

# The clinical impact and benefits of a simultaneous cardiopulmonary rehabilitation in a COVID-19 infected patient following cardiac arrest: A Case Report

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## Abstract

The decline in cardio-respiratory function is rising among COVID-19 survivors amid the pandemic. Cardiopulmonary rehabilitation is known to be clinically effective but no studies show data to substantiate its application. The simultaneous treatment improved cardiopulmonary clinical indicators in our patient yielding enhanced functional restoration to enable independent community participation.

Title Page:

## **The clinical impact and benefits of a simultaneous cardio-pulmonary rehabilitation in a COVID-19 infected patient following cardiac arrest: A Case Report**

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### **Key Clinical Message**

As COVID-19 cases rise the application of rehabilitation following acute treatment is increasing. This case emphasizes the critical need for cardiopulmonary rehabilitation for functional restoration after cardiac arrest and COVID-19 treatment.

### **Abstract\_Unstructured :**

Since the advent of the pandemic, cardiopulmonary rehabilitation (CR) has been shown to be an effective treatment. However, there are no studies showing data to substantiate its simultaneous application. A 62-year-old man was resuscitated for asystole during the work-up after presenting with two-day history of difficulty breathing. PCR test was positive for COVID-19. He was intubated and admitted to a negative pressure zone. Symptoms improved in response to acute treatment. Following extubation, respiratory distress persisted, and CR was implemented. Clinical indicators of cardiopulmonary function improved resulting in a successful return to community participation. The decline in cardiopulmonary function has been on the rise among COVID-19 survivors. The simultaneous application of CR treatment in our patient resulted in improved clinical indicators of cardiopulmonary function. The patient regained full function for independent community participation.

**Keywords :** cardiopulmonary rehabilitation, COVID-19, cardiac arrest

### **INTRODUCTION**

The application of cardiopulmonary rehabilitation (CR) has dramatically increased in many areas globally. Studies have reported that CR treatment has significantly decreased mortality rates, reduced re-admissions, and improved quality of life among patients with heart and respiratory diseases [1,2]. On the other end of the

spectrum, the current public health crisis stemming from the coronavirus (COVID-19) outbreak has taken many lives primarily owing to severely compromised respiratory status. Since the first human-infected case was reported in late 2019, followed by rapid transmission and its global spread, the state of a pandemic was declared by the World Health Organization in early 2020.

In response to the pandemic, various acute care and treatment methods for COVID-19 infection have been proposed based on limited research data. The recent and notable preventive measure in response to the crisis has been developing vaccines to achieve herd immunity. However, there is still insufficient research evidence for the treatment of conventional acute cardiopulmonary failure, which is accompanied by deterioration of physical condition, postural instability, muscle shortening, and contracture that may occur after COVID-19 infection. [3,4].

Our patient with cardiac arrest, presumably associated with recent COVID-19 infection, showed improvement in cardiopulmonary function after undergoing a simultaneously combined pulmonary and cardiac rehabilitation. The resultant effect was a rapid return to daily life activities and vital community participation.

## CLINICAL CASE

### 1. HISTORY OF PRESENT ILLNESS AND HOSPITAL COURSE

A 62-year-old man with chronic hypertension and no other significant medical history presented to the emergency department (ED) with complaints of severe dyspnea. He reported the onset of breathing difficulties two days prior to presentation. The patient's wife was undergoing mandatory self-isolation at home, where they reside together, due to a recent COVID-19 infection positive test result. In the ED, the patient required 15L of O<sub>2</sub> by mask and reported SpO<sub>2</sub> of 60% on saturation monitoring.

During the work-up in the ED, an onset of asystole required cardiopulmonary resuscitation for approximately 2 minutes. The efforts resulted in the return of spontaneous circulation (ROSC). PCR test result was positive for COVID-19. He was intubated and admitted to the Infectious Disease service for the acute treatment of COVID-19 in a negative pressure isolation room in a separate wing of the hospital. The patient was extubated on hospital day 10 with significantly improved clinical symptoms by hospital day 28. He was released from the quarantine zone following a confirmed resolution of COVID-19, and gradual improvement of pneumonia was observed via serial radiography (Figure 1).

Medical management was discontinued at this juncture of the hospital course, and discharge planning was initiated. However, as a former COVID-19 patient with a recent cardiac event, residual respiratory distress and symptoms were noted when engaging in any activity with the slightest movement. Upon returning home, he could not perform basic daily life activities independently and was prompted to undergo CR.

### 2. EVALUATION TOOLS

Pre-requisite evaluation (hospital day 38, T1) before CR involved the following areas of assessment: pulmonary function test (PFT), cardiopulmonary exercise (CPX) test, 6-minute walk test (6MWT), and Berg balance test (BBS). The patient was reassessed after seven days of CR (hospital day 48, T2).

Pulmonary function was based on PFT evaluation (Pony FX MIP/MEP, Cosmed Srl, Italy) which included measurements of Functional Vital Capacity (FVC%), FEV<sub>1</sub>(%), FEV<sub>1</sub>/FVC(%) with Peak Cough Flow (PCF), Vital Capacity (VC), Maximal Insufflation Capacity (MIC), Maximal Inspiratory Pressure (MIP), Maximal Expiratory Pressure (MEP). CPX test was conducted using American College/American Heart Association guidelines using Peak Oxygen uptake per Kilogram (VO<sub>2</sub>/Kg), Peak Oxygen uptake per Heart Rate (VO<sub>2</sub>/HR), and Oxygen Uptake Efficiency Slope (OUES) as clinical indicators.

### 3. CLINICAL INTERVENTION

The rehabilitation course required a combined program consisting of 1) 60 minutes of pulmonary rehabilitation, 2) 60 minutes of cardiac rehabilitation, and 3) 30 minutes of strengthening exercise with balance training. The regimen was applied once daily for a total of seven days.

Pulmonary rehabilitation comprised pursed-lip breathing exercises, deep breathing exercises (secretion mobilization and diaphragmatic breathing), rib cage expansion exercises, and controlled coughing exercises. The patient was also educated on self-management practices, emphasizing coping skills, dietary intake, self-medication, and performance in activities of daily living.

Cardiac rehabilitation involved the use of a hand-bike ergometer system based on CPX results of the initial evaluation. Our patient was supervised by a therapist using a pulse oximeter during the exercise period. The intensity of the activity was adjusted based on the patient's heart rate (HR). The criteria for discontinuing or reducing the exercise intensity was determined by using oxygen saturation of SpO<sub>2</sub> < 85%, symptom-limited by the subjective rating of perceived exertion (RPE >14).

The regimen also required 30 minutes of strengthening exercise and balance training, as aforementioned. A strengthening exercise was performed in 3 sets of 12-15 repetitions with the 30-40% of 1 repetition maximum (RM) [5]. When oxygen saturation fell below 85%, supplemental oxygen was added with 2 liters via nasal cannula to maintain oxygen saturation greater than 90%.

Despite the patient's confirmed resolution of the infection, precautionary measures were strictly enforced during the rehabilitation treatment phase. Protective equipment, including gowns, face shields, and masks, were required for patients and clinical staff in the rehab center to minimize potential risks of new infection and re-infection.

## DISCUSSION

The sequela of COVID-19 infection primarily cause a decrease in diffusion capacity and compromised function via obstructive respiratory patterns and weaknesses of accessory muscles [6]. In addition, impairment of cardiac function due to complex mechanisms, an inflammatory immune response from infection, virus invasion of cardiomyocytes, and hypoxic myocardial injury can all occur as complications [7]. A similar pathophysiologic mechanism presumably manifested in this patient.

Many experts in the field believe that it is indispensable to perform respiratory and cardiac rehabilitation treatment simultaneously. However, cardio-pulmonary rehabilitation's implementation and clinical practice are insufficient and sparse due to the lack of hospital resources and the heightened risks of contagion [3], especially during the current global public health crisis. Moreover, the decline in cardiopulmonary function is a clinical sequela observed as an increasing trend among COVID-19 survivors [9].

The effects of respiratory and cardiac rehabilitation therapies have been proven through various studies to date [8-10]. A recent systematic review showed that respiratory rehabilitation treatment after COVID-19 infection improves respiratory function and quality of life [10]. Since the advent of the current pandemic, CR has been combined with respiratory rehabilitation treatment across centers in many geographic areas. However, no studies show data to confirm its generalizability and substantiate its clinical application as a reliable treatment. The observed clinical result shown in our case study is consistent with the improved effects of CR when combined with respiratory rehabilitation in patients with severe COVID-19 infection following cardiac arrest. Symptoms improved, and bilateral patchy opacity was reduced on chest X-ray findings after acute pharmacologic treatment at 38 days of hospital admission. At this juncture, CR was implemented without concomitant antibiotic therapy. Subsequently, symptoms and radiographic findings were further diminished, and although unaffected by antibiotic treatment, the patient's decline in function improved following CR application. Nevertheless, the residual symptoms and radiographic opacity persisted.

Hermann et al. (2020) demonstrated in their study of 28 participants following 2-4 weeks of CR in which the group requiring mechanical breathing (n=12) compared to the group without (n=16) showed a significant increase in the measured outcome on 6MWT evaluation [9]. The improvement was shown in VO<sub>2</sub>/kg, VO<sub>2</sub>/HR, OUES, and 6MWT, all of which served as indicators of cardiovascular function. In addition, the BBS index by functional balance test also showed improvement.

Aytur, Y et al. (2020) proposed a theory and produced guidelines of respiratory rehabilitation for COVID-19-infected patients through a multi-center trial in Turkey [10]. We followed this model in our study and

applied the proposed treatment model in pulmonary rehabilitation. Upon completing the week-long CR treatment, the following respiratory function indicators improved: PFT, FVC, FEV1, PCF, VC, MIC, and MIP/MEP, as shown in Table 1. Simultaneously, cardiovascular function improved which enabled the patient to ambulate independently without difficulty in respiratory function.

CPX results showed improvement in VO<sub>2</sub>/Kg, VO<sub>2</sub>/HR, oxygen uptake efficiency slope (OUES), 6MWT, and BBS, as summarized in Table 2. The patient showed functional improvement after a short period of CR by independent ambulation and performance in daily life movements at home without dyspnea and other related respiratory signs and symptoms. As a result, the clinically improved patient successfully returned to community participation.

## SUMMARY AND CLINICAL APPLICATION

The presented case in this report substantiates the critical need for cardiopulmonary rehabilitation following the onset of a cardiac event preceded by the resolution of a recent COVID-19 infection. Under the usual protocol, following the resolution of COVID-19, individuals are immediately discharged to home regardless of overt residual symptoms. It is recommended that patients undergo cardiopulmonary rehabilitation directly following treatment of a COVID-19 infection, given its effectiveness and benefits for improved clinical status following a short treatment period.

### Authors' Contributions:

First author:

Jun Young Ko, MD

Initial investigation with clinical care and work-up; writing original draft and preparation; data acquisition and analysis.

Second author:

Jeong Jae Lee, MS, PT

Investigation; clinical evaluation and work-up; acquisition and interpretation of data; reviewing of final manuscript.

Co-author:

Mi rim Lee, MD

Clinical care and work-up; drafting original write-up; administration; proofreading.

Co-author:

Yong Kyun Kim, MD, PhD

Project administration and support with supervision of the clinical aspects; reviewing and editing.

Senior and Corresponding author:

Seungbok Lee, MD, MPH

Conceptualization and design; supervision with provision of resources; manuscript drafting, reviewing and final editing with technical language, proofreading.

All aforementioned authors participated sufficiently in the presented work; the authors have read and agreed to the final approval of the manuscript to be published.

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