from the 6th to 24th day.

After admission to the MICU, the patient was treated for COVID-19-related viral pneumonia and acute respiratory failure. Due to her fluctuating oxygen saturation and left lung collapse, we increased the pulmonary care and the patient’s mobility; as the pneumonic consolidation by chest radiography was significantly improved (Fig. 1; A, B), she was weaned from pressure-controlled ventilation (PCV) mode to pressure support ventilation (PSV) mode. According to the evaluation of our medical team, she was extubated and starting using a high-flow nasal cannula (HFNC) on day 19. After using the HFNC for 2 days, her dyspnea and condition improved gradually, and she was breathing supplemental oxygen by a nasal cannula. Eventually, she was transferred to an ordinary isolation ward on day 24. Negative conversions of her COVID-19 tests were confirmed by two consecutive tests of respiratory specimens using a real-time reverse-transcriptase-polymerase-chain-reaction (rRT-PCR) assay from days 19–28. After getting to a relatively stable condition, she was discharged on day 30 (June 30, 2021).

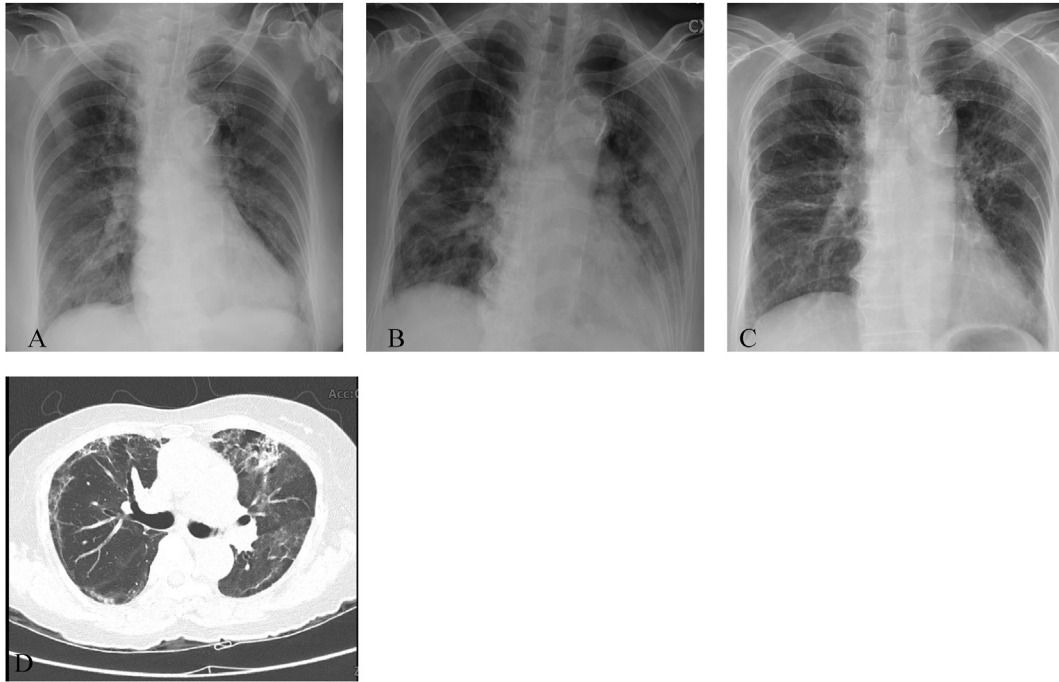
**Follow up.** After two weeks of self-health management, she came to our rehabilitation clinic for further treatment on

July 13, 2021 because of residual symptoms and physical limitations. At the time of consultation with a rehabilitation physician, she sat in a wheelchair and breathed supplement oxygen by nasal cannula, and she had obvious dyspnea and complained of general muscle weakness as well as an inability to stand. Before the rehabilitative intervention, we assessed the physical and functional status, including the degree of dyspnea, physical performance, pulmonary function, activities of daily living (ADL), psychological function, and quality of life (QoL), of this patient on July 15, 2021 (day 45). This study followed the principles of the Declaration of Helsinki, and our patient provided written informed consent prior to participating in the study.

**Clinical assessments.** The degree of dyspnea and disability caused by the patient’s breathlessness were evaluated using the modified Borg scale (MBS), modified Medical Research Council (mMRC) scale, and Chronic Obstructive Pulmonary Disease assessment test (CAT). The patient’s muscle strength in her upper limbs and her physical performance were tested by the hand grip strength test, SARC-F (sluggishness, assistance in walking, rise from a chair, climb stairs, falls), Short Physical Performance Battery (SPPB), 1-min sit-to-stand test, and 6-min walk test (6MWT).<sup>7,12,15</sup> We used an incentive spirometer to measure her lung volume.<sup>16</sup> For ADL, we used the Barthel Index (BI), BI-dyspnea, and Post-COVID-19 Functional Status scale (PCFS) to present the perception of COVID-19-specific limitations in daily life.<sup>1,17</sup> The fatigue severity scale (FSS), Pittsburgh Sleep Quality Index (PSQI), Beck Anxiety Inventory (BAI), and Taiwanese Depression Questionnaire (TDQ) were used for the assessment of post viral fatigue, sleep quality, and psychological function. QoL was quantified with the EuroQOL 5-level EQ-5D (EQ-5D-5L) visual analog scale (VAS) and the World Health Organization Quality of Life-BREF (WHOQOL-BREF).<sup>12,18</sup>

**Rehabilitation program.** The rehabilitative intervention consisted of respiratory muscle training, chest expansion, resisted diaphragmatic training, aerobic cycle endurance training, and resistance training. Our patient trained 50 min/twice a week for 8 weeks, and the patient was guided by a physiotherapist specializing in cardiorespiratory rehabilitation. The intensity of the exercise was progressively adjusted, reaching a perceived exertion of between 4 and 6 on the MBS. We also asked her to undergo some home exercises, including incentive spirometer training and lip breathing training, daily.

At the beginning, she could not speak smoothly because of breathlessness, and she also needed oxygen supplementation during exercise. Due to her physical dysfunction, she could not accomplish some physical tests, and she also needed a walker to execute the sit-to-stand and gait training exercises. After receiving 6 sessions of rehabilitation therapy, her oxygen supply was discontinued during exercise, and her muscle strength, balance function, and gait performance gradually improved. At the time of completion of the two-month rehabilitation, she was able to walk alone, go up and down one stair, and perform activities of daily life without oxygen supplementation and other help. She also had a significant improvement in her degree of dyspnea; her oxygen saturation could be maintained at 95–96% during rest and at 91–92% during



**Figure 1** A) Chest X-ray on day 7 revealed ground-glass opacities in both of the perihilar areas of the lungs due to infection; B) Chest X-ray on day 24 at the time of transfer to the ordinary isolation ward; C) Chest X-ray on day 57 when the rehabilitation had been ongoing for two weeks; D) Chest computed tomography on day 64 still showed extensive pulmonary fibrosis.

exercise. Her sleep quality and psychological function were still affected by the disease. For QoL, she had improvement in both the EQ-5D-5 L VAS and WHOQOL-BREF scores. However, we noticed a limited progress in the psychological domain of the WHOQOL-BREF. The detailed evaluation results are shown in [Table 1](#).

In addition, based on her more stabilized physical condition and her pulmonary fibrosis ([Fig. 1](#); D), we arranged a cardiopulmonary exercise test for her on day 128. The results showed that she had an adequate blood pressure/heart rate response, but her predicted VO<sub>2</sub> peak level was only 14.9 ml/kg/min (4.3 MET), which means her cardiopulmonary function was merely sufficient for basic daily activities but not for vigorous or intense activities. However, her pulmonary function test showed mild restrictive lung function and a mild expiratory muscle strength impairment. No obstructive lung function was observed, and her inspiratory muscle strength was intact. Her diffusing capacity for carbon monoxide (DLCO) showed a decreased DLCO, but she had a normal DLCO/VA. Furthermore, her breathing reserve was approximately 57.8%, which is within the normal range. The detailed results are shown in [Table 2](#).

## Discussion

To the best of our knowledge, this is the first Case on the comprehensive evaluation, including the physical, fatigue, sleep quality, psychological function, and QoL, in a patient with long COVID in Taiwan; we also revealed the feasibility and the effect of outpatient rehabilitation for this case. According to the severity classification of the World Health

Organization (WHO), the severity of pneumonia in our patient was compatible with severe illness.<sup>2,19</sup> She demonstrated typical novel coronavirus pneumonia with progression to acute respiratory distress syndrome (ARDS). Because of the possible sequelae of pulmonary fibrosis ([Fig. 1](#); C, D) and the inevitable consequences of long-term bedridden status (even though the patient had already recovered from the infection), she still suffered from various degrees of respiratory, physical, and psychological dysfunction,<sup>1,2,20</sup> and a negative impact on the patient's ADL and QoL was also found.<sup>1,11</sup>

Rehabilitation is important for admitted, discharged, and outpatient period for the treatment of the disease, and several studies have verified the benefits of rehabilitation for patients with COVID-19.<sup>2,4,5,7,11–14,20</sup>

At the beginning of rehabilitation, there were several limitations in our patient, including pulmonary function impairment (dyspnea and low inhale volume), muscle weakness, low exercise tolerance, fatigue, poor sleep quality, severe depression, anxiety, ADL dependence, and an impaired QoL. Our training programs consisted of respiratory rehabilitation, resistance training, and aerobic exercise; the content, dose and intensity were adjusted progressively according to the patient's condition. After finishing two months of rehabilitation, our patient demonstrated a clinical improvement in the degree of dyspnea, physical performance, and ADL function. The distance covered during the 6MWT increased 56 m, and the number of repetitions in the 1 min sit-to-stand test also increased to 12 times. She had negligible limitations in her daily life, as she could perform many of her usual duties. Her lung volume (incentive spirometer) also improved from <500 ml to 750 ml.

**Table 1** Physical and functional assessments before and after the rehabilitative intervention.

Measures	Before rehabilitation (Day 45)	With-in rehabilitation	After rehabilitation (Day 108)
<b>Degree of dyspnea</b>			
MBS [0–10]*	4		0
mMRC [0–4]*	4		1
CAT [0–40]*	35		17
<b>Physical performance</b>			
Hand grip strength (right/left, lb)	13/8.8		22/22
SARC-F [0–10]*	9		2
SPPB [0–12]	N/A**	8 (Day 50)	11
1 min sit-to-stand (repetition)	N/A**	3 (Day 50)	15
6MWT(m)	N/A**	262 (Day 57)	318
<b>Pulmonary function</b>			
Incentive spirometer (ml)	<500		750
<b>ADL</b>			
BI [0–100]	60		100
BI-dyspnea [0–40]*	32		1
PCFS [0–4]*	4		1
<b>Fatigue, sleep quality, and psychological function</b>			
FSS [1–7]*	6		3
PSQI [0–21]*	8		16
BAI [0–63]*	27		18
TDQ [0–54]*	30		21
<b>QoL</b>			
EQ-5D-5L VAS [0–100]	40		70
<b>WHOQOL-BREF</b>			
1.Physical domain4–20	5.14		12
2.Psychological domain4–20	8.67		10.67
3.Social domain4–20	16		17
4.Environmental domain4–20	15.11		16.89

Note: \*Higher score indicates a worse performance.

\*\*Due to her physical dysfunction, the patient could not complete the test.

**Table 2** Cardiopulmonary exercise test on day 128.

Measures	Results	Percentage of age predictive value/clinical significance
VO2max (ml/kg/min)	14.9	73% predictive value
METmax	4.3	
<b>Cardiac function parameter</b>		
Double product (SBPxHR)	24,704	Intermediate level of myocardial function
Oxygen pulse (VO2/HR)		83% predictive value
<b>Pulmonary function parameter</b>		
FVC (L)	1.76	71% predictive value
FEV1/FVC (%)	92.6	
MIP (cmH <sub>2</sub> O)	53	81% predictive value
MEP (cmH <sub>2</sub> O)	68	52% predictive value
DLCO		54%
DLCO/VA		94%
Breathing reserve (%)	57.8	

Abbreviations: VO2max = maximal oxygen consumption, METmax = maximal metabolic equivalent, SBP = systolic blood pressure, HR = heart rate, FVC = forced vital capacity, FEV1 = forced expiratory volume in 1 s, MIP = maximal inspiratory pressure, MEP = maximal expiratory pressure, DLCO/VA = diffusing capacity for carbon monoxide/alveolar volume

Although most patients with COVID-19 improve within weeks of the illness, some people experience post-COVID conditions (long COVID). Physical functions are still significantly hampered when the patients are discharged

home,<sup>4,5,9,10</sup> and pathological changes, such as pulmonary fibrosis, may lead to residual physical/pulmonary dysfunction of varying degrees even six weeks to one year after discharge.<sup>5,8</sup> Our patient still suffered some physical

limitations after two months of rehabilitation; for example, the result of the 1 min sit-to-stand on day 108 was less than 25% compared with members of the same sex and age from the general population.<sup>21</sup> The result of her 6MWT was 40% lower than the norm.<sup>22</sup> In addition, the grip strength of both of her hands was also two standard deviations below the mean of the normative data.<sup>23</sup> Skeletal muscle damage has been found in patients with COVID-19, and a combination of old age, physical inactivity, and certain antiviral drug use would be the triggers of muscle wasting.<sup>24</sup> According to the results of the cardiopulmonary test (Table 2), she had mild restrictive lung function and mild expiratory muscle strength impairment, but no obstructive lung function was observed, and her inspiratory muscle strength was intact. Therefore, the reason for exercise limitation might not be solely due to pulmonary dysfunction, and muscle wasting would also be one of the reasons. Continuing rehabilitation and solid monitoring of the patient's pulmonary and physical function during outpatient rehabilitation are recommended.

Furthermore, the fatigue symptoms of our patient greatly improved after two months of rehabilitation, but she still had severe sleep problems. Moreover, even though her test scores had improved, she still had moderate problems with anxiety and depression (Table 1). In one meta-analysis study, the prevalence of sleep problems among patients with COVID-19 was 74.8%,<sup>18</sup> and one study also reported high rates of posttraumatic stress disorder, depression, anxiety, insomnia, and obsessive-compulsive (OC) symptomatology in patients with COVID-19.<sup>25</sup> Considering the impact of COVID-19 infection on mental health, we suggested psychological counseling to our patient on day 109 combined with ongoing pulmonary rehabilitation. We will continue monitoring her change over time, with the aim of reducing the disease burden, and thereby will help the patient to recover and to return to her original life more promptly.

Many studies have shown that patients with COVID-19 have a significant impairment in QoL.<sup>1,8,11,12</sup> Based on the WHOQOL-BREF results, our patient showed great improvement in the physical domain after two months of rehabilitation, but she still had insufficient QoL in the psychological domain. The short-term goal of pulmonary rehabilitation is to alleviate dyspnea, improve physical performance, and relieve anxiety and depression, while the long-term goal is to preserve the patient's function to the maximum extent, and to improve his or her QoL.<sup>5</sup> We need to adjust our intervention programs gradually, especially focusing on the psychological function of our patient, to meet the personal goals of our patients and improve her QoL.

In summary, our patient had a severe case of COVID-19 infection. The patient suffered from multiple symptoms during hospitalization, and the acute care took place in strict isolation, which reduced her mobility and caused deconditioning. Even though she had already recovered from the infection, she still suffered from various degrees of dysfunction. Fortunately, after finishing the two-month rehabilitation, our patient showed a rapid improvement in the degree of dyspnea, physical performance, and ADL function. Huang L and colleagues reported that within 1 year after acute infection, most hospital survivors with COVID-19 had good physical and functional recovery over time, but their current health status was still lower than that in the

control population. The risk factors associated with muscle weakness, anxiety or depression were old age and female sex,<sup>26</sup> which are similar to our patient. Due to residual impairments, psychological problems, and insufficient QoL, she needs to continue her rehabilitation programs, including aerobic exercise, strength training, and psychological support; our team also needs to strengthen the rehabilitation program and follow-up on her health condition.

## Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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