

*CASE REPORT*

## **Monitored Home-based Exercise Rehabilitation for Patient with Chronic Respiratory and Cardiovascular Diseases During Covid-19 Pandemic: A Case Report**

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### **ABSTRACT**

**Introduction:** In patients with Chronic Obstructive Pulmonary Disease (COPD), due to shared-risk factors, concomitant chronic cardiovascular diseases include Congestive Heart Failure (CHF) are common and resulting in increase overall morbidity and mortality.

**Case Report:** A female patient, 52 years, came for pulmonary rehabilitation 2 weeks after hospitalization due to acute exacerbation of COPD. One week before the exacerbation, she showed symptoms of CHF. Physical examination showed signs of right and left heart failure, oxygen desaturation, and limited chest expansion. Functional assessment showed disability in self-care, instrumental activities of daily living (ADL), deconditioning, depression, and anxiety. Supporting examination confirmed very severe restriction and obstruction, bronchopneumonia, cardiomegaly, and pulmonary hypertension. Rehabilitation problems include cardiorespiratory, ADL, and psychological problems. The Covid-19 pandemic causing prohibition of supervised cardiorespiratory rehabilitation. Home-based exercise program was given for 5 months. Monitoring was done via video call before and after each exercise and through analysis of exercise diary. Psychological counseling also given at the beginning of the program. Patient did all of prescribed exercises. At the end, symptoms decreased, patient can do ADL and hobbies, no exacerbation or exercise intolerance, patient does not look anxious and consents to leisure activities.

**Conclusion:** Monitored-home based exercise programs can be used as safely alternative to hospital-based, if done according to the prescription. However, monitoring by physician is mandatory.

**Keywords:** chronic obstructive pulmonary disease, congestive heart failure, covid-19 pandemic, home-based exercise, rehabilitation

## ABSTRAK

**Pendahuluan:** Pada pasien dengan Penyakit Paru Obstruktif Kronik (PPOK), karena faktor risiko yang sama, penyakit kardiovaskular kronis yang menyertai termasuk Gagal Jantung Kongestif (GJK) sering terjadi dan mengakibatkan peningkatan morbiditas dan mortalitas secara keseluruhan.

**Laporan Kasus:** Seorang pasien wanita, 52 tahun, datang untuk rehabilitasi paru 2 minggu setelah rawat inap karena PPOK eksaserbasi akut. Satu minggu sebelum eksaserbasi, pasien menunjukkan gejala GJK. Pemeriksaan fisik menunjukkan tanda-tanda gagal jantung kanan dan kiri, desaturasi oksigen, dan ekspansi dada yang terbatas. Penilaian fungsional menunjukkan ketidakmampuan dalam perawatan diri, aktivitas kehidupan sehari-hari (AKS) instrumental, dekontinensi, depresi, dan kecemasan. Pemeriksaan penunjang menunjukkan restriksi dan obstruksi yang sangat berat, bronkopneumonia, kardiomegali, dan hipertensi pulmonal. Masalah rehabilitasi meliputi kardiorespirasi, AKS, dan masalah psikologis. Pandemi Covid-19 menyebabkan rehabilitasi kardiorespirasi tidak dapat diawasi secara langsung. Program latihan di rumah diberikan selama 5 bulan. Pemantauan dilakukan melalui video call sebelum dan sesudah setiap latihan dan melalui analisis buku harian latihan. Konseling psikologis juga diberikan di awal program. Pasien melakukan semua latihan yang ditentukan. Pada akhirnya gejala berkurang, pasien dapat melakukan AKS dan hobi, tidak ada eksaserbasi atau intoleransi latihan, pasien tidak terlihat cemas dan setuju untuk melakukan aktivitas santai.

**Kesimpulan:** Program latihan berbasis rumah yang dipantau dapat digunakan sebagai alternatif latihan berbasis rumah sakit yang aman, jika dilakukan sesuai dengan resep. Namun, wajib dilakukan pemantauan oleh dokter.

**Kata kunci:** gagal jantung kongestif, latihan berbasis rumah, pandemi covid-19, penyakit paru obstruktif kronik, rehabilitasi.

## INTRODUCTION

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Chronic obstructive pulmonary disease (COPD) is currently the fourth leading cause of death in the world, and is projected to be the 3<sup>rd</sup> in 2020. This disease resulting in heavy economic burden and known as one of the most common chronic diseases with an overall prevalence of 7.6% worldwide.<sup>1,2</sup> In patients with COPD, due to shared-risk factors, concomitant chronic cardiovascular diseases (CVD) are common and resulting in increase overall morbidity and mortality. Congestive Heart failure (CHF) is more common in COPD patients than in the general population. A study found that the risk of CHF

development was 4.5 times higher than in the age-matched controls.<sup>2,3</sup>

In patients with COPD and those with CHF, exercise capacity and level of physical activity are significantly reduced. Patients with COPD or CHF who are relatively inactive will experience more intense symptoms of dyspnea and leg discomfort when engaging activities of daily living (ADL), causing them to avoid such activities and becoming less active. Cardiopulmonary rehabilitation (CR), consisting of exercise training, was known as the most effective therapeutic strategy to improve dyspnea, exercise tolerance, and health status in patients with cardiopulmonary disease.<sup>1</sup> Exercise to improve functional capacity can increase exercise performance by reduction of symptoms.<sup>4,5</sup>

Patients with COPD are prone to exacerbations, and the frequency of exacerbations tends to increase as the severity of the disease increased. Exacerbations also known as an important cause of drop-out from CR programs, happening in 37% of those who failed to adhere to the program.<sup>6</sup> Scope of hospital-based CR programs are low because the implementation is generally resource-demanding and limited by low adherence rates. Only a small fraction of COPD patients enroll to CR programs per year. A number of barriers are found, including lack of family support, the presence of depression, difficulties in transportation, lack of perceived benefit by the patient, inconvenient timing, or disruption of established routine of the patients, inhibit patients to participate in hospital-based CR programs.<sup>4</sup>

Home-based tele-monitoring programs in patients with COPD or CHF showed significant increase in clinical, functional, and health-

related quality of life (HRQoL) status. The major important finding is decreasing rates of hospital readmissions secondary to cardiovascular events or due to COPD exacerbations.<sup>4</sup>

Since patients with COPD and CHF consider themselves functionally disabled, particularly those who have recently been hospitalized due to worsening of the disease and exacerbations, existing international guidelines recommend that CHF and COPD patients should be given a supervised hospital-based CR programs. Research of patients with CHF undergoing pulmonary rehabilitation found that no significant adverse events during CR programs. In addition, in the group of patients with CHF undergoing pulmonary rehabilitation, the dropout rate was similar compare with usual care. Exercise in group with COPD and CHF did not adversely affect outcomes for patients with COPD, similar to CHF patients who previously treated separately in the program.<sup>7</sup>

We report a case with the diagnosis of chronic respiratory diseases and CVDs, who was given a monitored home-based exercise rehabilitation. Covid-19 pandemic causing prohibition to attend hospital-based CR programs. The challenge in the rehabilitation of this patient is the safety issues of providing home-based exercise, because in addition to oxygen (O<sub>2</sub>) desaturation that can be induced by light activity, the patient also suffers from CHF which may increase risk of exercise intolerance. The patient was given explanation about implementation of home-based exercise and methods of monitoring that will be performed. The patient's family was also asked to participate actively in monitoring patient's compliance in carrying out the rehabilitation program. The program was started after the patient agreed and signed the informed consent.

## CASE DESCRIPTION

Female patient, age 52 years, Sundanese, came for phase 2 CR on March 2020, two weeks after hospitalization due to increased dyspnea with fever and cough with yellowish sputum. One week before the exacerbation, the patient also complained of dyspnea, so she had to sleep with 3 pillows. Mobilization and ADL were very limited, and she needed help for bathing and dressing. She couldn't do household chores. She should use a wheelchair propelled by other people for outdoor activities.

The patient had history of tuberculosis 20 years ago, and completed the treatment as given by physician. She gradually limited her activities because of dyspnea since one year ago, especially when walking more than 200 meters. The patient has O<sub>2</sub> and pulse oximetry, and she usually use O<sub>2</sub> when feels breathless and become fatigue. O<sub>2</sub> saturation usually less than 80% when breathless and improve with the use of O<sub>2</sub>. She also has treadmill so she can do exercise at home.

Physical examination showed tachycardia, respiratory rate 24 times per minute, O<sub>2</sub> saturation between 75-78% without O<sub>2</sub> and 95-97% with O<sub>2</sub> supplementation 3 liter/minute, and temperature 36,70C. Her body weight was 47.9 kg, body height was 149 cm with body mass index 21.3 (normoweight). Posture and balance were normal. Jugular venous pressure (JVP) 5+3 cmH<sub>2</sub>O. Thorax symmetric, chest expansion 1.5/1.5/1.5 cm. In auscultation, there were creckles in both lungs, no wheezing, and no secretion. Peak cough flow 220 cmH<sub>2</sub>O (prone to infection). Extremities show edema and clubbing fingers. Neuromuscular and

musculoskeletal systems are within normal limits. Bio-impedance analysis shows low visceral fat and normal muscle mass.

Barthel Index 13/20 (disability in bathing, toileting, dressing, mobilization, and stairs climbing), Lawton-Instrumental Activities of Daily Living (Lawton-IADL) 3 (patient was dependent in food preparation, household chores, laundry, shopping, and the choice of transportation). Six-minute walk distance (6-MWD) was 39 meters, the patient quitted in 3.5 minutes, with Borg scale 15/4/4. Score for Modified Medical Research Council (mMRC) 4 (too breathless to leave the house), COPD assessment test (CAT) 30 (impact level: high). Depression, Anxiety and Stress Score (DASS) showed mild depression and anxiety, and no stress. St. George Respiratory Questionnaire (SGRQ) of symptom/activity/impact was 404.7 (61%)/733.6 (60.6%)/1238 (58%).

Spirometry showed very severe restriction and obstruction, with FVC 25.3%, FEV<sub>1</sub>/FVC 67%, and FEV<sub>1</sub> 17.7%. Radiologic examination showed bronchopneumonia, cardiomegaly, and pulmonary hypertension. CT-scan showed cardiomegaly with elongated and atherosclerotic aorta, chronic bronchitis with bronchiectasis. ECG showed sinus tachycardia.

Medical diagnosis were COPD GOLD IV group D, restrictive lung disease due to sequelae of tuberculosis, chronic cor pulmonale, and left CHF functional class III due to dilated cardiomyopathy. Patient was given long-term O<sub>2</sub> therapy by the internist with O<sub>2</sub> 2-3 liters/minute via nasal cannula, 18-24 hours a day. Rehabilitation problems include dyspnea, O<sub>2</sub> desaturation increased with light activities,

restricted chest expansion, very low functional capacity, mild depression and anxiety.

The CR programs consisted of education, therapeutic exercise, and psychological counseling. Education consisted of basic information of the disease, ensure risk factor management by internist, symptoms and management of acute exacerbation, energy conservation and relaxation techniques, nutrition

management, airway clearance techniques, and exercises. Patients were given monitored home-based exercise program for 5 months. Programs consisted of pursed lip breathing, chest expansion, effective cough, cardiopulmonary endurance, and flexibility exercises with the prescription as describe in table 1. Psychological counseling also given to improve coping of the patient and family so psychological problems not develop and adherence to long-life exercise increase.

**Table 1. Prescription of Cardiorespiratory Endurance and Flexibility Exercises**

	<b>Cardiorespiratory Endurance</b>	<b>Flexibility</b>
<b>Frequency</b>	3 times a week	Once a day
<b>Intensity</b>	30- 40% HRR Borg Scale 9-11 / 2-3 / 2-3	Stretching muscles to the point of slightly discomfort
<b>Time</b>	20 minutes conditioning exercise (with bouts every 10 minutes as tolerated) 5 minutes warm-up and cool-down activities	4 repetition, hold 6 seconds
<b>Type</b>	Aerobic, using treadmill with O <sub>2</sub> support 3liter/minute	Stretching applied to head-neck, shoulder girdle, upper back, upper arm, lower limbs muscles
<b>Progression</b>	progress 2 minutes every 2 weeks as tolerated	Not applicable

HRR : Heart Rate Reserved

The patient had no caregiver to accompany her to go to the hospital. Covid-19 pandemic also prevented her to attend phase 2 hospital-based CR. However, she has a good motivation, home environment, and financial support. In addition, she has equipment to do and monitor exercise at home. The patient and her family agreed to do CR programs at home.

Monitoring was carried out via video call before and after each exercise session and analysis of the exercise diary in follow-up visit. Every time before starting an exercises, we called the patient

to conduct a remote assessment of the patient's readiness to exercise including measurements of blood pressure, heart rate, respiratory rate and O<sub>2</sub> saturation. Measurements was done by her daughter who is a nurse. The patient was also asked to record the results of measurements in the exercise diary. How to determine and maintain a low intensity exercise using talk test during exercise session was taught to the patient. The same examinations also done and monitored via video call after the patient completed exercise session, and recorded in the exercise diary. The patient was asked to report

any symptoms related to exercise intolerance and adverse event occurred in 2 days after each exercise session.

After 1 month, the patient can walk 100 meters slowly, she took a rest for a few minutes and could continue walking for another 100 meters. She did not complained of dyspnea. Cough symptom reduced, and she can expel the sputum effectively. She still needed to use O<sub>2</sub> especially when doing daily activities. She can do all ADL independently. Exercise was done regularly, treadmill walking 3 times a week, 10 minutes, 2 bouts with O<sub>2</sub> support.

Exercises was done regularly according to the prescription. After 5 months of exercise, sign and symptoms decreased, no dyspnea and fatigue during activities. Patient can exercise for 30 minutes (3 bouts of 10 minutes). Overground-walking is done once a week for about 400 meter. Patient can do leisure activities like cooking. Patient does not look anxious and consents to shopping and going to restaurants. The Barthel Index 19/20 (needs help in stairs), Lawton-IADL 6 (independent in almost all light and simple activity). MMRC scale 1 (patient feels dyspnea when walk in a hurry on level surface and walking-up a slope), and CAT score 9 (impact level low: most days are good, but COPD stops people doing 1-2 things they would like to do).

## DISCUSSION

Patient was diagnosed as COPD GOLD 4 group D, after hospitalization due to acute exacerbation, with the complaints of dyspnea and cough with a lot of sputum. Spirometry test conclusions were very

severe restriction and obstruction. The presence of a post-bronchodilator FEV<sub>1</sub>/FVC <0.70 confirms the diagnosis of COPD with persistent airflow limitation. FEV<sub>1</sub> 17.7% (<30% predicted) placing the patient in GOLD 4 class.<sup>1</sup>

In this patient, COPD associated with chronic diseases such as restrictive lung disease, chronic cor pulmonale, and left CHF with functional class III based on New York Heart Association classification. These diseases can increase COPD morbidity and mortality. Morbidity include emergency department visits and hospitalizations, also physician visits.<sup>1,8</sup>

Patient had a history of tuberculosis, physical examination showed limited chest expansion in addition to spirometry results. Imaging study showed parenchymal fibrosis and pleural thickening that lead to restrictive ventilation which was consistent with long-term effects of pulmonary tuberculosis.<sup>9,10</sup> A study found a higher decline in FVC than FEV<sub>1</sub> in patients with tuberculosis after 15 years follow up. The presence of airflow limitation as a main pulmonary impairment in post tuberculosis patients considered as a risk factor for COPD.<sup>11</sup> In this patient, there was the possibility that obstruction caused by tuberculosis.

COPD exacerbations defined as worsening of respiratory symptoms acutely and needs additional therapy. Severe exacerbations may be associated with acute respiratory failure.<sup>1</sup> This patient experienced acute exacerbation and hospitalized for 1 weeks, but no respiratory failure. Concomitant chronic cardiac disorders in COPD patients may also become a cause of hospitalization and death.<sup>3</sup>

Primary impairment that occur in COPD and CHF is different. COPD causes limitations of ventilation and gas exchange, while CHF causes abnormality of hemodynamic. However, in both diseases, the predominant complaint reported during exercise is leg discomfort. Leg discomfort in COPD and CHF cases caused by a number of changes in peripheral muscles. These changes reduce oxidative capacity, regional blood flow, and O<sub>2</sub> delivery to the peripheral muscles. These changes accelerate the occurrence of muscular fatigue during exercise. Dyspnea causes increase of respiratory drive which intensify dyspnea sensation, occurred due to metabolic acidosis induced by exercise.<sup>4</sup>

Pulmonary diseases as well as its treatments associated with lungs and limb muscle dysfunctions. Resistance exercise is the most important program to improve muscle dysfunction in COPD patients. Therefore, resistance exercise should be given as an integral part of exercise prescription. Peripheral muscle dysfunction contributes to reduce exercise tolerance. In addition, it is significantly related to poorer prognosis, mortality, as well as increased the use of health care resources. Patients with pulmonary disease may experience greater dyspnea while performing ADL involving the upper extremities. For that reason, resistance exercise for the upper body muscles should be prescribed.<sup>12</sup> The above pathophysiologic process formed the basis of giving the patient resistance exercise.

CR is one of the most effective intervention for patients with CVD and pulmonary disease, therefore, it is important for rehabilitation specialists to manage patients with primary or secondary disabilities caused by these diseases. Pulmonary rehabilitation programs is similar to

cardiac rehabilitation, and interventions include education, promote compliance with medical care, promote physical activity, respiratory muscle rest and support, O<sub>2</sub> supplementation, airway secretion management, exercise training, emotional support, facilitation of return to work, and promote satisfying life.<sup>13,14</sup> Early CR given greater benefits in physical performance in the first 6 months of follow-up. Compared with those who initiate CR later, participants of early CR group had higher adherence rate.<sup>1,15</sup>

Exercise training is recognized the cornerstone of CR program. Both COPD and CHF have a similar benefits of CR. The benefits include reduce work of breathing or leg discomfort, and improve exercise capacity, muscular fitness, as well as HRQoL. The physiological changes occur in many systems, include improvement of autonomic activation, endothelial function, and blood flow of the working muscle. Exercise training can also attenuate or reverse muscle atrophy, and increase oxidative or metabolic capacities of muscles. These benefits may decrease few weeks after completion of CR program due to reversible nature.<sup>4,5</sup>

In patients with cardiopulmonary disease particularly COPD, CR programs was reported underused.<sup>5,13</sup> The reasons for patients not attending to any sessions or not adhering with attending rate less than 60% of sessions are physical and disease limitations, transportation, and also psychosocial or economic problems. These include deconditioning, inability to perform exercise, exacerbation of COPD, hospitalization, feeling too well, does not feel it would benefit, experiencing a new limiting condition, anxiety about sessions, lack of awareness physician to encourage CR, cost,

preferring self-managing of disease, already did an exercise at home or in community, and time constraints.<sup>6,16</sup> Covid-19 pandemic added barrier to attend CR in this patient.

Another important barrier to attend CR in this patient was the present of mild anxiety and depression. Chronic psychological disorders may weaken immune system and increase sensitivity to respiratory infections which leads to COPD exacerbations. Anxiety and depression often leads patients to suffer from low self-confidence or self-efficacy, which lead to unwillingness to attend CR programs. In addition, patients may have poor medication adherence and refuse to maintain such a healthy behaviors include increase physical activity, healthy diets, as well as smoking cessation. This, in turn, could increase vulnerability to COPD exacerbations or worsening of the disease.<sup>17</sup>

To increase participation and adherence to CR programs, home-based tele-rehabilitation programs was introduced as an alternative to the conventional center-based CR. Home-based tele-rehabilitation allowed patients to connect with rehabilitation expert from their homes, make it possible to achieve the goals. Remote monitoring using information and communication devices can be done using steps counter, application in smartphone, text messages, phone call contact, and exercise diary.<sup>4</sup>

Buckingham et al. stated that in patients given CR program for  $\leq 12$  months or  $>12$  months either receiving home-based or center-based rehabilitation, there were no differences in patient's outcomes include modifiable risk factors, exercise tolerance, cardiac events, and HRQoL.<sup>18</sup> Study by Güell et al demonstrated

that similar improvements in dyspnea and exercise tolerance achieved with both home- and hospital-based CR programs in COPD patients.<sup>19</sup>

Mureddu et al stated that before telerehabilitation, enrolled subjects are evaluated and stratified to provide a suitable rehabilitation program at home. Patients can be provided with a brochure and are educated to the autonomous execution of the exercises. Home rehabilitation is provided with videoconference support. Patients perform daily programs as prescribed and are contacted with individual/group video calls no less than 2 times a week. The program is structured into different levels of intensity in relation to the initial assessment. Exercises of lung expansion and/or respiratory muscles training may be prescribed, when necessary.<sup>20</sup>

CR is believed as a good choice in treating psychological disorders. CR has been shown to reduce the deleterious effects of stress on the patients' mind and body. Education and counseling to reduce stress or improve coping strategies, cognitive-behavioral therapy, and psycho-pharmaceutical therapy was proven benefit, especially in the short term particularly after exacerbation of psychological symptoms. Positive influences such as health behaviors and adherence to CR programs can be encouraged to improve patients' cognitive and behavioral strategies in dealing with CVD.<sup>21</sup>

CR interventions for this patient consisted of initial assessment include exercise testing with 6MWT. Based on the result of initial assessment, a low intensity exercise was prescribed along with flexibility and breathing exercises. We planned to give a resistance exercise after the aerobic exercise is well-tolerated. Aerobic exercise was

given with O<sub>2</sub> supplementation and monitored done via telephone before and after each exercise. Self-monitored diary also provided. In addition, supervision by the patient's daughter also encouraged to ensure safety. At the beginning of the program, patient was given psychological counseling. Patient was taught about signs and symptoms of exercise intolerance, and encouraged to report any inconvenience occurred. Patient also taught about when to make an advancement of exercise.

The key of exercise prescription is exercise intensity, which can be monitor using heart rate. Monitoring device can be used to ensure safety of home-based CR programs in patients with CHF which may further improve effectiveness of CR programs. Prescription of exercise for chronic respiratory disease should be modified to include disease-specific strategies. Light intensity aerobic exercise is appropriate for those with severe pulmonary disease or very-deconditioned individuals. Intensity may be increased gradually as tolerated every 1-2 weeks. Exercise can be given continuously or intermittently, as well as in the bouts of minimum 10-minute per session given in one or more sessions in a day.<sup>12,22</sup> Aerobic exercise intensity given to this patient was low intensity, with the duration begin with 20 minutes in 2 bouts of 10-minute exercise. In addition to the above recommendation, the reason for prescribing low-intensity exercise were the high possibility of exercise intolerance due to COPD and CHF and lack of direct supervision by physician.

Dyspnea on exertions is a common symptom in patients with various pulmonary diseases, and can be measured using the modified Borg Scale (0-10 scale). Measurement of dyspnea should

be done before, during, and after exercise. Some caution is advised in the interpretation, because exercise intolerance may accompanied by exaggerated dyspnea scores without physiological signs. Termination of exercise is recommended when O<sub>2</sub> saturation  $\leq 80\%$  and marked dyspnea.<sup>12, 23</sup>

Clinical indications of supplemental O<sub>2</sub> during exercise are based on physiological reasons. Supplemental O<sub>2</sub> can decrease respiratory rate and dynamic hyperinflation, as well as increase delivery of O<sub>2</sub> that will cause decrease of metabolic acidosis induced by exercise. Supplemental O<sub>2</sub> given in outpatient clinic can support patients with chronic respiratory insufficiency to do an exercise. This effect resulted from increase of O<sub>2</sub> saturation, walking time and exercise duration. As the duration of exercise increases, a better tolerance to a higher intensity exercise will be achieved.<sup>24</sup>

The overall CR program in these patients showed benefit in improving symptoms and functional abilities, as well as improving psychological status. The important thing in providing exercise at home is the attention to safety that can be obtained by providing low-intensity exercise, slowly increasing the dose of exercise with attention to exercise tolerance, and careful monitoring despite limited facilities. In addition, O<sub>2</sub> supplementation is a must to prevent exercise intolerance that often occurs in severe COPD and CHF patients.

## CONCLUSIONS

In the presence of barriers to supervised hospital-based CR programs, monitored-home based programs can be used as an alternative.

The program should be done according to the prescription. Monitoring of the patient condition and execution of exercises by physician is mandatory to ensure safety and attainment of rehabilitation goals.

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