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Pulmonary Rehabilitation to Increase Cardiorespiratory Function in Bronkhiektasis Post-Tuberculosis Patient: A Case Report

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ABSTRACT

Background: Tuberculosis (TB) remains a global health concern, with 10.6 million cases in 2022. Indonesia accounts for 10% of cases worldwide. Post-TB bronchiectasis, a common complication, causes lasting bronchial damage and respiratory issues. Pulmonary rehabilitation (PR), including reconditioning exercise and airway clearance, is essential for improving patient outcomes. This case report focuses on a rehabilitation program arranged to improve the functional capacity and quality of life (QoL) of post-TB sequelae patients. ***Case Presentation:*** A 35-year-old male was referred with hemoptoe, dyspnea, and left chest pain. The patient has completed TB treatment in 2020. After a thorough evaluation, the patient was diagnosed with probable pulmonary mycosis and bronchiectasis, receiving treatment including azithromycin, N-acetylcysteine, and tranexamic acid. The result of a 6-minute walking test (198 meters in distance; 1.92 METs) was used to determine exercise prescription. Hospital-based programs included chest infrared radiation, breathing exercises, and cardiorespiratory endurance training. The intensity was started at 30-50% of HRR, 20-30 minutes in duration, 2x/week, while the home-based one included warming up and walking for 20-30 minutes, 3x/week in between (12-14 RPE). After 8 weeks of PR, the 6-MWT, St. George's Respiratory Questionnaire (SGRQ) score and QoL were evaluated. The results are shown in Table 1. Exercise intolerance and respiratory symptoms may exist although TB patients have already completed TB treatment as a result of pathophysiological changes of the lung that lead to decreased pulmonary capacity. **Conclusion:** Pulmonary rehabilitation was beneficial for post-TB bronchiectasis patients with low cardiorespiratory endurance. A comprehensive program improves exercise tolerance, reduces symptoms, and enhances QoL. This study encountered challenges in obtaining specific sources, highlighting the need for further research to deepen and strengthen the existing findings.

Keywords: pulmonary rehabilitation; cardiorespiratory function; bronchiectasis; post-tuberculosis sequelae.

INTRODUCTION

Tuberculosis (TB), along with HIV and malaria, ranks among the three leading infectious diseases contributing significantly to the global healthcare burden. Beyond its acute respiratory symptoms, TB can progressively lead to long-term impairment of lung function. Managing TB effectively involves a comprehensive approach that includes prevention, early diagnosis, proper treatment, and rehabilitation for post-TB complications, which are often overlooked aspects of TB care. Post-tubercular lung disease (PTLD) refers to the chronic respiratory issues that arise as a result of previous TB infections.[1]

Patients with pulmonary TB sequelae (PTB-sequelae) often experience dyspnea, fatigue, reduced exercise capacity, and impaired quality of life. Management of PTB-sequelae should encompass symptom alleviation, vaccination, smoking cessation, and strategies to enhance functional capacity and quality of life. [1]

The World Health Organization's (WHO) End TB strategy, launched in 2015, aims to eradicate the TB epidemic. The objectives are to reduce TB deaths by 95% and the TB incidence rate by 90% by 2035, compared to 2015 levels. WHO emphasizes The importance of early detection, accurate diagnosis, and standardized, supervised treatment of TB patients.[2] The Union, along with a global consensus of TB experts, defined post-TB sequelae as Post-TB Lung Disease (PTLD). This refers to chronic respiratory abnormalities, with or without symptoms, that are at least partly due to prior pulmonary tuberculosis.[3]

The treatment of pulmonary TB typically requires a multidisciplinary approach. Once diagnosed and a therapeutic regimen is established, the evolution and enhancement of healing chances and social reintegration are often supported through pulmonary rehabilitation (PR) and, in some cases, thoracic surgery. PR is a comprehensive program for patients with respiratory impairments who suffer from compromised clinical and functional status, affecting their daily activities and quality of life. This individualized therapy includes physical training, psychological counseling, nutritional support, and adherence to TB medication.

In selected patients, PR programs can significantly improve symptoms, exercise capacity, and social integration.[4]

Bronchiectasis is a prevalent chronic respiratory disease with significant geographical differences in its causes, severity, and outcomes. Its prevalence is rising, affecting approximately 0.25–0.50% of the adult population, making it the third most common airway disease after asthma and COPD.[15]

Bronchiectasis can be caused by a variety of infectious factors, with tuberculosis (TB) being one of the most significant contributors. Endobronchial tuberculosis often results in bronchiectasis, either through bronchial stenosis or secondary traction caused by fibrosis. In 2020, the Philippines ranked fourth among countries with the highest tuberculosis incidence, with approximately 1 million Filipinos still living with active tuberculosis. [3]

TB was also the 12th leading cause of death in the country that year, with no data available on the number of individuals experiencing post-TB sequelae [4]. Globally, The Union reported that approximately 155 million TB survivors were alive in 2020, with as many as 50% of these individuals still suffering from symptoms such as persistent cough, dyspnea, weakness, and diminished physical capacity [5]. Through a global consensus of TB experts, these symptoms were categorized as Post-TB Lung Disease (PTLD), defined by chronic respiratory abnormalities, with or without symptoms attributable, at least in part, to prior pulmonary tuberculosis.

Adults experiencing respiratory symptoms following tuberculosis (TB) often develop skeletal muscle dysfunction, which is linked to physical inactivity and systemic inflammation, and is further exacerbated by poor nutrition and socioeconomic challenges. These individuals may find themselves trapped in a cycle of declining body weight, worsening health, and increased risk of mortality. People living with chronic respiratory diseases (CRDs) frequently avoid physical activity, leading to further physical deconditioning and loss of motivation, which perpetuates the cycle of deterioration. Currently, there are no effective medications for post-TB lung disease (PTBLD), and treatment primarily focuses on prevention and supportive care. While previously overlooked by healthcare systems and researchers, this condition has recently garnered growing attention.[6]

Pulmonary rehabilitation (PR) is a nonpharmacological approach designed for individuals with chronic respiratory diseases. It includes exercise training, disease education, and behavioral interventions to improve both the physical and psychological health of these patients, encouraging long-term adherence to beneficial health behaviors. For those with bronchiectasis, PR aims to boost exercise capacity, enhance disease management, and improve overall quality of life.

Essential components of PR programs include teaching patients airway clearance techniques and encouraging regular exercise. Experts in microbiology, physiotherapy, thoracic surgery, and primary care have identified the most relevant clinical questions, benefiting both clinicians and patients.[4]

Pulmonary Rehabilitation (PR) is an affordable, high-impact intervention that can reverse disability associated with chronic respiratory diseases (CRDs) and is strongly supported by research evidence in high-income countries. PR programs involve health professionals from multiple disciplines, providing supervised exercise training and disease education to help patients manage their conditions. However, in low- and middle-income countries (LMICs), where the burden of CRDs is rapidly growing, PR is scarce and healthcare services are not well equipped to handle such diseases. Travel problems are a predictor of poor adherence to attendance at a pulmonary rehabilitation program, which makes pulmonary rehabilitation difficult. [8, 9]

Home-based pulmonary rehabilitation (HBPR) could be an appropriate choice in this situation to get around some of the roadblocks that prevent people from attending center-based sessions. While PR is a grade 'A' evidence-based treatment for adults with COPD and has been applied to other chronic lung diseases, its effectiveness for Post-TB Lung Disease (PTBLD) remains uncertain. A development study in Uganda exploring PR for PTBLD found that it was feasible to implement a PR program, with participants reporting significant improvements in quality of life, exercise capacity, and respiratory outcomes.[6]

Educating TB patients on proper coughing techniques is essential. This includes advising on body positioning during coughing and controlling their breathing (slow nasal inhalation, brief breath-holding, and forceful exhalation in 2-3 sessions). The goal is to mobilize and clear secretions from the bronchial tree. Additionally, postural drainage is considered the most effective way to ensure secretion removal. This method involves positioning the body to create a height gradient between the lung segment with secretions and the major bronchial pathways and trachea, aiding in their evacuation.[3]

CASE PRESENTATION

A 35-year-old male with post-tuberculosis bronchiectasis, initially diagnosed by the Pulmonology Department, was referred to the Department of Physical Medicine and Rehabilitation at Arifin Achmad Riau Hospital. The patient had a history of TB treatment in 2020. A few years later, he returned with similar complaints and was diagnosed with pulmonary mycosis and bronchiectasis. He received treatment from the pulmonary clinic, including azithromycin, N-acetylcysteine, and tranexamic acid.

The patient complained of a frequent cough with white sputum with shortness of breath that sometimes-had streaks of blood and was difficult to expel. He also experienced left-sided chest pain. These symptoms had been present for about two months, accompanied by episodes of shortness of breath, limiting his ability to perform daily activities such as climbing stairs. The patient occasionally had sleep disturbances caused by dyspnea. From his perspective, he felt relatively healthy with only mild medical conditions.

His past medical history includes a productive cough with blood-streaked sputum and frequent shortness of breath during long walks and climbing stairs. There was no weight loss, and he was diagnosed with pulmonary tuberculosis in June 2020 and completed treatment in December 2020. According to the patient, he felt better after the treatment. There was no history of hospitalization related to TB since completing treatment. No other family members had the same illness. The patient had no history of diabetes mellitus or hypertension.

The patient had a high school education and a moderate-income level. He did not work but usually picked up and dropped off his child and wife. His child's education level is sixth grade in elementary school, and the family's income comes from a self-employed business. Currently, he lives with his child and wife in a 60-square-meter house. The house is in a less crowded area with sufficient sunlight exposure and good ventilation. He usually travels to the hospital with his wife by motorcycle. He can still participate in community activities without difficulty.

During the physical examination, vital signs such as blood pressure, heart rate, respiration rate, and oxygen saturation were all within normal limits. According to the Asia-Pacific Task Force, a body mass index (BMI) of 24 kg/m^2 is deemed normal. Additionally, inspection, palpation, and percussion of both sides of the chest after the respiratory examination revealed no abnormalities, and no additional lung sounds were observed. From the musculoskeletal examination, the muscles were normotrophic and normotonic, with normal muscle strength and a limited range of motion in all extremities. The patient performed a six-minute walking test and covered a distance of 198 meters, achieving 1.92 METs.

For managing this patient, a six- to eight-week pulmonary rehabilitation program was planned, including hospital-based and home-based rehabilitation. Education was provided about his lung condition, medical conditions (bronchiectasis), the importance of controlling his medical conditions, the rehabilitation program plan, the importance of compliance, and program targets. In addition to verbal education, he was shown how to perform breathing and airway clearance techniques, especially active cycle breathing techniques. The hospital-based rehabilitation program included chest infrared radiation, breathing exercises, chest mobilization techniques, active cycle breathing techniques, and targeted endurance training with a stationary bike. The intensity started at 30-50% of HRR, 20-30 minutes in duration, twice a week. The home-based program included warm-up exercises and walking for 20-30 minutes, three times a week (12-14 RPE).

After eight weeks of rehabilitation, the examination revealed no episodes of dyspnea, he could easily expel sputum, and he was more active after the active cycle breathing program. The 6-MWT, St. George's Respiratory Questionnaire (SGRQ) score, and QoL were evaluated. Exercise intolerance and respiratory symptoms can persist even after completing TB treatment due to lung pathophysiological changes leading to decreased pulmonary capacity.

TABLE 1: Comparison of outcome measures before and after pulmonary rehabilitation.

	Before PR	2 months follow up
St. George's Respiratory Questionnaires (SGRQ) score		
Symptoms	73	56
Activity	69,7	52
Impact	52	41
Total	61	47
6-minutes walking test	198 meters ≈ 1.92 METs	400 meters ≈ 3.06 METs
mMRC dyspneu scale	+2	0

DISCUSSION

Chronic respiratory abnormalities, with or without symptoms, resulting from prior tuberculosis have been referred to as post-tubercular lung disease (PTLD). Similar to other chronic respiratory disorders, patients with PTB sequelae frequently experience fatigue and dyspnea, have a decreased capacity for activity, and have a lower quality of life. Therefore, symptom relief, vaccinations, quitting smoking, and other strategies to enhance functional capacity and quality of life should all be part of managing PTB sequelae. The goal of pulmonary rehabilitation (PR) is to address such needs in a comprehensive way.[1]

In this case, the patient was also diagnosed with bronchiectasis. Bronchiectasis, marked by irreversible dilation of bronchi and destruction of bronchial walls, is closely linked to tuberculosis. The mechanisms behind airflow obstruction in tuberculosis are complex and varied. Endobronchial involvement can lead to localized airway obstruction and scarring, while tuberculous lymphadenopathy may cause external pressure on the bronchi. Additionally, damage to lung tissue can impact lung compliance, increasing the likelihood of peripheral airways collapsing and leading to air trapping.

Hemoptoe in these patients is very frequent. Its main pathophysiology was chronic inflammation and weak bronchial walls that lead to high pressure and arterial bleeding.

The main complaint of this patient is shortness of breath and fatigue when climbing stairs. The patient also frequently complains of a productive cough and has a history of TB, which results in a poor quality of life when performing daily activities. Tiwari et al. describe Post-Tuberculosis Lung Damage (PTLD) as involving both obstructive and restrictive airway problems, resulting in increased respiratory symptoms and diminished quality of life (QoL). Chest pain and breathlessness have a significant impact on QoL, affecting the physical, psychological, and social health of patients with pulmonary TB sequelae. This condition is linked to depression, severe hypoxaemia, age, socio-economic status, and overall physiological well-being.[7]

A recent systematic review found only four randomised clinical trials on pulmonary rehabilitation for patients with PLTD. It revealed that pulmonary rehabilitation was successful in lowering the symptoms of fatigue and shortness of breath while also improving exercise tolerance, cough-related symptoms, and quality of life.8. Over a 12-month period, pulmonary rehabilitation effectively decreases the frequency of exacerbations.[9]

Bronchiectasis is a prevalent chronic respiratory condition. The primary objectives of its treatment include slowing disease progression, alleviating symptoms, enhancing quality of life, and preserving or improving lung function. According to the latest guidelines from the British Thoracic Society, pulmonary rehabilitation has been shown to provide significant benefits for bronchiectasis patients. These include improved exercise capacity and quality of life, a reduction in the frequency of acute exacerbations within a year, and a longer time before the first exacerbation occurs. The 2013 adult pulmonary rehabilitation guidelines from the British Thoracic Society recommend at least two supervised pulmonary rehabilitation sessions per week. It is widely accepted that meaningful benefits are achieved only when rehabilitation extends beyond six weeks, with a supervised program of 6–12 weeks being the standard recommendation.[14]

In this case, the patient is also scheduled to participate in Pulmonary Rehabilitation (PR) including reconditioning exercise and airway clearance, which is essential for improving patient outcomes. Singh et al. also reported a significant improvement in functional status and quality of life in their study of patients who received post-TB pulmonary rehabilitation. It is tailored individually and consists of physical exercises, breathing exercises, psychological counseling, and nutritional and educational components. It improves symptoms and the functional capacity of the lung.[10]

The patient underwent a 6-minute walk test (6MWT). The result of a 6-minute walking test (198 meters in distance; 1.92 METs) was used to determine exercise prescription. Hospital-based programs included chest infrared radiation, breathing exercises, and cardiorespiratory endurance training. In this patient, Pulmonary Rehabilitation (PR), which includes reconditioning exercises and airway clearance, is crucial for improving outcomes. This technique is in line with research by Rupert Jones et al., which emphasized the rehabilitation program's primary focus on lower limb aerobic workouts. By strengthening key muscles and increasing the consumption of oxygen, these workouts seek to physically recondition the body and enhance cardiopulmonary function.[11]

In this case, the patient started with an intensity of 30-50% of HRR, for a duration of 20-30 minutes, twice a week. The home-based program included warm-up exercises and walking for 20-30 minutes, 3x/week in between (12-14 RPE). After 8 weeks of PR, the 6-MWT, St. George's Respiratory Questionnaire (SGRQ) score and QoL were evaluated. This is quite similar to the study by Hussain et al. Their program lasted 6 weeks, focusing primarily on Pulmonary Rehabilitation (PR) through exercise training. All patients were part of the program, which included two weekly supervised exercise sessions led by a resident physician and qualified staff members. For endurance training, each 60–90-minute session includes stationary cycling and ten minutes of modified treadmill walking. Additionally, weights or weight cuffs were used for upper limb and quadriceps strengthening exercise sessions. Furthermore, all participants received instruction in breathing techniques.[1]

Patients with pulmonary fibrosis, including those with TB and bronchiectasis, who took part in an 8-week pulmonary rehabilitation program were the subjects of a study by Saha et al. By the end of the program, the 6-minute walk distance (6MWD) had significantly increased, and the study showed substantial improvements in lung function, physical ability, and quality of life. Warm-up and stretching exercises, aerobic exercises, upper and lower limb strength training, and a variety of breathing techniques such as pursed-lip breathing, diaphragmatic breathing, and thoracic expansion exercises were all part of the home-based pulmonary rehabilitation program. The program additionally involved energy efficiency measures, controlled coughing, positions for relieving dyspnea, and relaxation training.[12]

Jose et al., study examined, home-based pulmonary rehabilitation (HBPR) as an effective and safe alternative rehabilitation program for individuals with bronchiectasis, providing short-term improvements in functional capacity, peripheral muscle strength, and quality of life. However, the program was not effective in maintaining these improvements after a 6-month follow-up period. Patients with bronchiectasis require specialized training in airway clearance techniques as well as education tailored to their specific condition.[16]

A recent systematic review successfully highlighted the various short-term benefits that patients can gain from participating in well-structured and closely monitored pulmonary rehabilitation (PR) and exercise training (ET) programs. However, the review also pointed out that sustaining these benefits over the long term remains a significant challenge. The underlying rationale for PR and ET in patients with bronchiectasis is to address issues such as muscle weakness and physical inactivity, which contribute to disease progression and affect important aspects such as health-related quality of life (HRQoL), the frequency of infectious exacerbations, and the ability to mobilize airway secretions. An observational study involving 41 patients with bronchiectasis found that after undergoing 36 sessions of PR, there were notable improvements in forced vital capacity (FVC) and a reduction in residual lung volume. Similarly, a retrospective study involving 95 patients from two tertiary healthcare institutions in Australia showed improvements in the 6-minute walk distance (6MWD) and HRQoL, as assessed by the Chronic Respiratory Disease Questionnaire, after 6 to 8 weeks of PR. [16]

In this case, exercise intolerance and respiratory symptoms may exist although the TB patient has already completed TB treatment as a result of pathophysiological changes of the lung that lead to decreased pulmonary capacity. A retrospective study by Sevgi Ozalevli and colleagues found that pulmonary function tests (PFT) did not show any changes after a home-based exercise program. Similarly, research by Seema K. Singh and her team reported no significant improvement in PFT in patients with chronic lung impairment resulting from pulmonary tuberculosis.[2]

For patients in the active phase of TB, it is generally advised to have extended bed rest and avoid exercise. However, in typical cases of TB, avoidance of intense exercise might not always be necessary, except in special circumstances like severe haemoptysis. One notable study, which followed 454 TB patients over 7 years, involved a program combining exercise with drug therapy. This exercise regimen included arm, shoulder, elbow, and knee exercises (alternating between light and heavy), bicycle exercise, and occupational therapy. The findings indicated that an early initiation of a comprehensive pulmonary rehabilitation program could facilitate the social and work reintegration of TB patients post-hospital discharge.[3]

The results of this case suggest that a pulmonary rehabilitation (PR) program can significantly improve lung functional capacity by alleviating dyspnea and leg fatigue, boosting exercise capacity, and enhancing overall health-related quality of life. Consequently, incorporating such programs into treatment plans is highly recommended. Notably, this study found that aerobic exercise-based PR was safe for patients with hemoptysis, provided the exercise intensity was carefully adjusted. When combined with adequate treatment by a pulmonologist, patients not only experienced improvements in exercise tolerance and quality of life but also showed a reduction in hemoptysis symptoms during the rehabilitation program. There are no specific studies yet on PR in patients with hemoptoe. In fact, most patients are afraid to engage in physical activities due to these symptoms.

CONCLUSION

Pulmonary rehabilitation was beneficial for post-TB bronchiectasis patients with low cardiorespiratory endurance. A comprehensive program improves exercise tolerance, reduces symptoms, and enhances QoL. The above conclusions need to be verified in future research with specific studies.

DISCLOSURE

The authors, Fuji Mentari Ginting, Luluk Qurrota Aini, and Tengku Misdalia, report no conflicts of interest related to this study. The research was carried out independently without any financial support or sponsorship from commercial entities.

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