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Impact of Home-Based Pulmonary Rehabilitation (PR) Program on Patients with Severe Chronic Obstructive Pulmonary Disease (COPD) and Interstitial Lung Disease (ILD) Who are on Long Term Oxygen (O_2) Therapy (LTOT)

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ABSTRACT

Introduction: Prevalence of chronic lung diseases such as COPD and ILD is increasing at a very alarming rate in India. The most challenging aspect in their management; is the maintenance of optimal saturation levels with minimal oxygen. Home-Based pulmonary rehabilitation (PR) program may play a promising role in not only preventing oxygen dependency but also alleviating the risk of frequent hospitalization.

Objective: To understand the impact of home-based PR program in patients with ILD and COPD who are on Long-Term Oxygen Therapy (LTOT).

Materials and Methods: We selected 27 COPD and 18 ILD stable patients who are on LTOT; for an 8-week home based PR program. Baseline assessment of Exercise capacity, Lung function and dypsnea levels were measured every week. At the end of the 8th week, we analyzed the duration and flow of 0_2 required to maintain an acceptable saturation >88% and compared it to the baseline levels.

Results and Discussion: Following the PR program, we found that the duration and amount of supplemental 0_2 requirement gradually dropped from 3(± 0.9)l/min and 17(±4.5)hours to 1(±0.4)l/min and 7(1.7) hours. Also, 6-MWT test results showed improvement (p=0.05). Both the disease groups were comparable anthropometrically and showed a similar pattern of improvement with PR.

Application: Adherence to PR will bring about a positive impact on day to day functional capacity.

Conclusion: PR therefore should be considered as a modality for management of chronic lung diseases.

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INTRODUCTION

Chronic diseases are the largest cause of death in the world and chronic lung diseases accounts for 4 million death across the world. Disability due to chronic obstructive lung diseases are increasing manifold in various regions of the world[4]. Maintaining an optimal saturation level in patients with chronic lung diseases such as Chronic Obstructive Pulmonary Disease (COPD),Interstitial lung disease(ILD) has always been a challenge. Also, patients with chronic lung diseases have both physical as well as psychological limitations due to which their quality of life is unsatisfactory.[6]Many researchers have found a promising role of pulmonary rehabilitation which is an evidence-based, multidisciplinary and comprehensive intervention for patients with chronic lung disorders who are symptomatic and have some disability.[5][7]This therapeutic approach typically combines exercise

training along with patient education with the goal to improve the quality of life and alleviate the risk of frequent re- hospitalizations.

High flow and long term oxygen therapy for greater duration has been found to cause oxygen dependency, decrease in physical ability and most importantly stress and negativity among patients. [8] According to a study conducted in India by Raksha Thakrar, et al, in the year 2014 it was found that there is a lack of awareness regarding the benefits of Pulmonary rehabilitation.[9]This lack of awareness is the major cause why most patients are reluctant to take up exercise training programs.

The focus of this study is to not only assess the effectiveness of pulmonary rehabilitation program in decreasing the need for long term oxygen therapy (LTOT), but also to spread the awareness among the patients regarding the effectiveness of daily exercise sessions.

METHODS

SUBJECTS AND STUDY DESIGN

Forty-five patients with clinical diagnosis of Chronic Obstructive Pulmonary Disease (COPD) or Interstitial Lung Disease (ILD), after discharge from the hospital who were asked to take up pulmonary rehabilitation program by the clinician, were enrolled for the study. All the patients had a history of their known illness for more than five years, and were prescribed with 2-5 litres/minute supplemental oxygen at home, for duration of 8-24 hours in a day.

The home based pulmonary rehabilitation was an 8-week program that consisted of daily two times 60 minutes morning and evening exercise sessions. The program included integrated **endurance** training activities (walking, thera-band exercises, inspiratory muscle training exercises and breathing exercises) and **strengthening** exercises (dumbbell exercises).

Prior to enrolment of the patients, a baseline assessment of all the patients was done after taking their written consent; which included a complete medical history, Spirometry tests,6-Minute Walk Test along with assessment of dyspnea using Borg Dyspnea scale. Patients were included if they had not participated in a pulmonary rehabilitation programme in the past 12 months and were in a stable state (no exacerbation of their disease in the preceding month) at study entry. Any patient with a history of recent surgery, blood disorders, immune disorders, nervous disorders, psychological and cardiovascular disorders or those who were found to be dependent on ventilatory support were not included in the program.

All the patients were given at least two counseling and practice sessions before enrolling them in the study. Any patient who was declared to be unfit by the clinician for exercise training were excluded from the study. After enrollment in the first week of the program, every alternate week (i.e 2nd week, 4th week, 6th week and 8th week), Spirometry and Six minute walk test (without supplemental oxygen)were performed and dyspnea level at rest using Borg Dyspnea Scale[3] was also assessed.

SPIROMETRY-Spirometry test was conducted on the participants prior to which anthropometrical parameters such as height (in cm) and weight(in kg) were measured using FREEMANS Max 3m:16mm Measuring Tape and Equinox Personal Weighing Scale- respectively. Age of the participants was self reported by them. Saturation was measured by Fingertip Pulse Oximeter model no MD300c228; The precise technique of performing spirometry in the present study was based on the operation manual of the instrument with special reference to the official statement of the American Thoracic Society (ATS) of standardization of spirometry[1]. Both pre and post-bronchodilator testing using formeterol was undertaken and best reading were recorded.

6-MINUTE WALK TEST-The Six Minute Walk Test (without supplemental oxygen) was performed following the guidelines of the American Thoracic Society[2]

Endurance and Muscle Strengthening exercises

In the 1st week- A preliminary 30- minute exercise training session consisted of 10 minutes of warm-up exercises such as Arm circles, general mobility exercises and stretching exercises, 6 sets of thera-band exercise,15 minutes of breathing exercises such as 5 sets of Pursed lip breathing, diaphragmmatic breathing, butterfly breathing and bubble breathing, 3 minutes of inspiratory Muscle training exercise using threshold IMT device with a inspiratory resistance load of 10cmH_20, 2 minutes of upper limb strengthening exercise using dumb-bells with 0.5-1.5 kg weights. **In the 2nd week-**A -40 minute exercise training session consisted of 10 minutes of warm-up exercises such as Arm circles, general mobility exercises and stretching exercises, 8 sets of thera-band exercise, 20 minutes of breathing exercises such as 6 sets of Pursed lip breathing, diaphragmatic breathing, butterfly breathing and bubble breathing, 6 minutes of inspiratory Muscle training exercise using threshold IMT device with a inspiratory resistance load of 10cmH_20, 4 minutes of upper limb strengthening exercise using dumb-bells with 2-4 kg weights. **In the 4th week-**A 50 minute exercise training session consisted of 5 minutes of warm-up exercises such as Arm circles, general mobility exercises and stretching exercises, 10 sets of Thera-

band exercise, 30 minutes of breathing exercises such as 8 sets of Pursed lip breathing, diaphragmmatic breathing, butterfly breathing and bubble breathing, 9 minutes of inspiratory Muscle training exercise using threshold IMT device with a inspiratory resistance load of 10-15cmH_20, 6 minutes of upper limb strengthening exercise using dumb-bells with 4-6 kg weights. **In the 6thweek-**A 60 minute exercise training session consisted of 5 minutes of warm-up exercises such as Arm circles, general mobility exercises and stretching exercises, 10 sets of Thera-band exercise, 25 minutes of breathing exercises such as 10 sets of Pursed lip breathing, diaphragmmatic breathing, butterfly breathing and bubble breathing, 5-6 minutes of inspiratory Muscle training exercise using threshold IMT device with a inspiratory resistance load of 15-30cmH_20, 15-20 minutes of upper limb strengthening exercise using dumb bells with 0.5-1.5 kg weights **In the 8th week-**A 60 minute exercise training session consisted of 5 minutes of warm-up exercises such as Arm circles, general mobility exercises and stretching exercises, 20-30 sets of Thera-band exercise, 30 minutes of breathing exercises such as 10-15 sets of Pursed lip breathing, diaphragmmatic breathing, butterfly breathing and bubble breathing, 3-4 minutes of inspiratory Muscle training exercise using threshold IMT device with a inspiratory resistance load of 25-45cmH_20, 20minutes of upper limb strengthening exercise using dumbells with 0.5-1.5 kg weights.

(Flexibility was allowed with regards to repetition of sets and duration of exercise sessions as in accordance to the tolerance level of the patient. In an event of de-saturation, the exercise program for the day was terminated.)

RESULTS

TABLE 1- CHARACTERISTICS OF THE STUDY PATIENTS.

CHARACTERISTICS	TOTAL N=45	ILD N=18	COPD N=27	p-VALUE
GENDER Male Female	 30(66.7) 15(33.3)	 11(61.1) 7(38.9)	 19(70.4) 8(29.6)	0.001
HEIGHT(CM)	*163(7.6)	*164(6.5)	*163(8.2)	0.45
WEIGHT(KG)	*52(6.9)	*51(8.1)	*52(6.3)	0.62
BMI	*20(3.5)	*19(3.7)	*20(3.4)	0.47
SMOKING HISTORY Ex-Smoker Non-smoker	 16(100) 29(100)	 9(56.2) 9(31.0)	 7(43.8) 20(69.0)	0.98
AGE	* 63(8.9)	* 62(9.2)	* 63(8.8)	0.62
OCCUPATION Professional Group Non-Professional Group	 32(100) 13(100)	 12(37.5) 6(46.2)	 20(62.5) 7(53.8)	0.59
Note: *values are mean (standard Deviation); others are count(percentage);BMI, Body Mass Index; *p* by Pearson Chi-Square test ,and p of * values by ANOVA.				

The overall anthropometrical parameters such as Age, Height, Weight and Body Mass Index (BMI) showed no significant difference between the groups of patients. Also the smoking history and occupation showed no difference. Hence, the two groups of patients are comparable statistically.

TABLE II- CHANGES IN THE PARAMETERS OVER VARIOUS WEEKS OF THE PROGRAM

PARAMETERS N=45	WEEK-0 N=45	WEEK-2 N=45	WEEK-4 N=45	WEEK-6 N=45	WEEK-8 N=45	P-VALUE
1.SUPPLEMENTAL OXYGEN REQUIREMENT (in Litres/min)	3.40(0.9)	2.84(0.8)	2.54(0.7)	1.83(0.4)	1.20(0.4)	0.04
2. DURATION OF SUPPLEMENTAL OXYGEN REQUIREMENT. (in Hours/Day)	16.84(4.5)	15.73(4.1)	14.18(3.9)	11.40(2.9)	6.80(1.7)	0.05
3.SIX MINUTE WALK TEST (in Meters)	35.44(6.3)	36.84(5.5)	38.47(5.3)	38.47(5.3)	44.20(4.8)	0.05

4. CHANGE IN SATURATION (In %)BEFORE AND AFTER SIX MINUTE WALK TEST EACH WEEK	4.08(1.9)	3.95(2.1)	4.02(2.1)	3.95(2.1)	3.42(2.0)	0.05
5. CHANGE IN SATURATION (In %) AFTER SIX MINUTE WALK TEST COMPARED TO WEEK 0	-	0.60(0.6)	1.53(1.1)	2.35(1.2)	3.84(1.4)	0.04
6.FORCED EXPIRATORY VOLUME (in Litres/minute)	0.50(0.2)	0.51(0.1)	0.51(0.1)	0.51(0.1)	0.52(0.1)	0.05
Note: Values are mean(Standard Deviation); p-value *p* by ANOVA.						

Table 3-COMPARISON OF THE EFFECTS OF PULMONARY REHABILITATION IN ILD AND COPD PATIENTS

PARAMETERS	ILD N=18	COPD N=27	p-VALUE
1.SUPPLEMENTAL OXYGEN REQUIREMENT (in Litres/min)			
Week0	3.28(0.8)	3.48(0.9)	0.45
Week2	2.72(0.8)	2.93(0.9)	0.47
Week4	2.39(0.6)	2.65(0.8)	0.24
Week6	1.72(0.4)	1.91(0.3)	0.11
Week8	1.22(0.4)	1.19(0.4)	0.77
2. DURATION OF SUPPLEMENTAL OXYGEN REQUIREMENT(in Hours/Day)			
Week0	17.67(4.7)	16.30(4.4)	0.32
Week2	16.44(4.2)	15.26(4.0)	0.35
Week4	14.89(4.1)	13.70(3.7)	0.32
Week6	11.83(3.3)	11.11(2.8)	0.43
Week8	6.89(2.1)	6.74(1.4)	0.78
3.SIX MINUTE WALK TEST(in Meters)			
Week0	36.39(6.2)	34.81(6.5)	0.42
Week2	37.61(5.6)	36.33(5.5)	0.46
Week4	39.17(5.5)	38.00(5.2)	0.47
Week6	39.17(5.5)	38.00(5.2)	0.47
Week8	45.11(3.9)	43.59(5.4)	0.31
Note: Values are mean (standard Deviation); *p* by ANOVA.			

Table III suggests that there is similarity between the two groups of patients in terms of the effects of pulmonary rehabilitation. In both the groups, pulmonary rehabilitation shows a decline in the requirement of supplemental oxygen, the duration of supplemental oxygen and a positive change is seen in the 6- minute walk test in both the groups.

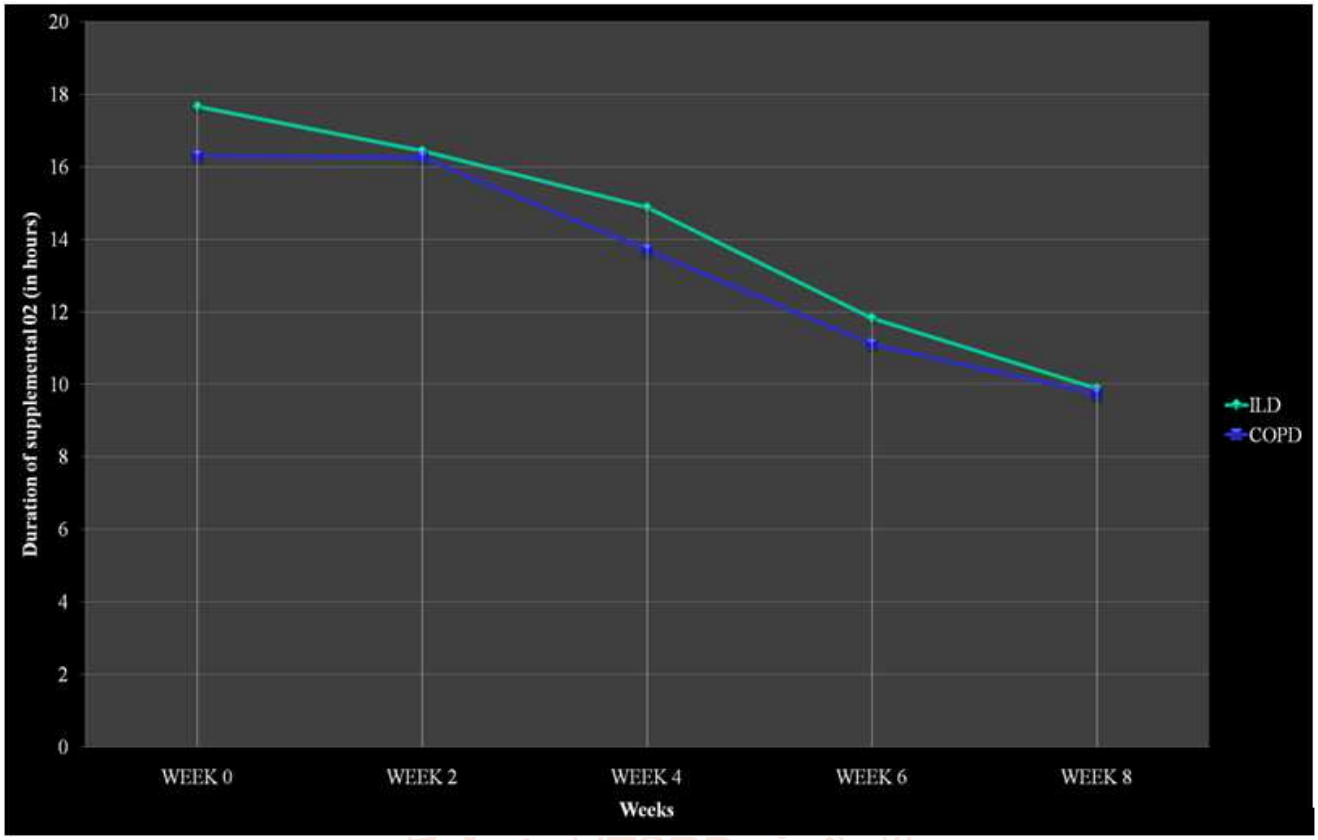

FIGURE 1- DURATION OF SUPPLEMENTAL OXYGEN REQUIREMENT (IN HOURS) WEEK WISE REDUCTION

DISCUSSION

This study shows that following the PR program, we found that the duration and amount of supplemental 0_2 requirement gradually dropped from 3(± 0.9)l/min and 17(±4.5)hours to 1(±0.4)l/min and 7(1.7) hours. Also, 6-MWT test results showed improvement (p=0.05). This is in line with the findings by Sahin et al.in his study.The study findings showed that there was significant improvement in COPD patients prescribed with LTOT, enrolled in 8 week PR program.[10]

In another study by Carone M et al, COPD patients with or without hypercapnic respiratory failure underwent a PR program. Both groups significantly benefitted in terms of 6-minute walk test-distance and lower dyspnea scores after PR but the difference between group were not significant.[11]

A retrospective study conducted by Brunette et al. involving a total of 240 in -patients with varied etiologies of ILD who were enrolled for a pulmonary rehabilitation program regimen; highlighted improvement in all the outcome measures mentioned in the study.[12] Also, Naji et al[13] concluded in his study that PR program benefited patients with restrictive lung diseases.

A prospective cohort study of 50 ILD patients conducted by Ryerson et al. [14] showed that patients with a low baseline 6MWD had greater benefit from pulmonary rehabilitation rehabilitation. A study by Maria-Rosa Güellet al.[15] comprising a total of 138 (96.5%) completed the 8-week program, outcomes measures-BODE, 6MWD, and health-related quality of life showed clinically and statistically significant improvements ($P \leq 0.001$) using pulmonary rehab program. A study by Claire M.Nolan et al.is in agreement with the findings of our study.[16]

Most the studies aimed to find correlation between PR and quality of life using 6 minute walk test and quality of life using questionnaires. Contrary to this, our study establishes the correlation between oxygen need and the impact of PR regimen. Most studies are done involving smaller group of patients. Hence, larger studies are required to validate the findings.

CONCLUSION

Adherence to PR will bring about a positive impact on day to day functional capacity in both COPD and ILD patient who are on long term oxygen therapy.

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