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Impact of pulmonary rehabilitation on lung functions and quality of life in chronic respiratory disease patients

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ABSTRACT

Introduction: Patients with chronic pulmonary disease commonly present with dyspnea, cough, fatigue, physical limitations, and low Quality-of-Life (QoL). With these morbidities and physical limitations, it may be difficult to perform their day-to-day activities. The London Chest Activity Daily Living (LCADL) scale assesses the self-reported dyspnea of patients with chronic respiratory disease during Activities of Daily Living (ADL). The study was designed to assess the impact of pulmonary rehabilitation on the dyspnea grade (mMRC scale), the Quality-of-Life parameters viz LCADL scale, 6 Minute Walk Test (6MWT) and lung functions (FEV1 & FVC).

Materials and Methods: The study is a retrospective observational study conducted over a period of 1 year, at the Department of Pulmonology, Bhakti Vedanta Hospital & Research Institute. Patients with different pulmonary conditions such as Chronic Obstructive Pulmonary Disease (COPD), Interstitial Lung Disease (ILD), Post-covid Lung Dysfunction, etc. were enrolled in the study. A total of 80 patients were referred to Pulmonary Rehabilitation (PR). Out of which, 40 patients completed an 8-week program. The distribution of the study population was as follows: 18 patients with COPD, 13 patients with ILD, 9 patients with other pulmonary diseases. 15 patients required oxygen support where oxygen saturation (SpO2) was < 90% at baseline at room air. The outcome measures were assessed in these patients at the time of enrollment (Week 0) and at the end of the program (Week 8).

Result: Overall, the statistically significant difference noted in Quality-of-Life parameters like LCADL score, mMRC, 6MWT, and lung functions (FEV1, FVC) with an 8-week Pulmonary Rehabilitation program.

The p-value (< 0.001) was found in London Chest Activity Daily Living (LCADL) score. Domestic, physical activity had better scores with respect to all parameters after completion of the 8-week Pulmonary Rehabilitation (PR) program. The dyspnea grade on the mMRC scale improved from 1.9 ± 0.591 to 0.45 ± 0.50. The p-value was statistically significant (p < 0.001). 6 MWT distance was improved from 169.5 meters to 324.5 meters at the completion of 8-weeks, the mean difference was 155 meters which was found to be statistically significant. The p-value (< 0.001) was found in 6MWT distance. In lung functions, FEV1 improved from 52.30 % to 56.73 % of predicted and FVC improved from 56.20 % to 58.20 % of predicted. The mean difference of FEV1 and FVC was 4.43 to 2.0, respectively.

Conclusion: An 8-week supervised pulmonary rehabilitation program has demonstrated that the inclusion of pulmonary rehabilitation, not only reduces the symptoms but also improves the exercise capacity and add significant positive effect on the quality of life as well as lung functions in patients with chronic respiratory disease.

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1. Introduction

Chronic pulmonary disease is a complex disease characterized by slowly progressive airflow limitation, which is reversible or non-reversible.[1] This disease includes heterogeneous conditions with different clinical, functional, and radio logical features, and it is associated with several comorbidities.In ILD patients persistent inflammatory process and formation of fibrotic tissue, structural and mechanical pulmonary system alterations are observed and considered main cause of pathological reduction of pulmonary and cardiovascular functions.[2,3] For instance, patients reported exhibiting reduced static and dynamic lung volume.[2] Moreover, the diffusing capacity is also impaired. Collectively, these pathological reduction in cardiopulmonary function to an increase in exertional dyspnea and exercise intolerance; thus. ILD patients tend to avoid situations where they might experience breathlessness, fomenting a cycle of reduced physical activity levels, low exercise tolerance and fatigue, leading to poor health related quality of life and an increased sedentary lifestyle and an increased risk of exacerbations and death.[3]

Pulmonary rehabilitation (PR) is one of the most cost-effective treatments for chronic pulmonary disease.[4] It is standard core elements are physical exercise training, patients-directed education, self-disease management and behavior changes.[5] Clinical practice guidelines across the world suggests pulmonary rehabilitation. Pulmonary rehabilitation is regarded as the hallmark of treatment in all chronic respiratory patients.[6]Typically, the pulmonary rehabilitation program is implemented by multidisciplinary teams in the outpatient department pulmonary rehabilitation reduces dyspnea and fatigue and improves exercise endurance and many areas of health-related quality of life (HRQOL). Pulmonary rehabilitation is aimed to decrease symptoms, optimize functional state, increase participation, and reduce health-care costs through stabilizing or reversing systemic manifestations of the disease".[7] The practical need of pulmonary rehabilitation occurred because patients with a respiratory disease are highly symptomatic, need frequent hospitalizations, are physical deconditioning, and have reduced day to day activity. From these observations it also came out the particularity of pulmonary rehabilitation intervention namely that it primarily addresses the subjective aspect of disease, represented by the persistence of symptoms and the degree of disability.[8] As exercise training is a main component of PR programs it is important to accurately measure an individual's exercise outcomes. 6-minute walking tests have been commonly used to assess changes in functional exercise capacity as they are low cost, require minimal equipment and reflect daily living.

The London chest activity daily living scale is used is frequently used to analyze dyspnea limitation during exercise and activitites of daily living (ADL) accomplishment in chronic respiratory disease patients.[9] Quality of life is an important domain for measuring the impact of chronic disease. We are using the LCADL scale. The London Chest Activity of Daily Living (LCADL) scale is reliable and valid to assess functional status in chronic lung disease. It addresses 15 activities of daily living commonly performed by patients to assess the level of dyspnea during ADL. It has four domains: self-care; household activities; physical activity; and leisure activities.[10,11] Each question in each domain is scored by patients on a 0-5 scale with 5 representing the greatest dyspnea related impairment in ADL. The LCADL scale, which is considered an inexpensive and user-friendly instrument, can be a feasible clinical tool for assessment and monitoring of dyspnea-related functional impairment in chronic lung disease patients, as well as for pre- and post-intervention assessment. Wholesome platter where therapy gets individualized as per patients, capabilities, and requirements. In totality recruits all the peripheral muscle functioning, enhances endurance of various groups muscle, helps with coping strategies, breathing techniques and provides psychological and nutritional support. Thereby, allowing the patients to participate better in their activities around and improving their quality of life. Our study focuses upon the various beneficial aspects of an 8-week PR program on patient with respiratory disease patients.

The ATS Guidelines summarized the role of pulmonary rehabilitation for chronic respiratory disease patients have three primary roles 1) Improving exercise capacity. 2) Improving dyspnea. 3) Improving quality of life. The components of pulmonary rehabilitation may vary but evidence-based practice for program delivery includes structured, supervised & individual tailored exercise training and self-management educations.[12]

There was no study which compared the improvements of structural, functional capacity after pulmonary rehabilitation between different lung conditions. The aim of this study was Impact of lung function & quality of life in chronic respiratory disease patients.

1.1. Article highlights

1. Chronic pulmonary disease is a heterogeneous clinical syndrome. PR as comprehensive individualized intervention based on a thorough assessment of functional, emotional, and social traits is a complex management strategy to implement.
2. PR is a multifaceted, multidisciplinary management approach with individually tailored interventions requiring full understanding of mechanisms underlying patient's experienced disease burden.

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3. Improving functional performance as part of PR is more than exercise-based care and needs to integrate new innovative interventions based on profound pathophysiological.

2. Objectives

1. To study the effect of London chest activity daily living scale score Pre & post rehabilitation (LCADLS).
2. Assess the effects of dyspnea grade pre and post rehabilitation.
3. Compare the 6 MWTD pre & post rehabilitation.
4. To study the changes in FEV1 & FVC in rehabilitation.

2.1. Inclusion criteria

1. Clinically stable chronic respiratory disease.
2. Both Gender included.
3. Age 30 to 70 years.
4. Dyspnea grade at least 1(MRC) scale.
5. Who have PFT done?

2.2. Exclusions criteria

1. Unstable Vitals.
2. Severe exercise-induced hypoxemia, not correctable with O_2 supplementation.
3. Angina pectoris, recent myocardial infarction, severe pulmonary hypertension.
4. Recent surgical or any other musculoskeletal injury.
5. Psychiatric illness, dementia.

3. Materials and Methods

A total of 80 patients with diagnosed chronic respiratory disease were referred for pulmonary rehabilitation OPD in the chest department over a period of 1 year. Out of these 40 patients enrolled into the program. Patients with clinically stable mild to moderate obstructive & restrictive condition were included in the study. The diagnosis lung disease was based on the pulmonary function test with detailed history & HRCT. As a prerequisite to enrollment, all patients underwent a detailed assessment of clinical history, investigation, and comorbidity status assessment by a Pulmonologist by any other fraternity physicians were needed. A written informed consent was obtained. The study population included 14 male and 26 females. With the mean age of 56.3± 13.6. The outcome measures namely quality of life (LCADLS), aerobic capacity (6MWTD), and MRC grade, functional capacity (PFT) was assessed in these patients when they enrolled into the program (0 week) and at the end of the program (8 week).

3.1. Exercise prescription

3.1.1. Goals

Physical reconditioning, respiratory muscle training and upper and lower extremities strengthening exercises.

Breathing training comprised of breathing technique (pursued lipped, Diaphragmatic breathing, intercostal and segmental), pacing and energy conservations.

Lower limb: lower limb muscle dysfunction is largely responsible for exercise limitation in respiratory disease patients.[11] Exercise training has muscle group specific effects and lower extremity training provides the best physiological gains, according to the present evidence-based guidelines.[1,2,12] Lower exercise training usually done by level walking, treadmill walking, cycling, modified weightlifting may be considered.

Upper limb: upper extremity training is useful as it has been shown to decrease oxygen demand and increase arm muscle capacity at similar work level following pulmonary rehabilitation, arm weightlifting.

Combined upper & lower limb training results in significant improvement in exercise performance and health related quality of life.

Type of exercises. Patients were subjected to a structured program which was individually tailored to each patient according to their level of functional impairment, severity of disease like (Grade of dyspnea, hypoxemia), presence of co morbid disease and any other potential factors that could limit intensity or safety of exercise. patient's mandatory exercised for 45 to 60 minutes, 2 to 3 times a week for 8 weeks. The program focusing on endurance training, strength training, and flexibility is the cornerstone of pulmonary rehabilitation. The goal is to improve patients aerobic capacity and muscle strength.[13]The exercise load and repetitions are increased over a time in supervised fashion to help build up strength, muscle mass, endurance. The best strategy is to include endurance training or interval training along with resistance The training in individual exercise plan as it is known to confer best benefit than individuals components by themselves.[14]

Reassessment on the end of the 8th week, hemodynamic measurement (BP, PR SPO2), Dyspnea grade by MRC scale, quality of life LCADL score (London chest activity daily living sale), 6-minute walk distance, pulmonary function.Table 1

3.2. Statistical analysis

Data was entered into Microsoft Excel and analyzed using Stata Version 13. For linear variables, mean, medians, standard deviation, and Inter Quartile Ranges (IQR) were calculated and for categorical variables, proportions were used. Paired t-test was used to compare mean between two groups (pre-and post-means respectively). Distribution of continuous variables across multiple groups were assessed

Table 1: Exercise training session was composed of.

Warm up & cool down	Endurance training	Strength training	Flexibility exs
ROM exs Breathing es 5 to 10 min	Level Walking (60-80%)/Treadmill walking, Cycling. 10 to 15 min	Upper limb free weight, lower limb ankle weight. (50 to 85% of the 10 RM), Pelvic floor muscle training. 15 to 20 min	Stretching exs (TheraBand, Thera tube,) Postural corrections exs, Core muscle training exs, Balance training exercise.

using the Kruskal Wallis test.

p Value of less than 0 05 was statistically significant

4. Results

A total 80 patients were referred for pulmonary rehabilitation over a period of 1 June 2022 to 30 December 2022 at pulmonary rehabilitation department, 59 patients got enrolled in the study. 40 patients completed 8 weeks, 19patients completed 6-week PR, 12 Patients completed 4-week PR, 31 patients not enrolled in PR Program. Overall 18 patients diagnosed COPD, 13 Patients ILD, 9 patients' other conditions (OSA, Post-COVID, Bronchiectasis). LCADL score, MRC grade, 6MWTD, pulmonary function test, could show statistically significantly difference, pre and post PR Program as depicted in Table 2 around 40 patients could successfully finish 8 weeks of PR Program. We found that pulmonary rehabilitation had beneficial effects on the patients, both subjectively and objectively at the end of the 8 weeks as depicted inTable 2.

We found that pulmonary rehabilitation had beneficial effect on patients both subjectively and objectively at the end of 8^{th} week as depicted in Table 3. Effects of PR Program pre & post on patients' parameters. Distance walked on the 6 MWT increased by 20%; dyspnea score decreased by 6.4%; quality of life (LCADLS) score reduced disability; FEV1 & FVC had improved 5.6%. Improvement, in 6MWT, LCADLS, MRC grade, were greater than the MCID (Minimal clinically import.

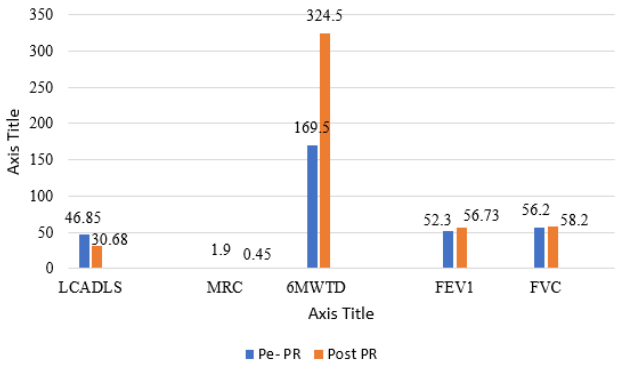

Figure 1: Effects of PR, Pre & Post parameters

Figure 1 A graph showing the parameters for which statistically significant differences were observed in patients who participated in an eight-week PR program.

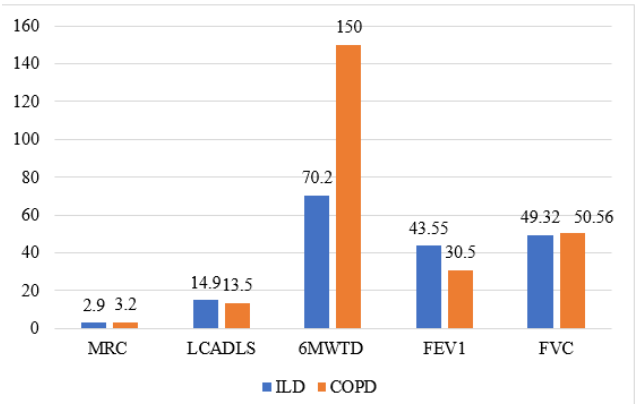

Figure 2: Response of PR in ILD & COPD

Figure 2 & Table 4 showed significant difference in the ILD & COPD patients Improved MRC Grade reduced, LCADL score reduced, FEV1& FVC improved post rehabilitation.

Table 5 & Figure 3 showed that control group parameters, 6MWTD, LCADL significant but, MRC Grad&FEV1, FVC not significant.

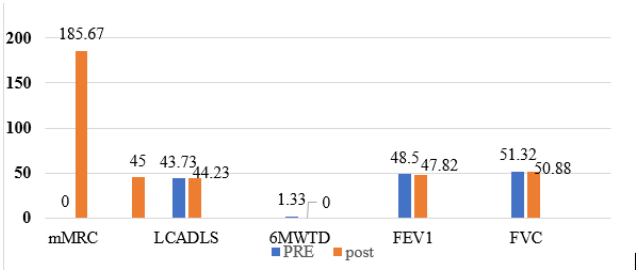

Figure 3: Effect on control group parameters pre and post 8th week PR .

Figure 3 Showed control group parameters, mMRC grade increased post 8^{th} week, 6MWT distance reduced, LCADL scale score had same, FVC&FEV1 no improvements.

5. Discussion

We showed that the 8-week PR program has improved exercise capacity, quality of life and lung function of a chronic respiratory disease, PR Program in a specialized center on patients with chronic respiratory disease patients.

Table 2: Baseline characteristics of all parameters.

Baseline characteristics Variables	PR GroupPreMean & SD n=40	PR GroupPostMean & SD n=40	Control GroupPreMean & SD n=40	Control GroupPostMean & SD n=37
MRC Grade	1.9±0.591	0.45±0.50	1.33-0.479	0.87-0.34
LCADL score	46.85±6.923	30.68±7.25	43.±12.32	44.23±6.04
1-Self care	8.71±12.32	7.60±11.20	7.74±11.5	8.50±12.5
2-Domestic	13.5 ±9.3	8.8±2.05	12.49±8.5	11.5±7.5
3-physical	6.54±-0.45	5.5±0.30	7.56±1.40	6.7±1.60
4-Leisure	6.40±2.20	5.30±2.10	6.49±3.0	7.50±4.5
6MWTD	169.5±68.5021.	324.5±71.515	155.33±33.08	185.67±45.0
FVC	56.20±3.24	58.20±2.70	48.50±6.9	47.82±6.6
FEV1	52.30±3.23	56.73±3.05	51.32±2.98	50.88±2.30

Table 3: Effects of PR Program pre & post on patients' parameters.

variable	Pre-PRn=40 Mean±SD	Post-PRn=40 Mean±SD	P value
LCADLS	46.85±6.923	30.68±7.259	<0.001
MRC	1.9±0.591	0.45±0.50	<0.001
6MWTD	169.5±68.502	324.5±71.515	<0.001
FEV1	52.30±3.23	56.73±3.05	<0.05
FVC	56.20±3.24	58.20±2.70	<0.05

LCADL-London chest activity daily living mMRC-modified medical research council.

Table 4: Response to PR.

Variable	ILDn=15 Mean±SD	COPDn=19 Mean±SD	P Value
mMRC	2.9±1.3	3.2±1.0	<.001
LCADLS	14.9±5.8	13.5±3.4	<.001
6MWTD	250±3.2	330±10.2	<.001
FEV1	58.3±3.5	53.5±4.5	<.004
FVC	49.5±2.6	56.3±6.8	<0.05

Table 5: Effects on control group parameters after 8 weeks.

Parameters Control group	Pre-PRMean±SD. n=40	Post-PR Mean±SD. N=30	P value
6MWTD	155.33+33.086	185.67±45.0	<0.001
LCADL	43.73±7.965	44.23±6.463	<0.001
MRC	1.33±0.479	1..87±0.734	>0.0002
FVC	48.50±6.9	47.82±6.6	>0.482
FEV1	51.32±2.98	50.88±2.30	>0.45

Our data demonstrate that PR is beneficial in these patients and appears to be a valuable adjunct therapy.

Our results show statistically significant all the parameters. (LCADL, 6MWTD, FEV1). Among non-pharmacological interventions treat these clinical entities, regular exercise is known to be a low-cost solution to improve health, well-being, and economic productivity of patient's chronic lung disease, especially for those with ILD, in whom conventional pharmacological treatment has shown a limited response.

LCADL score was pre 46 points to after 8 week PR 30 points for the PR group and for the control groups, 43 to 44 score respectively. Therefore, the control group presented higher LCADL scores than the PR group.it mean that. Control group patients leads to higher dyspnea perception which leads to a lower ability to perform activities of daily living.

LCADL score >28% had worse pulmonary function, dyspnea & health related quality of life 15 patients required oxygen support (where spo2<90% at baseline). Use of oxygen during rehabilitation has been shown to help an individual to undergo moderate intensity exercise training. Oxygen is supplied continuously or on demand basis, according to the need of individual patients.

This study has shown support for the hypothesis that dyspnea during routine activities leads to significant disability in chronic respiratory disease. Total score LCADL Score was in the present study 69% of the patients in the sample achieved a total LCADL score. The improvement in dyspnea, evaluation was matched with Tonelli et al.,[15]

Baradzina et al. who demonstrated a decline in mMRC score was statistically significant difference after the PR Program.

5.1. Dyspnea & quality of life

Health related quality of life can be defined as "the gap between our expectations of health and our experience of it".[14] A primary aim of the treatment of chronic disease is to enhance quality of life by reducing the impact of the disease. However, the relationship between symptoms and exercise capacity, or functional limitation and quality of life, is neither simple nor direct. Therefore, we explored the association between dyspnea & quality of life.

A Dyspnea grade clinical improvement in dyspnea was observed > 50% of the patients, in line with existing evidence on the benefits of PR in patients' chronic respiratory disease patients.[12] This result demonstrates that patients with chronic respiratory disease already experience restrictions in their daily life due to dyspnea and that PR has the potential to reverse this situation. Regarding the effect on day-to-day activities, a change in LCADLS score pre & post mean difference was -2 to -5.9 points. This change is MID, MID range for LCADL total range -3.88 obtained by Bisca et al.,2014.

Quality of life was also associated with decreased dyspnea in all the patients ,which is consistent with a previous study that identified HRQoL to be adversely and independently associated with respiratory symptoms (dyspnea, wheeze, and cough, fatigue, leg pain), age and female gender.[15] where the advancements in medicine still facing challenges offering enthusiastic options in pharmacological therapies to this subset of patients, at least PR helps by alleviating the symptoms which is of a paramount importance by preventing them from falling in the vicious cycle of deconditioning and poor exercise tolerance. Benefits in QOL and symptoms cannot be ignored, indicate to continue PR as regular part in patients care.

5.2. Effects on exercise capacity (6MWT)

The post PR found significant improvement in 6MWTD of 324m±(76.6) m which was 20.8% of the baseline value. The mean difference in distance covered pre and post PR was the change was 155m, which was clearly more than minimal clinically important distance. When ILD Patients were analyzed 56 m gain was noted in 6 MWTD was found. In COPD patients 64 m is accepted as significant. Across the world when literature on ILD and COPD patients was analyzed, our findings matched almost all the available work in this area. Holland et al.[16] may conclude that between 29 to 34 m in ILD Patients is significant improvement functional capacity in this population. In ILD Patients Ryerson and colleagues showed how a lower baseline 6MWD could predict larger improvement in distance covered after PR.

5.3. Effects on FEV1& FVC

PR has been proven that significant difference in FEV1 & FVC after PR. Pre PR FEV1 52.30 & Post PR 56.73 mean difference was 5.3. This result had a better baseline score compared with the patient's previous study. Cristina et al., Pre PR FVC 56.20 & post PR was 58.20, the mean difference was pre & post 2.40. The MID range 0.08 to 0.1.L.[17] We noted an improvement in FEV1& FVC after PR, which indicates that PR can be beneficial to lung function in patients with chronic respiratory disease.

FEV1 & FVC The current study investigated the possible effect of PR on some spirometry parameters FEV1. There was statistically significant improvement between the PR group pre & post, there was greater improvement in the PR groups than the control group at 8 weeks.

There is a good rationale for the use of PR in chronic respiratory disease. Exercise training aerobic capacity, muscle strength and flexibility, contributing to less dyspnea on exertion and improvement of functional status.

Supervised PR maintenance program is effective in the early stages to better tailor exercise training to the patient and thereby increase program compliance,[2–4] and can replaced by non- supervised sessions, maintaining a good impact on functional capacity, and decreasing health system burdens.

6. Conclusion

Pulmonary rehabilitation is a scientifically endorsed modality for patients with respiratory diseases. We documented improvement in quality of life, which is lesser symptoms and improved exercise capacity. It's no longer all about comfort zone that patient gets, it has rather emerged as a measure that imparts statistically significant enhancements patients care in term of both subjective and objective parameters.

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8. Conflict of Interest

None.

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None.

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