A Prospective Cohort Study on the Effects of Pulmonary Rehabilitation on Non-COPD Lung Disease

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Background --- Pulmonary rehabilitation is described as a multidisciplinary program of care that is individually tailored and designed to optimize physical and social performance and autonomy. The effects of pulmonary rehabilitation on COPD patients are well documented. However studies are limited on the role of pulmonary rehabilitation in patients with chronic lung diseases other than COPD. This study therefore aimed to determine the effects of the program on patients with non-COPD lung disease.

Methods --- This was a prospective cohort study involving non-COPD patients as well as COPD patients (which serves as comparator group) enrolled in the pulmonary rehabilitation program of the Philippine Heart Center. Six minute walk test as well as symptom-limited exercise testing was done at baseline and at the end of the eight week program.

Results --- There were 48 patients, predominantly female (31 females, 17 males), with a mean age of 62.3 years, with various pulmonary problems (kyphoscoliosis, asthma; bronchiectasis, and sequelae of tuberculosis), who were recruited in the pulmonary rehabilitation program. The mean FEV1 was 1.1 liters and the mean FVC was 1.7 liters. Ten of these patients were on oxygen therapy, using a mean of 2 lpm. After an 8 week rehabilitation program, results showed an improvement in exercise tolerance in the study population. An increase in the 6 minute walk distance covered and workload tolerated in the incremental symptom limited exercise testing on a treadmill were observed. A greater improvement among non-COPD lung patients was also noted when compared with the COPD group in the following parameters: the 6 minute walk distance test (p=0.000), the incremental symptom limited exercise testing (p=0.007) and the perceived breathlessness (p=0.015) and muscle fatigue (p=0.005) using the Modified Borg's scale in the post –rehabilitation 6 minute walk distance test.

Conclusion --- In conclusion, this study showed a significant improvement in exercise capacity, shortness of breath and muscle fatigue, in patients with pulmonary diseases other than COPD after undergoing pulmonary rehabilitation. Improvements demonstrated by these patients were observed to be significantly better than the COPD patients. Phil *Heart Center J 2007;13(2):139-143.*

Key Words: Pulmonary Rehabilitation ■ COPD ■ non-COPD ■ six-minute walk test ■ exercise testing ■ exercise training

Pulmonary rehabilitation is defined as an "evidence-based, multidisciplinary, and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decrease daily life activities. Integrated into the individualized treatment of the patient, pulmonary rehabilitation is designed to reduce symptoms, optimize functional status, increase participation, and reduce healthcare costs through stabilizing or reversing systemic manifestations of the disease.[1] The goal of pulmonary rehabilitation is to allow patients to work toward exploring the boundaries that ventilatory limitation places on them from physical, cognitive and emotional perspectives. Most published studies focus on pulmonary rehabilitation in chronic obstructive pulmonary disease (COPD) in comparison with asthma, cystic fibrosis, and pre- or post-lung transplantation. Pulmonary rehabilitation can offer much to patients with ventilatory limitation from other causes as it does in COPD.[2] In the study conducted by Foster and co-workers,[3] there was a significant improvement in the distance covered during the six minute walk test in both non-COPD patients and COPD patients. Non-COPD indications for pulmonary rehabilitation, include: asthma; chest wall disease ; cystic fibrosis; interstitial lung disease, including post ARDS pulmonary fibrosis; lung cancer; selected neuromuscular diseases; peri-operative states; post-polio syndrome; pre-lung and post-lung transplantation; pre-lung and post-lung volume reduction surgery. A prospective non-randomized open trial conducted over a 9 week period on patients with post tuberculosis by Ando 4 showed that there was an increase in the 6 minute walk distance after rehabilitation in both the post-tuberculosis group and COPD group by as much as 42m vs. 47m ($p<0.01$) respectively. In patient with

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idiopathic pulmonary fibrosis, the impairment of the quality of life areas, "physical health" and "level of independence" are important issues. Rehabilitation programs were found to enhance the quality of life of these patients.[5] The benefits achieved from rehabilitation programs extend beyond an increase in exercise ability. It includes a reduction of dyspnea and an improvement in health status. Comprehensive pulmonary rehabilitation is a standard of care in COPD patients. Similar benefits which include improvement in exercise capacity and shortness of breath can be observed in patients with chronic respiratory disease other COPD. This study therefore aimed to determine the effects and benefits of pulmonary rehabilitation on patients with non-COPD lung disease. Specifically, the study aimed to determine the effect of pulmonary rehabilitation on the distance covered during 6 minute walk test as well as the maximum workload tolerated during exercise testing. Also, the study compared the effects of pulmonary rehabilitation on non-COPD lung disease with COPD patients.

Methods

This is a prospective cohort study which included all non-COPD patients recruited in the pulmonary rehabilitation program of the Philippine Heart Center from January 1991 to December 2005. Entry criteria included the following: (a) Clinical diagnosis of non- COPD lung disease confirmed by history, physical examination, spirometry and chest roentgenogram; (b) stable condition for 2 weeks while receiving an acceptable medical regimen prior to entry, and (c) no unstable cardiac disease or other medical problem that would hinder a patient's participation in the program.

COPD patients enrolled in the pulmonary rehabilitation program the Philippine Heart Center were also included in the study for comparison. Entry criteria were as follows: (a) clinical diagnosis of COPD lung disease confirmed by history, physical examination, spirometry and chest roentgenogram; (b) stable condition for 2 weeks while receiving an acceptable medical regimen prior to entry; and (c) no unstable cardiac disease or other medical problem that would hinder a patient's participation in the program.

Baseline test

Each patient underwent pre-rehabilitation testing which included arterial blood gas analysis, six minute walk distance test and incremental symptom limited exercise testing using the treadmill.

Exercise Training

Rehabilitation sessions were done three times a week for 8 weeks. Upper body exercise training included unsupported upper arm exercises using the Qi-Gong (a Chinese arm exercise) done for 3 cycles and 6 repetitions and the upper body cycle ergometer. The lower body exercises included supervised walking on a treadmill with goal of walking continuously for 30 minutes and home walking exercises to the level similar to the treadmill. Perceived breathlessness and muscle fatigue were rated using Modified Borg's scale.[21]

Education

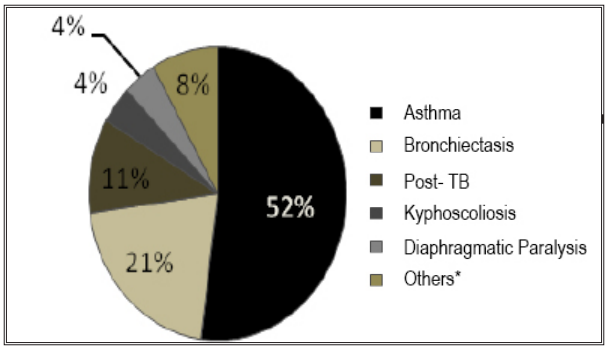
The education sessions consisted of lectures and discussions on the following topics: breathing strategies; normal lung function and pathophysiology of lung disease; proper use of medications, including oxygen; bronchial hygiene techniques; benefits of maintaining physical activities; energy conservation and work simplification techniques; nutrition; avoiding irritants and smoking cessation; indications for calling health provider; anxiety and panic control, including relaxation techniques and stress management and leisure, travel and sexuality; with the help of visual aids, slides, and videotapes. The assigned member of the rehabilitation staff (which includes the pulmonary physician, respiratory therapist, psychiatrist, and nutritionist) conducted the lectures for an hour twice a week.

Follow-up

At the end of the eight week program, each patient performed the six minute walk distance and the incremental symptom limited exercise testing utilizing identical protocols done at baseline. At the end of each test, perceived breathlessness and muscle fatigue were rated using the Modified Borg's scale.

Result

There were 48 non-COPD patients included in the study, 31 were females and 17 were males. Eighty two COPD patients were also recruited from the same pulmonary rehabilitation program to be a part of the investigation for comparison with the non-COPD population. Figure 1 shows the distribution of the diagnoses of the non-COPD patients.



**thymoma, post-cardiac surgery, pulmonary malignancy*

Figure 1. Distribution of Non-COPD paients according to lung pathology (n=48)

Table 1. Baseline Characteristics of included patients

Characteristics	Non-COPD Mean ± SD n=48	COPD Mean ± SD n=82	p-value
Age	62.3 ± 13.8	67.1 ± 10.3	***0.040***
Smoking(No. of pack years)	18.5 ± 28.4	38.8 ± 19.8	***0.004***
FEV1	56.3 ± 28.8	49.0 ± 23.7	0.159
FEV1 (liters)	1.1 ± 0.6	1.1 ± 0.6	0.893
FVC (liters)	1.7 ± 0.7	1.9 ± 0.7	0.198
FEV1/FVC	67.3 ± 18.3	58.6 ± 18.2	***0.020***

In comparison to the COPD group, the non-COPD group was relatively younger (p=0.040), had greater FEV1/FVC ratio (p=0.020), and with a smoking history that was shorter in duration (p=0.004). No significant difference was noted between the 2 groups except for the smoking history and the FEV1/FVC ratio (Table 1). There were 10 non-COPD who were on oxygen therapy utilizing a mean of 2lpm, while there were 9 COPD patients utilizing a mean of 1 lpm. No significant difference was noted between the 2 groups in terms of O^2 consumption. (p=0.307)

There was an increase in the workload tolerated using the incremental symptom limited exercise test using the treadmill in both the non-COPD and COPD group. Statistical analysis of the perceived breathlessness and fatigue did show significant change despite increase in the workload post- rehabilitation. This may be attributed to the improvement in exercise endurance (Table 2).

Table 2. Comparison between the pre- and post- rehabilitation treadmill exercise test parameters among the COPD and non-COPD groups

	Pre-rehabilitation Mean ± SD	Post-rehabilitation Mean ± SD	p-value
NON-COPD			
METS	5.0 ± 3.1	6.0 ± 3.6	*0.021*
Modified Borgs:			
Perceived breathlessness	3.3 ± 1.2	2.7 ± 1.3	0.061
Perceived muscle fatigue	2.7 ± 1.7	2.7 ± 1.4	1.00
COPD			
METS	3.3 ± 1.3	4.8 ± 2.0	*0.000*
Modified Borgs:			
Perceived breathlessness	2.9 ± 1.5	2.8 ± 1.3	0.835
Perceived Muscle Fatigue	2.6 ± 1.1	2.7 ± 1.3	0.950

A significant improvement in the six minute walk distance for both Non-COPD and COPD group post rehabilitation (p=0.00) was also noted, from a baseline of 293m to 578m post rehabilitation, and from a baseline of 294m to 372m post rehabilitation, respectively. (Figure 2). A significant improvement was also observed in perceived breathlessness using the Borg's scale in the non-COPD group (p= 0.039) which was not observed in the COPD group.

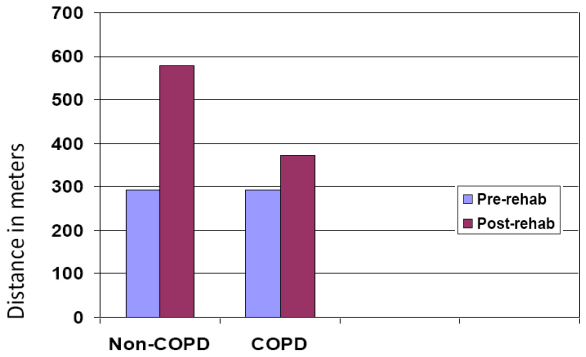


Figure 2. Six minute walk test results of the COPD and non-COPD groups, pre-rehabilitation and post-rehabilitation

Table 3. Comparison of the Incremental Symptom limited exercise testing on a treadmill between Non-COPD group and COPD group

	Non-COPD Mean ± SD	COPD Mean ± SD	p-value
Pre-Rehabilitation:			
METS	4.5 ± 3.2	3.3 ± 1.3	***0.007***
Modified Borg's:			
Perceived breathlessness	3.3 ± 1.3	3.0 ± 1.5	0.319
Perceived muscle fatigue	2.6 ± 1.6	2.8 ± 1.3	0.427
Post-rehabilitation:			
METS	6.2 ± 3.1	4.7 ± 2.1	***0.029***
Modified Borg's			
Perceived breathlessness	2.7 ± 1.3	2.9 ± 1.3	0.635
Perceived muscle fatigue	2.7 ± 1.4	2.7 ± 1.3	0.913

Comparing the two groups, the Non- COPD group performed better than the COPD group in the incremental symptom limited exercise test on a treadmill pre- rehabilitation and post rehabilitation.

On the other hand, the pre-rehabilitation 6 minute walk test was comparable between the 2 groups. But post rehabilitation, the non-COPD improved better than the COPD group in terms of distance covered (p=0.000), perceived breathlessness (p=0.015) and perceived muscle fatigue (p=0.005).

Discussion

Pulmonary rehabilitation is regarded as an important treatment modality in the management of patients with COPD. The beneficial effects of Pulmonary Rehabilitation had been well documented. It is widely accepted that Pulmonary Rehabilitation is beneficial in various non-COPD lung disorders, which includes cystic fibrosis, pulmonary fibrosis and restrictive thoracic disease. The American thoracic society cited the following non-COPD conditions as indication for pulmonary rehabilitation: asthma, chest wall diseases; cystic fibrosis interstitial lung disease, including post ARDS pulmonary fibrosis; lung cancer; selected neuromuscular diseases;

peri operative states; post-polio syndrome; pre-lung and post-lung transplantation; and pre-lung and post-lung volume reduction surgery. However, little evidence is available to indicate whether pulmonary rehabilitation is truly effective in the treatment of these lung disorders.[4]

The results of this study showed a significant difference between the non-COPD and COPD groups in terms of age and airflow obstruction. The non-COPD groups were younger, with less severe airflow obstruction. A significant improvement in the exercise performance post rehabilitation of the non-COPD patients in both exercise testing and the six-minute walk test. The results of the exercise tests of the non-COPD group improved significantly than the post rehabilitation results of the COPD patients. Foster and Thomas[3] compared the effect of pulmonary rehabilitation among COPD and non-COPD patients. He concluded that post rehabilitation, there was an improvement in exercise tolerance in non-COPD patients. The non-COPD group was very heterogeneous, which included neuromuscular disease, whose exercise tolerance could be limited by the disease itself. Crouch and MacIntyre[11] reported a similar comparison and also showed equivalent benefits of pulmonary rehabilitation among those patients. The study of Morihide Ando4 on patients with post tuberculosis lung disorder, were relatively homogeneous. Results also demonstrated the efficacy of pulmonary rehabilitation in non-COPD patients.

Our study, however, manifested more improvement in the non-COPD patients. The mean difference of the distanced walked pre- and post rehabilitation was 72.2 m. for the COPD group and 285.7 m. for the non-COPD group. A change of 54m had been suggested to be the minimum needed for clinical significance in a properly conducted 6MWT.[7] This could be ascribed to the fact that about 52% of the non-COPD subjects were diagnosed asthmatics and may not be severely impaired and are younger than the COPD group. On the other hand, COPD patients are limited primarily by ventilation limitation, physical deconditioning, brought about by their sedentary lifestyle, which affected their exercise capacity.

An improvement in exercise performance and a decrease in dyspnea using the Modified Borg's scale were demonstrated on post- rehabilitation testing. Of the various components of a pulmonary rehabilitation program, exercise training is the only one demonstrated in controlled clinical trials to enhance exercise endurance, dyspnea and quality of life.[1]

Improvements in exercise tolerance can be attributed to one or more of the following mechanisms: physiologic changes, improved efficiency, better coordination of neuromuscular activity and desensitization to dyspnea. [12] The patients in this study underwent maximum intensity exercises. This advocates training intensity targets near the maximally tolerated work rate for patients, which was about 80% of their maximum peak work rate. Patients with chronic lung disease are limited by their ability, and not by limits of muscle metabolism. It was postulated that, in order to be effective, a training program must involve exercise intensities associated with lactic acidosis. Patients who exercise at high intensities associated with lactic acidosis demonstrated greater evidence of a physiologic training effect.[13] The level of the lactic acidosis in our non-COPD patients was not determined. Further studies in the future may be recommended to provide data on this matter.

A patient's level of exertional dyspnea is markedly reduced after exercise training. Previously, the benefits gained were thought to be purely psychological. In patients with COPD, dyspnea correlates better with general health status than with the degree of airflow obstruction,[14] suggesting this symptom is complex and probably modulated by non-physiologic as well as physiologic factors. It has been shown that anxiety, depression, hysteria, degree of social support, grief, anger, frustration, fear, and past-life experiences may all affect perception.[15] KC Ong showed that patients have "desensitized" to their symptoms with frequent episodes of breathlessness while undergoing exercise training. A measure of dyspnea of fatigue (VAS or Borg) alongside is considered to increase the sensitivity of exercise measurements.

The limitations that could be cited in our study include heterogeneity of the non-COPD study population and non-rehabilitation of control patients could not be made for ethical reasons. The proponents of the study recommend a prospective randomized controlled study to be undertaken, and ideally, a study with large sample size is recommended for non-COPD, wherein each non-COPD disorder is well represented, to show statistical equivalence.

Conclusion

In conclusion, this study showed a significant improvement in exercise capacity using the incremental symptom limited exercise tolerance test and six minute walk test as outcome measure in patients with pulmonary diseases other than COPD after undergoing pulmonary rehabilitation. Improvements demonstrated by the Non-COPD lung disease patients were observed to better than the COPD patients.

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