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Case report

Pulmonary rehabilitation for critically ill elderly patients with COVID-19 in Thailand: Two case reports

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Many patients exposed to coronavirus disease 2019 (COVID-19) were likely to have complications during their recovery. Critical illness elderly patients with COVID-19 experienced more complications in various systems such as neurological, cardiovascular, mental health, and general deconditioning. There are few publications that mention the impairments of critical illness survivors. Regarding to the limited research evidences we have, this made the physical therapy role challenging. However, we suggest that the physical therapy needs to be fast and more intensive for critical illness in elderly patients with COVID-19. The first case was an old Thai woman presented with severe COVID-19 pneumonia. The other was an old Thai man presented with COVID-19 with complications such as acute respiratory distress syndrome, hyperglycemia, thrombocytopenia, right tension pneumothorax with recurrent pneumothorax, and monoparesis. These two cases presented the experiences and role of physical therapy for critically ill elderly patients with impairments from COVID-19.

Keywords: Case report, COVID-19, physical therapy.

Coronavirus disease 2019 (COVID-19) is the most recently discovered infectious disease caused by the coronavirus. The emerging disease was never known until it spread from Wuhan, China in 2019.[1-7] Now COVID-19 has been a pandemic outbreak affecting many countries around the world. It has involved more than 513.54 million confirmed cases of the coronavirus, 395 thousand new cases per day and 6.23 million deaths over the world, according to the report of the world Health Organization on May 2nd, 2022. However, the spread of COVID-19 pandemic reached Thailand on January 12th, 2019. There are 4.26 million cases of coronavirus, 28,617 deaths and 11,535 new cases, based on the report of the world Health Organization on May 2nd, 2022.[8]

COVID-19 is mainly spread through droplets and airborne transmission.[9, 10] The manifestations of COVID-19 infection range in severity from asymptomatic infection to severe sickness.[1, 4, 9, 11, 12] In the respiratory system, COVID-19 causes symptoms of cough, trouble breathing which potentially leads to serious complications such as acute respiratory failure and acute respiratory distress syndrome (ARDS).[3, 4, 10, 13, 14]

Aside from respiratory symptom, COVID-19 critical illness patients also have multisystem symptoms and impairments which involved neurological, cardiovascular, neuromuscular, psychological dysfunction, and general deconditioning. [10, 14, 15, 17] As a result, many COVID-19 survivors, particularly those with critical illnesses, have functional deterioration, putting them at risk of long-term functional

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impairment, social impairment and disability; therefore, early physical therapy is essential.

To date, there was limited evidence and data on the efficacy of physical therapy in COVID-19 patients. The objective of this report was to discuss the role of physical therapy during hospitalization in critically ill COVID-19 patients at King Chulalongkorn Memorial Hospital.

Case report 1

A 73-year-old Thai woman with type 2 diabetes mellitus controlled with oral medication, dyslipidemia and osteoarthritis of both knees presented with fatigue and progressive dyspnea 3 days prior to admission. She was previously independent in activities of daily living and ambulation, and she could work as a street vendor. There was no significant family history, history of smoking or alcohol drinking. At the hospital, her vital signs were stable with oxygen saturation (SpO_2) of 75.0%. Chest-x-ray showed ground-glass and reticular opacities in both lungs. A real-time polymerase chain reaction of severe acute respiratory syndrome-coronavirus-2 test (SARS-CoV-2 RT PCR) was detected. On June 23, 2021, she was admitted to King Chulalongkorn Memorial Hospital (KCMH) with a diagnosis of severe COVID-19 pneumonia that required remdesivir injection and endotracheal intubation.

On the 3rd hospital day, her portable chest radiograph was found to have slightly increased ground-glass and reticular opacities on the right lung, new patchy opacity on the left retrocardiac region (Figure 1A). On the 12th hospital day, her portable chest radiograph was found blunting of left costophrenic angle, probably superimposed pulmonary opacity or small amount of left pleural effusion (Figure 1B). On the 15th hospital day, she presented with desaturation from baseline and got and emergency computed tomography angiography of the pulmonary arteries, there were multifocal ground-glass opacities as well as irregular consolidations involving both lungs with peripheral part and lower lung zones predominant, compatible with typical appearance of COVID-19 pneumonia. The involvement of both lungs were approximately 70.0%. On the 20th hospital day, her nasopharyngeal swab PCR test result was negative. She was transferred to the general medical ward (Figure 2). After 22 days of prolonged tracheal intubation, the patient underwent tracheostomy operation. She had secondary Acinetobacter Baumannii pneumonia infection and was treated with levofloxacin. Rehabilitation program was started at postoperative day 6 to improve ventilation and ambulation (Table 1).

At the start of the program, oxygen saturation and respiratory ventilation were monitored while doing physical therapy treatment. The patient had a good consciousness and followed 3 steps command; she had short breaths with ventilator (spontaneous mode) and secretions retention with rhonchi at both lungs all lobes; she could not move herself on bed easily and had mild to moderate pain at her both knees due to osteoarthritis. The patient was instructed to perform a physical therapy program with keeping oxygen saturation consistently above 85.0%. Breathing exercises, active cycle breathing technique (ACBT), forced expiratory techniques (FET), active assisted exercise on bed and positioning was started to reduce secretion retention and increase muscle strength. The physical therapist was required to use personal protective equipment (PPE), wear a mask around patients and staff, maintain good hand hygiene, and keep a safe distance. An improved recovery mobilization and ambulation program had progressed after four days of rehabilition. Progressive sitting balance training and standing balance training were promoted. She received pain relievers for her knees so that she could stand comfortably. After that, the patient stood for a longer period of time while using a walker before taking a brief side stride. After eight rehabilitation days, contact precaution from Acinetobacter Baumannii was released. The patient breathed better with an oxygen collar mask (3L/ min) alternated with room air and marched with a walker for 3 to 4 steps, maintaining SpO_2 = 88.0 - 93.0% in a few days. On rehabilitation day 21, her physical capacity was getting better. Owing to short distances, we used two-minute walking tests (2MWT) to measure patient endurance. She walked with a walker for 10 meters with some rest, but her endurance was limited to 10 meters with oxygen supplementation needed. The physical therapist continued to increase exercise endurance with breathing control and tried to clear secretions before entering a rehabilitation program. We encouraged the patient to perform sided walk long as patient could tolerate and gave her some rest in total practicing time 20 minutes. Interestingly, the patient had a strong motivation to get better in every training day. Finally, she could walk with a walker for 20 meters without rest time and significant deoxy-

genation in five weeks. Furthermore, the patient could take deeper breaths, and expel phlegm that was well associated with chest radiograph (Figure 1C).

The patient underwent a ten-week pulmonary rehabilitation program, consisting 2 - 5 sessions per week. The program included secretion clearance technique such as the active cycle breathing technique and forced expiratory technique for secretion repellant, and 28 sessions through the rehabilitation program, each lasting 45 minutes. The sessions involved 15 minutes of active assisted exercise and active exercise, 10 minutes of sitting and standing training, and 20 minutes of exercise endurance training through marching and walking. A pre-discharge evaluation (including SpO_2, 2MWT and chest radiography) was performed at the end of the PR program. Her oxygen saturation increased from 93.0 to 97.0%. The optimal outcome of the patient was she able to walk independently with a walker for 50 meters in two minutes. Her portable chest radiograph was found decrease patchy opacity in left lung and multifocal patchy opacities in right lung (Figure 1D). But it seems like unchanged from a previous one. The patient was subsequently closed tracheostomy tube and completed the physical therapy program before being dischargedfrom the hospital on day 101 after admission (Figure 2).

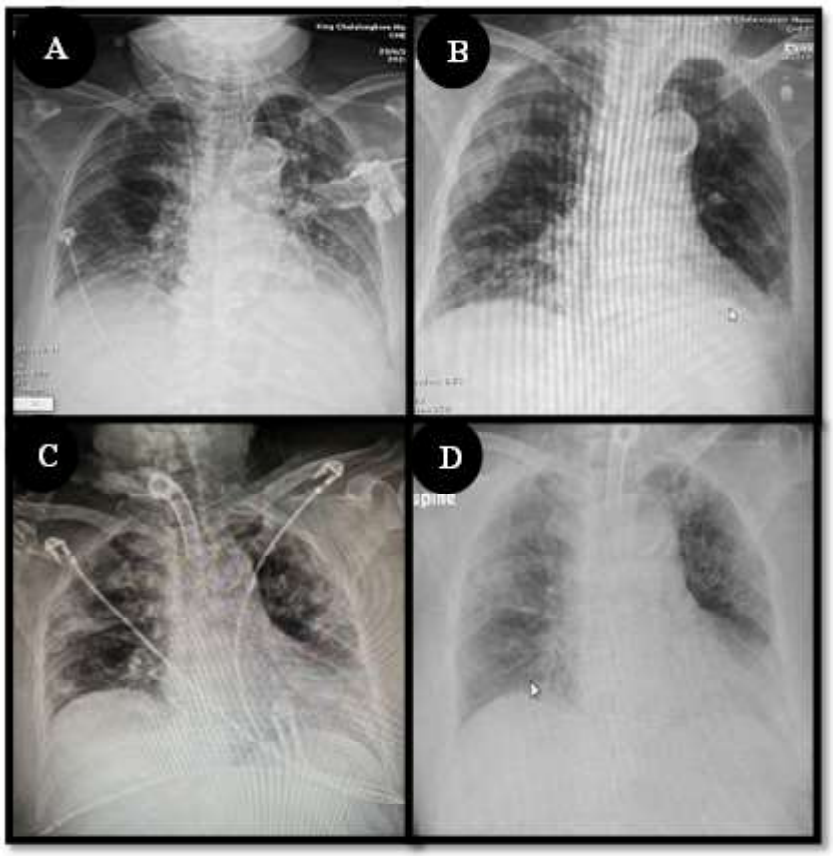

Figure 1. Chest radiography: **(A)** Diffuse patchy opacity in left lung and multifocal patchy opacities in right lung; **(B)** Blunting of left costophrenic angle, probably superimposed pulmonary opacity or small amount of left pleural effusion; **(C)** Mildly decrease in multifocal consolidation and ground glass opacities at both lungs, especially in peripheral lung zones; and **(D)** Mildly decrease patchy opacity in left lung and multifocal patchy opacities in right lung.

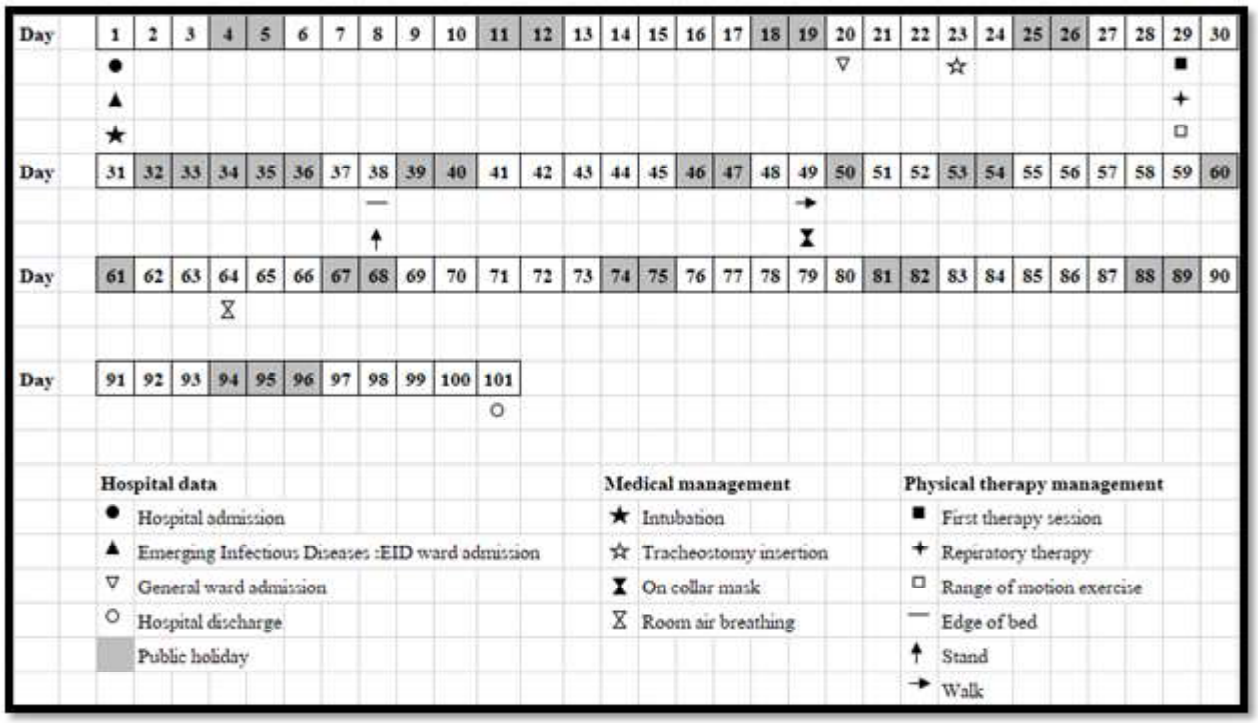

Figure 2. Hospital timeline of case no.1.

Table 1. Physical therapy interventions of case no.1.

Number	Impairment	Main therapy goals	Frequency, Duration	Physical therapy interventions	Therapy equipment
1	Cough, dyspnea, secretion retention	Improved oxygenation, airway clearance technique	5 times a week, once daily (except public holiday)	Active cycle breathing technique (ACBT), Forced expiratory tertechnique (FET)	Pulse oximeter
2	General weakness	Increased strength	5 times a week, once daily (except public holiday)	Active assisted exercise	Manual muscle test
3	Reduced physical function	Encourage early mobilization and ambulation, Increased endurance capacity	2 times a week, once daily (except public holiday), 25 - 40 min with 1 PT	Sitting training, standing training, progressive ambulation training	Walker, mRPE rate, Pulse oximeter

Physical therapy interventions

Secretion clearance technique

Auscultation lung examination demonstrated rhonchi at both lungs, hypersecretions and dyspnea. On chest x-ray found multifocal patchy opacity at both lungs (Figure 1). Therefore, the physical therapist suggested the patient sit in a semi fowler's position and then perform the forced expiratory techniques to expel secretion with suction included. We applied an active cycle breathing technique which includes breathing control, deep breathing exercises, thoracic expansion exercises and coughing to regain chest expansion, train respiratory muscles and expel mucus from the airway.

Exercise and mobility training

The patient reduced strength of the respiratory muscles and limb muscles due to symptoms of post COVID-19 pneumonia and decreased ability to perform functional activity. The physical therapist encouraged the patient to do bed mobility (side lying, shift body up and down), side of bed sitting, beside standing training, marching and walking with gait aid.

Exercise endurance

Because of poor ventilation and deconditioning of respiratory muscles and limb muscles, the patient was easily dyspnea and tired during exercises. The physical therapist advised the patient to perform deep breathing exercises and breathing control during physical activity training to reduce the degree of dyspnea. The patient was prescribed based on modified rate of perceived exertion (mRPE) with initial rating of 3 - 4/10 scale. We gradually increased distance and time to increase exercise endurance (Table 1).

Outcome

The patient underwent a rehabilitation program for 28 days, the patient showed improvement in cleaning out of secretion with an effective productive cough via tracheostomy tube. The patient could get out of bed without assistant. She was eventually able to walk with a walker independently with increasing distance from a two-minute walking test without dyspnea or desaturation. She did not require oxygen therapy. She was discharged from the hospital on day 101. Moreover, she had confidence to take care of herself and returned to normal life.

Case report 2

A 78-year-old Thai man with atrial flutter, hypertension, dyslipidemia and gout presented with fever, cough and rhinorrhea for two days prior to admission. He was an ex-smoker 60 packs per year and denied alcohol drinking. He was tested positive SARS-CoV-2 RT PCR (CT ratio ORF1 ab gene Ct 18.85, N Gene Ct 19.82) and admitted at other hospital on April 26th, 2021. On May 6th, 2021, he was transferred to KCMH with COVID-19 pneumonia. On the first day at KCMH the physical examination showed body temperature of 36.8 ^{o}C and respiratory rate 24/min. The blood examination showed: red blood cells count (RBCs) = 5.37 million/mL, hemoglobin (Hb) 12.1 g/dL, hematocrit (Hct) 35.5%, platelets (Plts) 133 milliliter/uL, white blood cells (Wbcs) 1111 milliliter/uL, blood urea nitogen (BUN) 22 mg/dL, creatinine (Cr) 0.64 mg/dL, blood sugar 123 mg/dL. Chest x-ray showed bilateral ground glass opacity with scattered multifocal patchy infiltration more prominently in both lower lung zones and right middle lobe, no pleural effusion of pneumothorax (Figure 3A). Initially, he was on a high flow nasal cannula 60 L/min but because of worsening oxygenation he required endotracheal intubation in the same day. He had COVID-19 complications, including hyperglycemia in non-diabetes mellitus due to high dose steroid and thrombocytopenia followed by disseminated intravascular coagulation.

The patient had severe ARDS with respiratory failure and required mechanical ventilation. Clinically, the patient was placed in a prone position. But due to back pain problems, he was unable to do so. He had fever, dyspnea, productive cough with hypoxemia and sepsis due to pseudomonas aeruginosa infection, ceftazidime was administered to treat the infection. On the 6th hospital day, he developed right tension pneumothorax and needle thoracotomy was done (Figure 3B). On the 20th hospital day, COVID-19 swab tests were negative, he was transferred to the medical intensive care unit (MICU) owing to ventilation support needed. Right pneumothorax was recurred and chest tube drainage revision was done (Figure 3C). The patient had a problem with provoking cough easily when he got any activity from ARDS. He was delirium and mostly asleep due to sedation treatment. He then developed left arm weakness of grade II by the manual muscle testing (MMT) and was diagnosed of left monoparesis due to critical illness myopathy. During the medical intensive care

unit admission, the patient was consulted for a rehabilitation program on the 27th hospital days. An intensive 5-week rehabilitation program was conducted to improve ventilation, strengthening and ambulation. After 39 days of prolonged tracheal intubation, he underwent tracheostomy and mechanical ventilation was provided to improve oxygenation and respiratory function. In the first phase of physical therapy treatment, we focused on breathing, expanding the chest, strengthening and early mobilization after the patient gained more consciousness. He was given a segmental breathing exercises and active assisted chest trunk mobilization. Adjusting the bed in a slightly more upright position was also suggested. When the left arm strength improved to grade II+ by MMT, we encouraged the patient to do active assisted range of motion exercises. After 10 postoperative days, chest tube drainage was off and lungs were in full expansion (Figure 3D). Leg cycling was applied to the patient for 20 minutes through maintaining a range of motion. The left arm muscle strength was then improved to grade IV by MMT within four weeks after the operation. On 13 postoperative days, the mechanical ventilator was successfully weaned off. The patient breathed with a tracheostomy tube with T-piece 10 L/min and could do breathing exercises and range of motion exercises after command. But while exercising, the patient was also provoked to cough easily. When the clinical stable after 19 postoperative days, the patient was transferred to the general ward (Figure 4). After 20 postoperative days, the patient breathed better with an oxygen collar mask (from 6 L/min to 3 L/min) and received sitting and standing balance training for 20 minutes. Since then, progressive ambulation training was promoted to a patient consequently with a walker. The patient received a good encouragement from his children and grandchildren. The physical therapist was asked to take his picture when he had a progression during treatment. Eventually, the patient was successfully discharged from hospital day 73 (7 weeks of rehabilitation program).

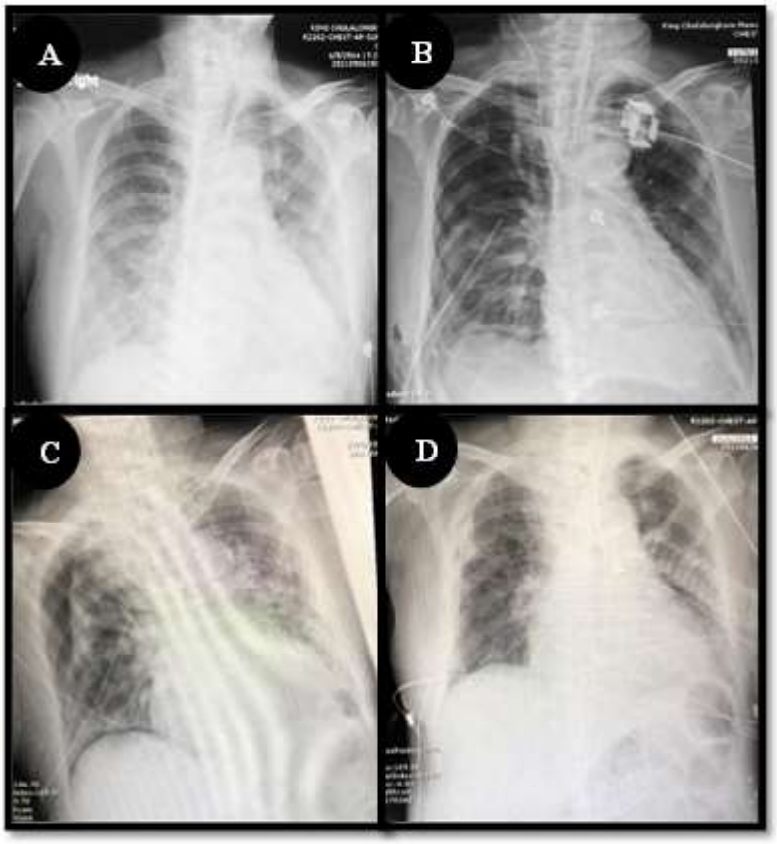

Figure 3. Chest radiography: **(A)** Bilateral ground glass opacity with scattered multifocal patchy infiltration more prominence in both lower lung zones and right middle lobe; **(B)** Right tension pneumothorax with chest tube; **(C)** Revised chest tube; **(D)** No pneumothorax.

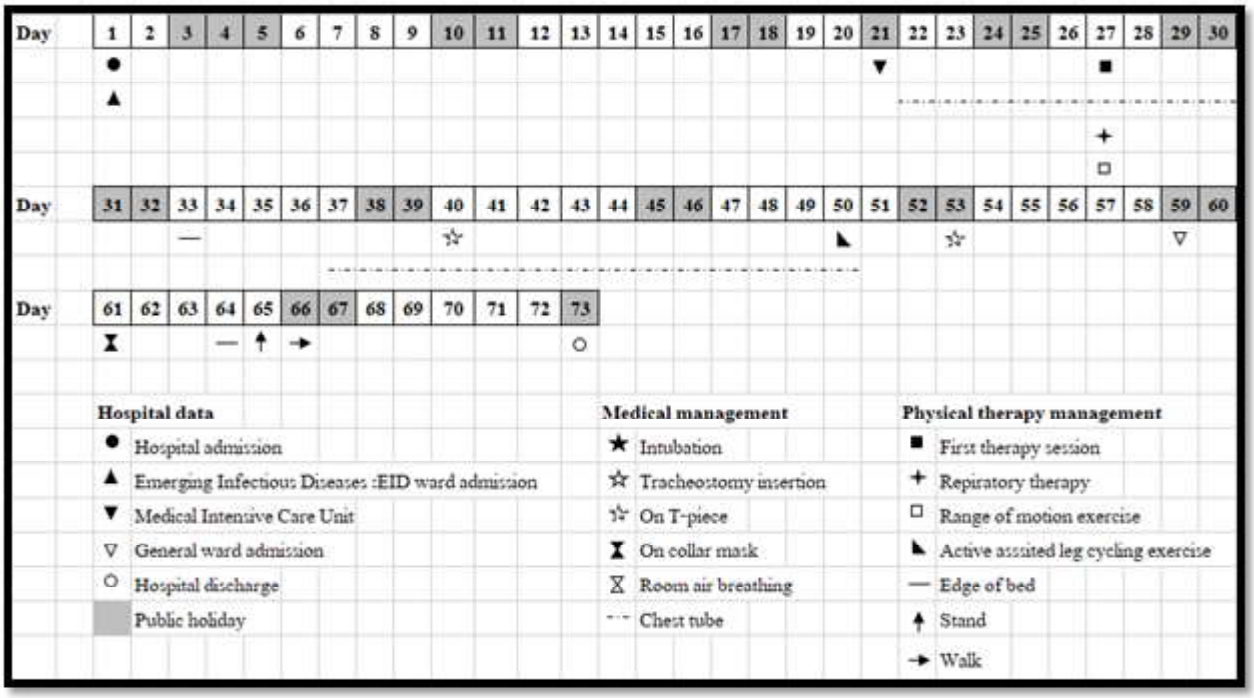

Figure 4. Hospital timeline of case no.2.

Table 2. Physical therapy interventions of case no.2.

Number	Impairment	Main therapy goals	Frequency, Duration	Physical therapy interventions	Therapy equipment
1	Dyspnea, decreased lung expansion	Improved oxygenation, increased lung expansion	5 times a week, once daily (except public holiday)	Segmental breathing exercise, chest trunk mobilization, upright position	Pulse oximeter
2	General weakness	Increased strength	5 times a week, once daily (except public holiday)	Active assisted exercise, leg cycling exercise	Manual muscle test
3	Reduced physical function	Encourage early mobilization and ambulation, Increased endurance capacity	5 times a week, once daily (except public holiday), 25 - 40 min with 1 PT	Sitting training, balance training, standing training, progressive ambulation training	Walker, Pulse oximeter

Treatment

Respiratory training exercise

The patient was unable to breathe normally due to restricted lung expansion from pneumothorax and post-acute sequelae of COVID-19 infection symptoms, resulting in reduced breathing effort, shortness of breath, cough, and the need for ventilator support. Furthermore, when he was in the intensive care unit, he was delirious and could not follow commands. Therefore, we needed to wait till he was taken off sedative medication before starting segmental breathing exercises and deep breathing exercises to increase lungs expansion.

Exercise and mobility training

As a consequence of prolonged use of the sedation and intensive care unit acquired weakness, the patient had general weakness in all limbs especially on the left arm. The physical therapist was responsible for the prevention and treatment of deconditioning, as well as management of the respiratory system.

Exercise and mobility training were applied in the medical intensive care unit. Position change could promote reorientation and reduce risk of lung collapse. We tried to provide the patient in a sitting or semi-recumbent position while doing respiratory training exercises and range of motion exercises. Passive exercise and active assisted exercises were applied to the patient. We instructed the patient to perform a range of motion exercises for 8 to 15 repetitions, 2 to 3 sets. In addition, leg cycling was applied for 20 minutes to encourage the patient to follow the cycling control. Gaining muscle power was also an important part of mobilization training which includes sitting, standing and walking (Table 2).

Outcome

After participating in a 7 - week rehabilitation program, the patient was well able to improve chest expansion and physical ability.

Discussion

To the best of our knowledge, this is the first case report on post - COVID-19 pneumonia rehabilitation which presents detailed physical therapy management for a hospitalized patient in Thailand. In recent years, COVID-19 pneumonia has become a severe public health epidemic worldwide. Many patients who had been diagnosed post COVID-19 pneumonia and admitted in the intensive care unit or in hospitalization had experienced impairments in respiratory function, severe weakness, anxiety or delirium and restricted physical fitness.[2, 4 - 7, 10, 14, 16 - 18] Even the report of chest X - ray in case no.1 was unchanged, but the result of functional outcome of patient was improved. Both survivors of COVID-19 presented the impairments of critical illness elderly patients who were facing with physical problems in many aspects. The importance factor to the patient's recovery was to receive the proper physical therapy as soon as possible and a good motivation.

Due to lack of evidence of pulmonary rehabilitation programs for post - COVID-19 patients.[3, 15] The physical therapist experienced similar cases during the same period. Based on respiratory management for the previous study we knew that rehabilitation and mobilization have become the priority for patients admitted to the intensive care unit.[6, 11, 15] The main goal of physical therapy rehabilitation is chest physical therapy, encouraging early mobilization and preventing further complications [10,11] such as breathing exercises, range of motion exercises, strengthening exercises, endurance training and progressive ambulation training [3, 5, 12, 17, 18] which should be provided to the patient who had deconditioning and respiratory problems. However, the physical therapist needed to be concerned about body temperature, heart rate, oxygen saturation, mean arterial pressure, dyspnea scale and other vital signs that must be monitored throughout the physical therapy sessions.[12] In addition, the selection of rehabilitation procedures and standard measurement should be chosen according to the abilities of each patient.[5, 6]

There are also other issues regarding rehabilitation in COVID-19 patients. First, the appropriate start period of physical therapy intervention. According to the review by Demeco A, *et al.*[6], early respiratory rehabilitation is not recommended for severely and critically ill patients during periods of possible and progressive deterioration. In our cases, the rehabilitation intervention has been introduced around 3 - 4 weeks after the first diagnosis of COVID-19 when isolation was no longer required and PCR test was negative. Both patients went through the critical period, but they still needed respiratory support, while complications from immobilization were present. Early physical therapy has been shown to have an important effect on maintaining the musculoskeletal

system. and has a long-term effect on the recovery of the patient such as shortening the time of use of a ventilator and reduced length of stay in the hospital. The issue of when to start rehabilitation should be explored and included in clinical practice guideline. Second, amount of physical therapy sufficient to improve functional status should be concerned. Johnson JK, *et al.*[17] proposed the amount, frequency and amount of physical therapy performed directly affects the ability to increase mobility status at hospital discharge. The amount of physical therapy delivered to our inpatients was approximately 0.4 visits per day (an average of 3 visits over 7 - day stay) with a visit lasting 45 minutes averagely, which was shown to be adequate to enhance our patients' functional outcomes. The frequency of visits is slightly lower, but the visit time is longer when compared with the cohort in the United States. [17] (0.4 versus 0.5 visits per day and 45 versus 25.3 minutes per visit, respectively) Further study is needed to establish the proper amount of physical therapy to balance resources and outcomes.

The present study has some limitations, however. Firstly, it is impossible to demonstrate the role of physical therapy in changing pulmonary function because the test is not routinely accessed in our general practice. Secondly, due to the loss of patients to follow-up, there is a lack of data to determine the long-term outcome of physical therapy interventions.

Conclusion

Elderly patients with severe COVID-19 who require mechanical ventilation are more likely to develop complications from immobilization syndrome. Breathing exercises, exercises, mobility training and endurance training may reduce mechanical ventilation, improve respiratory function, regain muscle strength, improve cognition and increase functional ability. Moreover, we ensure that early rehabilitation should be provided to patients as soon as possible to promote the patients return to their normal activity daily life.

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Conflict of interest statement

Each of the authors has completed an ICMJE disclosure form. None of the authors declare any potential or actual relationship, activity, or interest related to the content of this article.

Data sharing statement

The present review is based on the reference cited. Further details, opinions, and interpretation are available from the corresponding authors on reasonable request.

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