Rehabilitation Therapy for a COVID-19 Patient Who Received Mechanical Ventilation in Japan

Takuya Saeki, RPT, MSc, Fumihiro Ogawa, MD, PhD, Ryosuke Chiba, RPT, Manabu Nonogaki, MD, Jo Uesugi, RPT, Ichiro Takeuchi, MD, PhD, and Takeshi Nakamura, MD, PhD

Abstract: A 65-yr-old man visited a primary care hospital with a continued fever of 38°C for 3 days. His fever did not improve until 8 days after he was admitted into another acute care hospital, where his respiratory condition rapidly worsened. Therefore, the patient was transferred to our hospital. On the day of transfer (day 1), he was started on mechanical ventilation. COVID-19 was diagnosed using a polymerase chain reaction assay 6 days after admission (day 6). The rehabilitation therapy was begun on day 6. The initial rehabilitation programs focused on positioning and postural drainage. The patient was extubated on day 19, and he began standing and stepping on the same day. Gait exercises began on day 22, and endurance training was initiated on day 28. The patient was discharged from our hospital on day 34 as he met the physical function milestones. One month after discharge, the Medical Research Council sum score and Barthel Index had each improved; therefore, muscle strength and daily activities had returned to normal. It was assumed that mobilization should be performed as soon as possible after the end of sedation during the acute phase of severe COVID-19 infection in patients receiving mechanical ventilation.

Key Words: Novel Coronavirus Infection, Mobilization in the Acute Phase, Acute Phase, Physical Function, Case Report

(Am J Phys Med Rehabil 2020;99:873–875)

A novel coronavirus infection (COVID-19) emerged in December 2019 in China and rapidly spread throughout the world. The first patient with COVID-19 in Japan was identified on January 16, 2020. The World Health Organization declared COVID-19 a pandemic on March 11, 2020, and COVID-19 patients have also been increasing in Japan. As of June 14, 2020, there are 17,502 patients in Japan who have had COVID-19, including 925 who have died from the disease. Fifteen percent of COVID-19 patients require mechanical ventilation and life support. Some COVID-19 patients, who have received intensive care including extended mechanical ventilation, develop intensive care unit (ICU)–acquired weakness. It was thus postulated that these patients will require respiratory physiotherapy and mobilization in the acute phase to restore pulmonary and physical function.

In early February 2020, a COVID-19 patient was admitted who had received mechanical ventilation and underwent rehabilitation therapy beginning as soon as practical within the ICU, which improved the patient’s physical recovery. There are very few reports of rehabilitation therapy for COVID-19 patients who have received mechanical ventilation in Japan.

Case Description

A 65-yr-old man with a history of hypertension visited a primary care hospital with a fever of 38°C that had continued for 3 days. A doctor at this hospital prescribed antibiotics to address his symptoms. As his fever did not improve until 8 days after, he visited the Department of Respiratory Medicine in another acute care hospital. The assigned physician suspected viral pneumonia based on his symptoms and admitted the patient to the acute care hospital. On the day of admission, his respiratory condition rapidly worsened until his percutaneous oxygen saturation was less than 80% while receiving 10 l/min oxygen via a nonrebreather mask (arterial blood gas values: pH = 7.54, PaO2 = 37.8, PaCO2 = 29.8). On the same day, the patient was transferred to our hospital’s ICU, where mechanical ventilation (pressure controlled/assisted control ventilation, FiO2 = 0.7, pressure control = 17 mmHg, positive end-expiratory pressure = 8 mmHg) was started. After intubation, his arterial blood gas values were as follows: pH = 7.349, PaO2 = 134, PaCO2 = 46.2, and lactate = 0.9. Heparin (5000 U/IM) was injected twice per day to prevent deep thrombosis.

Upon admission to our hospital (ICU day 1), his Acute Physiologic Assessment and Chronic Health Evaluation II score was 16 points and his Sequential Organ Failure Assessment score was 3 points. The patient’s laboratory test results were 12.45 mg/dl for C-reactive protein, 5800/ul for white blood cells with a relatively high percentage of neutrophils (74%) and a low percentage of lymphocytes (15.6%), and 14.3 g/dl for hemoglobin. D-dimer was 0.86 μg/ml. His body weight was 84.4 kg, height was 174 cm, and body mass index was 27.9 kg/m². A chest radiograph and an axial computed tomography image showed bilateral ground-glass opacities in his peripheral regions. In contrast to the peripheral regions, relatively normal structures were maintained in the patient’s hilar regions and larger bilateral ground-glass opacities. The images also revealed some consolidations with a striking peripheral distribution. The actions taken to manage the patient’s pulmonary condition are mentioned in Figure 1. COVID-19 was diagnosed
6 days after admission to our hospital (day 6) using a polymerase chain reaction–dependent method.

Rehabilitation therapy was started on day 6. All rehabilitation therapy staff underwent more strict precaution to prevent COVID-19 infection by air droplet or aerosol with personal protective equipment. To control infection, rehabilitation therapy was performed with the minimal required staff: a physical therapist and a nurse. Rehabilitation programs are described in Figure 1. The initial rehabilitation steps were limited to positioning, postural drainage, and passive range of motion exercises due to mechanical ventilation and sedation to a −4 on the Richmond Agitation–Sedation Scale. Prone positioning was not performed because his PaO2/FiO2 ratio (cmH2O/%) was not severe (>100). Sedation was reduced from the Richmond Agitation–Sedation Scale −4 to −2 on day 12, and active range of motion exercises, muscle power training, and sitting on the edge of the bed were initiated on day 14. The patient was extubated on day 19 in response to improved pulmonary function. His laboratory test results were 2.38 mg/dl for C-reactive protein, 6300/μl for white blood cell, and 10.6 g/dl for hemoglobin. Standing and stepping were initiated on day 19. Gait exercises were initiated on day 22, and endurance training (cycle ergometer exercise) was initiated on day 28. The patient was discharged from our hospital on day 34 as his physical condition had improved sufficiently (Table 1). However, his body weight was 76.9 kg, a decrease of 8.9% compared with when he was hospitalized. He was instructed to continue home exercise including walking and muscle strength exercise. One month after discharge, the patient’s Medical Research Council sum score and Barthel Index scores had further improved (Table 1); therefore, muscle strength and activity of daily living had returned to normal.

The patient gave written consent for publication of this case report. This study conforms to all case report guidelines and reports the required information accordingly (see Supplemental Checklist, Supplemental Digital Content 1, http://links.lww.com/PHM/B81).

**TABLE 1. Physical function assessments of the COVID-19 patient**

|                              | ICU Discharge (Day 21) | Hospital Discharge (Day 34) | 1 mo After Hospital Discharge |
|------------------------------|------------------------|-----------------------------|------------------------------|
| MRC-sum score, point         | 50                     | 53                          | 60                           |
| Grip right/left, kg          | NC                     | 28.1/25.2                   | 34.9/30.4                    |
| Gait speed, m/sec            | NC                     | 1.3                         | 1.5                          |
| 6MWD, m                      | NC                     | 360                         | 509                          |
| Barthel Index, point         | 15                     | 90                          | 100                          |

Grip of the average value in the Japanese elderly persons (65–69 yrs): 39.68 ± 6.04 kg.
6MWD of average value in the Japanese elderly persons (65–69 yrs): 626.36 ± 87.68 m.
6MWD, 6-min walking distance; MRC, Medical Research Council; NC, not completed.
DISCUSSION

Elderly patients, and those with underlying medical problems, for example, hypertension, type II diabetic mellitus, cardiovascular disease, chronic pulmonary disease, obesity, or cancer, are more vulnerable to severe symptoms resulting from COVID-19 infection.\(^4\)–\(^6\) This patient had hypertension and obesity as preexisting risk factors of severe COVID-19 symptoms. Many patients with severe COVID-19 symptoms might need medical care that includes extended mechanical ventilation under deep sedation to treat acute respiratory distress syndrome and protect them from accidental extubation and decannulation. It has been reported that patients with severe COVID-19 have a high risk of ICU-acquired weakness.\(^2\) Therefore, these patients are at a high risk of developing postintensive care syndrome, including ICU-acquired weakness, and are prone to decreased physical function. Those who receive mechanical ventilation need mobilization in the acute phase.\(^7\)

Rehabilitation therapy was started 6 days after admission to our hospital after established infection control procedures. Although the patient did not meet the diagnostic criteria for ICU-acquired weakness, he had muscle weakness in his limbs (he had Medical Research Council sum score of 50 points) on the day he was transferred from the ICU to the general ward (day 21) after having received mechanical ventilation for 19 days. When the patient was discharged, muscle weakness and exercise intolerance persisted, but his capacity to perform activities required for daily living improved to the level of independence at his home. One month after discharge, good recovery of physical function was observed. Therefore, mobilization in the acute phase is a necessary component of rehabilitation therapy for severely affected COVID-19 patients.

Respiratory physiotherapy might not be broadly required because many COVID-19 cases do not show increased respiratory secretions different from general acute respiratory distress syndrome without COVID-19. Respiratory physiotherapies, including postural drainage, were performed in this case, but their benefit is unknown. Respiratory physiotherapy might be effective in patients with bacterial pneumonia and high levels of respiratory secretion.

It was considered that patients with severe COVID-19 need rehabilitation therapy in the acute phase to improve physical function. However, infection control is also important. Therefore, during hospitalization, the rehabilitation therapy was performed only in the isolation area for patients with COVID-19; personal protective equipment was used and respiratory physiotherapy that generates aerosols was avoided.

CONCLUSIONS

Patients with severe COVID-19 symptoms who need mechanical ventilation will likely develop muscle weakness and exercise intolerance. This study showed that mobilization in the early stages of the disease, after the end of sedation, can be beneficial.

ACKNOWLEDGMENT

The authors thank the clinical nursing staff in the acute care unit for supporting this rehabilitation therapy. The authors also thank Editage (http://www.editage.com) for English language editing.

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