Effectiveness of Out Patient Pulmonary Rehabilitation Program in Patients with Chronic Lung Diseases

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ABSTRACT

Introduction: Pulmonary rehabilitation is an important tool in the management of patients with chronic lung disease. The usage of various methods in rehabilitation program should have positive benefits in these patients. Study aimed to evaluate the efficacy of an outpatient based pulmonary rehabilitation in improving health outcome in patients with chronic pulmonary disease.

Material and Methods: We undertook a prospective study of an outpatient based rehabilitation program in 100 patients with chronic pulmonary disease. The following evaluations were carried out at baseline and at four to six weeks: PFT (pulmonary function test), six minute walk test, SGRQ, SF-36 and Borg dyspnea scale. Pulmonary rehabilitation program involved the following components: 1) Exercise training: upper body training, lower body training, breathing strategy, removal of secretions, energy conservation and work simplification. 2) Educational component, and 3) Psychosocial/behavioral intervention.

Results: 101 patients with chronic pulmonary disease were studied. There was male preponderance of cases (54%). The number of patients with COPD were 52 (51.49%), bronchial asthma were 10 (9.90%), restrictive lung disease were 12 (11.88%) and bronchiectasis 27 (26.73%). We found that in all patients with asthma there was a more significant changes in pulmonary function and SPO_2 and in COPD changes in lung function parameters and other parameters were significant except for SPO_2.

Conclusion: A simple outpatient-based pulmonary rehabilitation program of Respiratory rehabilitation relieves dyspnea and improves control over chronic pulmonary disease. These improvements are clinically important. Respiratory rehabilitation is an effective part of care in patients with chronic pulmonary disease.

Keywords: Chronic Pulmonary Disease, Outpatient-Based Pulmonary Rehabilitation Program (PRP), PFT, Six Minute Walk Test, SGRQ, SF-36 and Borg Dyspnea Scale.

INTRODUCTION

Chronic pulmonary diseases is one of the important causes of morbidity and mortality in India. The resultant decline in the physical capacity and associated effects with the disease causes greater morbidity.

Pharmacological interventions is still an important stay in the treatment of patients with chronic obstructive pulmonary disease. Yet there are certain limitations where the patient cannot achieve full functional improvement[1]. Comprehensive pulmonary rehabilitation programs aims at tackling the systemic consequences of chronic pulmonary diseases, as well as the behavioral and educational deficiencies observed in many patients.

There is not much data available for the comparisons in the effectiveness of rehabilitation in non-COPD chronic pulmonary disease. Where-ever comparisons have been made, the results in non COPD appear to be identical those in patients with COPD[2]. There are very few studies the reevaluated pulmonary rehabilitation in our country. The present study was done in our hospital to evaluate the efficacy of an outpatient based pulmonary rehabilitation program [PRP] in improving health outcome in patients with chronic pulmonary disease.

Study was done to evaluate the efficacy of an outpatient based pulmonary rehabilitation in improving health outcomes in patients with chronic pulmonary disease.

MATERIAL AND METHODS

Patients of chronic pulmonary disease visiting Navodaya Medical College, Hospital and Research Centre, Raichur over a period of 22 months [August 2018 to June 2020] were included in the study.

Method of collection of data

A detailed history and examination was under taken in all patients who met the inclusion criteria. Routine investigations were under taken in all patients [CBC, RFT, Serum electrolytes, Chest radiogram, Pulse-oximetry.ABG,ECG and echocardiogram were done where ever indicated.

Baseline evaluation included PFT (pulmonary function test), six minute walk test, St George respiratory disease questionnaire (SGRQ), SF-36 quality of life questionnaire and Borg dyspnea scale. Patients attended two sessions a week for four to six weeks. Patients were evaluated after 1 week of completion of PRP.

Spirometry with bronchodilator reversibility was performed in all patients according to ATS guidelines.

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Spirometry result was interpreted as follows:
Obstructive abnormality if FEV1/FVC < 70% and FEV1 was< 80% of predicted

Restrictive abnormality if FEV1/FVC >70% and FVC < 80% predicted.

Bronchodilator reversibility: If either the FEV1 or the FVC increases by at least 12% and by at least 200 ml and/ or increase in PEFR by 18% from the pre bronchodilator values, then the patient is said to have a significant bronchodilator response. These patients are diagnosed as B. asthma and if there is no bronchodilator reversibility and if chronic smoking history is present they are diagnosed as COPD.

Six minute walking test
In six minute walking tests patients were asked to walk as far and as fast as they could in six minutes in a covered corridor. The distance was measured in meters.

St George respiratory disease questionnaire (SGRQ) This is a disease-specific questionnaire designed to measure impact on overall health, daily life, and perceived well-being. It was developed for use by patients with fixed and reversible airway obstruction. The questionnaire consists of 50 items, is self-administered/ administered by interviewer and takes 10-15 minutes to complete. The domains assessed in this questionnaire include:

- Symptoms (frequency and severity)
- Activity
- Impact (social functioning, psychological disturbances)

The total score was calculated from all three components, with 0 indicating no health impairment and 100 representing maximum impairment

SF-36 quality of life questionnaire The questionnaire consists of 36 items, self-administered /administered by interviewer and takes 5-10 minutes to complete. The domains assessed in this questionnaire are:

- Physical functioning
- Role limitations due to physical health problems
- Bodily pain
- Social functioning, general mental health
- Role limitations due to emotional problems
- Vitality
- Energy or fatigue
- General health perceptions

Ability to calculate a physical component and mental component score. Scores on the above mentioned nine health concepts were transformed linearly to scales of 0 to 100, with 0 indicating maximal impairment and 100 indicating the minimal impairment.

Borg dyspnea scale
Borg scale is a category scale used to measure exceptional and overall dyspnea. Using the Borg scale, breath lessees was rated by selecting a number corresponding to a verbal descriptor. Descriptors usually ranged from no breathlessness (zero) to maximal breathlessness (ten).

Protocol used for pulmonary rehabilitation
Each session in the PRP lasted for 50 to 60 minutes. The protocol followed involved the following components:

1. Exercise training
2. Education
3. Psychosocial/behavioral intervention

1. Exercise training:
Upper extremity endurance training: Training was accomplished using supported arm exercises with ergometry supported arm exercises by lifting free weights, dumbels and stretching elastic bands.

Lower extremity endurance training: Training was done using stationary cycle exercise, treadmill walking, or ground- based walking. During walking they used pursed lip breathing.
Breathing strategies
Pursed-lip breathing: This involved a nasal inspiration followed by expiratory blowing against partially closed lips, avoiding force full exhalation. The exhalation was twice as long as inhalation**.**
Diaphragmatic breathing: Patients consciously expanded the abdominal wall during inspiratory diaphragm descent and exhale slowly through pursed lips while drawing the abdomen in wards. This was used only for some patients who had respiratory muscle weakness and breathless ness
Removal of secretions

Postural bronchial drainage: Bronchodilators and moist air inhalation were used for conditioning. Patients were advised bout various positions of postural drainage to facilitate gravity aided drainage. Patients were asked to breath through pursed lips. They coughed after each position by controlled coughing technique.

Controlled coughing technique: Patients took slow deep breath using diaphragmatic breathing. They then coughed twice after a pause with the mouth slightly open.

Chest Vibration and Percussion Technique patients are explained about the chest vibration and percussion technique and taught them and advised to do regularly.

Energy conservation and work simplification: The patients were taught to breath with pursed lips while they performed activities of daily living. Inspiration and expiration was also taught to be timed so as to minimize the work of breathing, advanced planning, prioritization of activities, and the use of assistive devices.

2. Education
Instruction can be provided individually or in small groups, but it should be adapted to different learning abilities. Individual instructions were given regarding the use of inhaler devices and use of supplemental oxygen, breathing techniques, postural drainage.

3. Psychosocial and Behavioral Intervention
Psychosocial and behavioral intervention in the pulmonary

rehabilitation program was in the form of regular patient and family educational sessions.Issues like depression,anxiety, denial and lack of social, family support were discussed.

Definitions

Completers *versus* Drop-outs Completers:

Patients were considered to BEA "completer" if they had attended at least 8 out of the 12 possible pulmonary rehabilitation sessions.

Drop-outs:

Drop-out patient are those who attended less than 8 pulmonary rehabilitation sessions.

Inclusion criteria

- Symptomatic chronic lung disease
- Stable on standard therapy
- Functional limitation from disease
- No other interfering or unstable medical conditions
- The diseases included were COPD, severe persistent asthma, interstitial lung disease, bronchiectasis and post thoracic surgery (lobectomy).

Exclusion criteria

- Severe cardiovascular disease
- Other co-morbidities that limited exercise training (eg:advanced arthritis)
- Acute exacerbation of underlying pulmonary disease
- Pneumothorax
- Haemoptysis

STATISTICAL ANALYSIS

The following methods of statistical analysis have been used in this study.

The results were presented in number and percentage in Table and Figure.

1) Proportions were compared using Chi-Square (2) test

Rows	Columns			Total
	1	2	c	
1	a1	a2	ac	t1
2	b1	b2	bc	t2
.	.	.....	.	.
.	.	.....	.	.
r	h1	h2	hc	tr
Total	n1	n2	nc	N

a,b…..h are the observed numbers. N is the Grand Total

$$\chi^2 = N\left[\frac{1}{t_{11}}\sum_{i}^{1}\frac{a^2}{n_i} + \frac{1}{t_{21}}\sum_{i}^{1}\frac{h^2}{n_i} + \cdots + \frac{1}{t_{r1}}\sum_{i}^{1}\frac{h^2}{n_i}\right]$$

DF=(r-1)*(c-1), where r=rows and c=columns

DF= Degrees of Freedom (Number of observation that are free to vary after certain Restriction have been placed on the data)

In above test P value less than 0.05 was taken to be statistically significant. The data was analyzed using SPSS (Statistical Package for Social Science, version 10.5) package

RESULT

This study was done over a period of 24 months (August

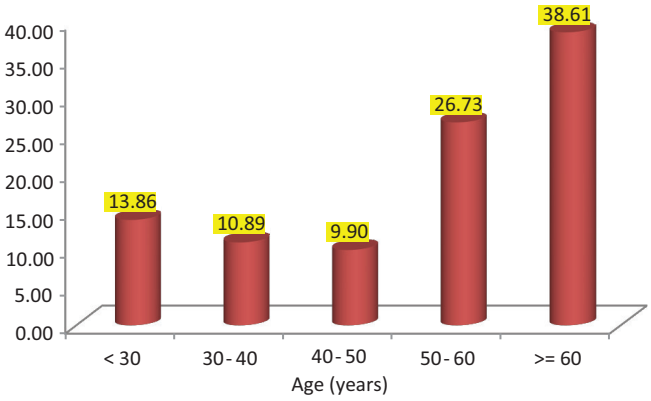

Figure-1: Age distribution of the study group

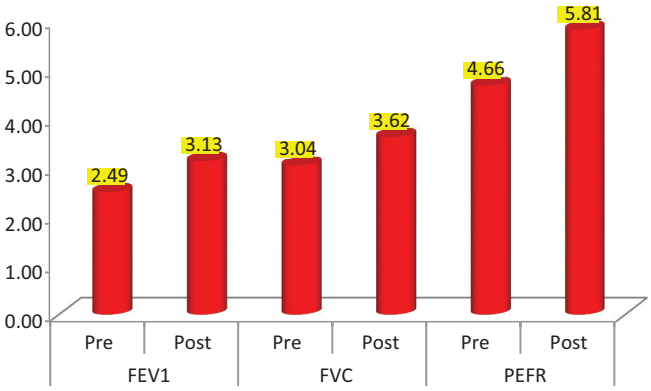

Figure-2:

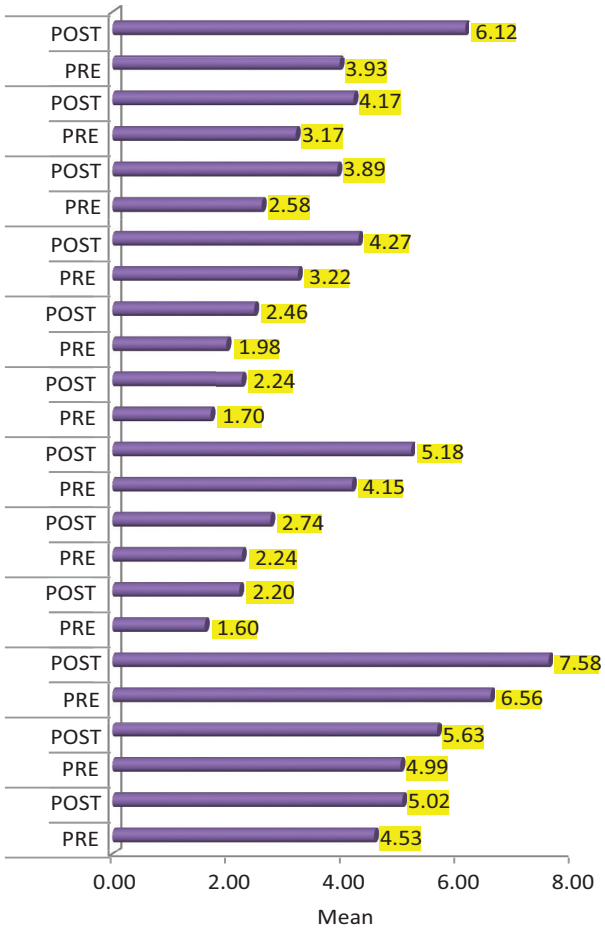

Figure-3: Pre and post pulmonary function test and comparison in study sub-group

2017 to AUGUST 2018). A total of 101 patients who met the inclusion criteria were screened. All these patients had moderate to severe pulmonary impairment with markedly reduced exercise tolerance and quality of life despite optimal medical management.

Characteristics of those patients who were screened are as follows: the age range of the patient 16-85 years of the patients was years there were 55 (54%) males and 46 (46%) females (figure-1).

One hundred one (100%) patients completed the pulmonary rehabilitation program (PRP). This included 55 (54%) male and 46 (46%) female patients.

BMI: Out of 101 patients who completed the PRP, 14 (13.86%) were underweight**,** 53 (52.48%) had normal BMI, 29(28.71%) were overweight and 5(4.95%) were obese (table-2).

Distribution of BMI in study sub-groups is shown in Figure-.

Disease spectrum in patients completing the PRP: Out of 101 patients who completed the PRP, 52 (51.49%) patients had COPD, 10 (9.90%) had bronchial asthma, 12 (11.88%) had restrictive lung disease and 27 (26.73%) patient had bronchiectasis (table-3).

At the end of the PRP, FEV1, FVC and PEFR improved significantly in all patients ('p' value< 0.05), When the changes in the above mentioned lung function parameters were analysed in different disease sub-groups, it was found that in patients with COPD and restrictive lung there is a significant improvements. However, in patients with bronchial asthma there was a more significant improvement in all the three parameters (table-4, table-5, fugure-2,3).

Effect of PRP on oxygen saturation

Oxygen saturation improved significantly in all patients ('p' value< 0.05).

When sub-group analysis was done, it was found that oxygen saturation improved significantly in patients with bronchial asthma ('p' value < 0.05), but there was no significant improvement (p value>0.05) in oxygen saturation in patients with COPD (table-6).

Borgs score improved significantly (p value< 0.05) in all patients and in all disease sub-groups. SGRQ improved significantly (there was a significant decrease in the total score) (p value< 0.05) in all patients who completed the PRP as well as in all disease subgroups.

SF-36 improved significantly (there was a significant increase in the total score) in all patients. The score improved significantly (p value< 0.05) in all subgroups of patients

Measurement	Obstructive pattern	Restrictive pattern
Forced vital capacity (FVC) Forced expiratory volume in 1 second	Decreased or normal Decreased	Decreased or Decreased normal
(FEV1) FEV1/FVC ratio Total lung capacity (TLC)	Decreased Normal or increased	Normal Decreased

Table-1: Obstructive and restrictive patterns

BMI (kg)	No. of cases	Percentage
< 18.5	14	13.86
18.5 - 24.9	53	52.48
25.0 - 29.0	29	28.71
>= 30	5	4.95
Total	101	100.00

Table-2: BMI distribution of the study group

Diagnosis	No. of cases	Percentage
Bronchiectasis	27	26.73
COPD	52	51.49
RLD	12	11.88
Asthma	10	9.90
Total	101	100.00

Table-3: Disease frequency among the study group

Parameter		N	Min	Max	Mean	SD	t' value	P value
FEV1	Pre	101	0.40	2.00	2.49	6.84	7.228	0.000
	Post	101	0.80	3.00	3.13	6.24		
FVC	Pre	101	1.00	3.90	3.04	6.09	13.034	0.000
	Post	101	1.30	4.20	3.62	6.17		
PEFR	Pre	101	1.90	8.10	4.66	6.28	9.235	0.000
	Post	101	2.09	8.50	5.81	5.44		

Table-4: Pre and post pulmonary function test and comparison in study group

			N	Min	Max	Mean	SD	t' value	P value
Bronchiectasis	FEV1	PRE	27	0.4	70	4.53	13.114	1.852	0.042
		POST	27	1.2	64	5.02	11.847		
	FVC	PRE	27	1.2	63	4.99	11.619	6.315	0.000
		POST	27	1.6	64	5.63	11.712		
	PEFR	PRE	27	2.2	66	6.56	11.957	2.719	0.012
		POST	27	2.6	58	7.58	10.174		
COPD	FEV1	PRE	52	0.6	3.9	1.60	0.819	7.686	0.000
		POST	52	0.8	4.9	2.20	1.122		
	FVC	PRE	52	1.2	4.2	2.24	0.782	9.103	0.000
		POST	52	1.5	4.9	2.74	1.002		
	PEFR	PRE	52	1.9	8.1	4.15	1.269	9.559	0.000
		POST	52	2.09	8.5	5.18	1.409		
RLD	FEV1	PRE	12	0.8	3.3	1.70	0.810	2.964	0.013
		POST	12	1.1	4.2	2.24	1.238		
	FVC	PRE	12	1	3.2	1.98	0.871	5.197	0.000
		POST	12	1.3	4	2.46	1.066		
	PEFR	PRE	12	2	4.5	3.22	0.706	4.074	0.002
		POST	12	2.5	6.8	4.27	1.522		
Asthma	FEV1	PRE	10	1.4	3.3	2.58	0.72	7.389	0.000
		POST	10	3	4.8	3.89	0.50		
	FVC	PRE	10	2	4.1	3.17	0.69	7.596	0.000
		POST	10	3	4.9	4.17	0.54		
	PEFR	PRE	10	3.2	4.6	3.93	0.49	9.615	0.000
		POST	10	4.5	6.9	6.12	0.70		

Table-5: Pre and post pulmonary function test and comparison in study sub-group

Parameter		N	Min	Max	Mean	SD	t' value	P value
SPO_2	Pre	101	58	98	93.56	4.07	3.337	0.044
	Post	101	66	997	105.50	89.65		
BORGS scale	Pre	101	4	65	5.99	5.98	28.112	0.000
	Post	101	2	57	3.42	5.44		
SGRQ	Pre	101	50	82	66.25	6.24	16.951	0.000
	Post	101	6	65	53.16	7.89		
SF36	Pre	101	40	72	59.31	6.65	17.072	0.000
	Post	101	50	78	69.10	5.79		
6M WT	Pre	101	210	450	324.01	46.81	27.782	0.000
	Post	101	320	530	438.26	51.10		

Table-6: Comparison of pre and post prp other outcome measures in study sub group

COPD		N	Min	Max	Mean	SD	t' value	P value
SPO_2	Pre	52	90	97	94.17	1.82	1.155	0.254
	Post	52	94	997	114.19	0.96		
BORGS SCALE	Pre	52	4	7	5.46	0.78	22.408	0.000
	Post	52	2	5	3.06	0.87		
SGRQ	Pre	52	50	80	65.75	6.15	13.928	0.000
	Post	52	34	65	53.79	5.98		
SF36	Pre	52	40	70	59.35	6.66	11.037	0.000
	Post	52	50	76	68.29	6.04		
6M WT	Pre	52	250	450	336.73	47.83	18.659	0.000
	Post	52	320	530	442.65	56.64		

Table-7: Pre and post other outcome measures in patients with COPD

also.

Six minute walking distance improved by 110 m in all patients. This was statistically significant ('p' value< 0.05). On subgroup analysis, there was significant improvement (p value < 0.05) in 6MWT in patients with COPD (106 m)(table 7) and bronchial asthma (126 m) (table 9).

Bronchiectasis		N	Min	Max	Mean	SD	t' value	P value
SPO_2	Pre	27	58	98	92.26	7.26	10.289	0.000
	Post	27	66	99	95.70	6.08		
BORGS scale	Pre	27	4	65	7.44	11.52	12.266	0.000
	Post	27	2	57	4.48	10.52		
SGRQ	Pre	27	50	80	65.52	6.29	7.028	0.000
	Post	27	6	64	50.63	11.45		
SF36	Pre	27	47	72	60.11	6.98	9.567	0.000
	Post	27	68	78	72.41	2.83		
6M WT	Pre	27	210	400	302.56	38.16	15.17	0.000
	Post	27	380	520	433.85	41.96		

Table-8: Pre and post other outcome measures in bronchiectasis

RLD		N	Min	Max	Mean	SD	t' value	P value
SPO_2	Pre	12	91	97	94.25	1.42	11.757	0.000
	Post	12	94	98	97.08	1.31		
Borgs scale	Pre	12	5	7	5.58	0.67	12.845	0.000
	Post	12	2	5	3.08	0.79		
SGRQ	Pre	12	62	82	70.33	7.06	8.373	0.000
	Post	12	40	65	55.00	7.40		
SF36	Pre	12	40	64	56.08	7.17	9.815	0.000
	Post	12	50	72	64.58	7.60		
6M WT	Pre	12	280	400	324.67	46.12	11.681	0.000
	Post	12	320	530	426.33	57.57		

Table-9: Pre and post other outcome measures in patients with restrictive lung diseases

Asthma		N	Min	Max	Mean	SD	t' value	P value
SPO_2	Pre	10	90	95	93.1	1.66	8.251	0.000
	Post	10	96	98	96.8	0.63		
Borgs scale	Pre	10	4	6	5.3	0.67	15.000	0.000
	Post	10	2	3	2.8	0.42		
SGRQ	Pre	10	60	72	65.9	4.28	7.125	0.000
	Post	10	50	64	54.5	3.92		
SF36	Pre	10	56	68	60.8	4.24	9.000	0.000
	Post	10	64	72	69.8	2.74		
6M WT	Pre	10	230	400	315	46.62	13.536	0.000
	Post	10	380	490	441.6	36.44		

Table-10: Pre and post other outcome measures in patients with asthma

On subgroup analysis, there was significant improvement (p value < 0.05) in 6MWT in patients with RLD (102 m)(table 8) and Bronchiectasis (131m) (table 7).

DISCUSSION

Chronic pulmonary disease is a major cause of morbidity and mortality in our country. In India, pulmonary rehabilitation program (PRP) is available in only limited number of tertiary care hospitals[7].In this prospective study done in patients with chronic pulmonary disease over a period of TWENTY FOUR months, a total of 101 patients who met the inclusion criteria were screened. All these patients had moderate to severe pulmonary impairment with markedly reduced exercise tolerance and quality of life with optimum medical management.

101 patients who met the inclusion criteria completed the pulmonary rehabilitation programme (PRP).

Lung functions

Study showed significant improvement in FEV1, FVC and PEFR in all patients with asthma. In COPD and restrictive lung disease, PRP is not expected to produce an improvement in lung function as there is a irreversible change in lung architecture.

On sub-group analysis, it was found that more significant improvements in lung function were seen only in patients with asthma than other groups, which supports the hypothesis proposed for lung function improvement in all patients who completed the PRP. Predictably, patients with COPD and restrictive lung disease did not exhibit as much as asthma patients significant improvement in lung function. A study done by Hui et al [3] in 36 patients with COPD demonstrated that there was no change in the lung function after PRP.

A study by Kobayashi et al [4] in 17 patients with chronic bronchial asthma demonstrated that after pulmonary

rehabilitation showed a significant improvement in FEV1, FVC and PEFR.

Oxygen saturation (SPO_2)

In all patients SPO_2improved significantly after PRP. On sub-group analysis, there was a significant improvement in patients with asthma as it is predominantly an airway disease which is reversible.

In patients with COPD SPO_2 didn't improve significantly as there is a irreversible change in lung architecture. The results were similar in a study done by Hui[3] et al, in which they demonstrated that there was no change in the lung function and SPO_2 in COPD patients [4].

Six minute walking test (Exercise tolerance)

The present study showed significant improvement in six minute walking distance in all patients, and also in sub groups of patients with COPD and asthma bronchiectasis, RLD. When compared to patients with COPD and restrictive lung disease, the increase in six minute walking distance was more in patients with asthma and bronchiectasis.

A study done by Goldstein et al.[2], which showed that the COPD patients receiving pulmonary rehabilitation program walked more during a six minute walking test than the patients receiving conventional treatment.

Strijbos *et al* [11]demonstrated, up to 3 months after a 3 month hospital-based out-patient rehabilitation programme in a group of COPD patients, significant improvements in maximal workload during cycling and 4 min walking distance compared to baseline assessments.

Quality of life measurements

SGRQ: (St George respiratory disease questionnaire)

After the completion of the PRP there was a significant decrease in SGRQ total score in all patients**,** in patients with COPD, asthma, bronchiectasis and restrictive lung disease.

The study done by Rossi et al[5], in patients with COPD demonstrated that, SGRQ significantly improved at 10 sessions and 20 sessions as compared with baseline.

A prospective study done by Singh et al [6] in patients with COPD demonstrated that, SGRQ improved after PRP.

These findings are comparable with the study done by Finnerty et al[7] in patients with COPD, showed that the significant improvement in health status using the SGRQ total score after pulmonary rehabilitation.

A study done by Griffiths et al [8] in COPD patients showed a significant improvement favouring rehabilitation in the SGRQ.

SF-36

A significant increase in SF-36 in all patients**,** in patients with COPD, bronchial asthma, bronchiectasis and restrictive lung disease.

A study done by Fernanda et al [9] concluded that health-related quality of life assessed by the SF-36, improves following an intensive 3-week pulmonary rehabilitation program.

A study done by Griffiths et al [10] in COPD patients showed a significant improvement favouring rehabilitation in the SGRQ and most of the components of the SF- 36 questionnaire.

Borgs dyspnoea scale

In all patients there was a significant decrease in Borg dyspnea scale**.** Similarly, in patients with COPD asthma, bronchiectasis, RLD, there was a significant decrease in Borg dyspnea scale after completion of PRP**.**

These results were comparable with study done by O'Donnell et al [10,17] who demonstrated that dyspnea and fatigue, during graded cycle exercise, decreased significantly in the treatment group receiving pulmonary rehabilitation.

Benefits of PRP summarised

Our study has demonstrated a statistically significant improvement in exercise tolerance and QoL following a OPD based PRP. This study is consistent with previous reports,[11,12,13] showing that a PRP for chronic pulmonary disease patients encompassing education, breathing retraining, and chest physiotherapy followed by exercise training leads to improvement in dyspnea, functional exercise capacity, and health related quality of life.The improvement in exercise tolerance and QoL can be attributed to aerobic tolerance, motivation,compliance to treatment, desensitization to sensation of dyspnea,respiratory muscle conditioning and improved technique of performance.[14] Recently Clark et al [15] and Cambach et al [16] also found that less strenuous exercise performed with minimal facilities provide significant improvement in exercise tolerance and HRQL.

CONCLUSION

It was found that, this program benefited patients with COPD, asthma, and RLD. In patients with moderate to severe COPD, there was no improvement in the lung function but there was a significant improvement in exercise tolerance, dyspnea, and quality of life after PRP. In patients having severe persistent asthma, it was found that PRP improved lung function, exercise tolerance, dyspnea, and quality of life.

In patients with moderate to severe RLD, there was no improvement in the lung function and exercise tolerance, but there was a significant improvement in dyspnea and quality of life after PRP.

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