Improvements in exercise capacity during a 4-weeks pulmonary rehabilitation program for COPD patients do not correspond with improvements in self-reported health status or quality of life

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Abstract: Ninety-two patients with moderate or severe chronic obstructive pulmonary disease (COPD) were assessed for walking tolerance, lung function, perceived health status (HS), perceived quality of life (QoL) and anxiety before and after a four weeks inpatient pulmonary rehabilitation (PR) program. There were significant improvements on all outcomes except anxiety, although the effect sizes were small or moderate. The largest improvement was observed on the walking test, but patients also improved on perceived health status (HS) and perceived quality of life (QoL). Relations between outcome indicators were analyzed cross-sectionally and longitudinally. Cross-sectional correlations were in line with earlier studies. However, improvements on the walking test were generally unrelated to changes in lung function, HS and QoL. Different patients improve on different outcome measures following PR, and this could have implications for the planning and designs of PR programs.

Keywords: COPD, pulmonary rehabilitation (PR), health status (HS), quality of life (QoL)

Introduction

Chronic obstructive pulmonary disease (COPD) can have a substantial effect on the physical, emotional and social aspects of patients' lives (Guthrie et al 2001). Activities of daily living are often considerably impeded (McSweeny et al 1982) and many COPD patients suffer from emotional problems such as anxiety and depression (Kunik et al 2005). Perceived health status (HS) and quality of life (QoL) tend to be low in COPD (Prigatano et al 1984; Yohannes et al 1998).

Questionnaires, such as HS instruments, QoL instruments or anxiety/depression inventories, and physical indicators – eg, spirometric values or walking tests – have several uses. First, they can show how patients' lives are affected by COPD; second they are useful to evaluate effects of pulmonary rehabilitation (PR) programs. Such effects have been well documented (Ambrosino 2002; Lacasse et al 2002; Salman et al 2003), but the magnitude of improvement has varied considerably, both for physical tests and self-reported outcome variables.

In this study we assessed a sample of COPD patients on a set of outcome variables before and after a PR program. The first aim of our study was to assess whether physically related variables would improve more than emotionally related variables, since the rehabilitation program was focused primarily on physical exercise. However, since COPD is a chronic disease, we did not expect any major changes in lung function for the sample.

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Previous studies have shown that cross-sectional correlations between objective versus subjective indicators tend to be low, but walking distance has been moderately and significantly correlated to self-reported health status (Jones and Kaplan 2003; Haave et al 2005). Few studies, however, have investigated whether longitudinal change in one outcome variable correlates with change in another outcome variable. The second aim of our study was therefore to assess the relations between changes in different outcome variables. Our main expectation was that changes in exercise capacity (walking distance) would be at least moderately related to changes in perceived health status and quality of life – particularly to the physically related subscores. That is, we expected that if patients responded well to PR by improving their exercise capacity, this would be reflected in consistent improvement across several other outcome variables.

Method

Patients and procedures

Data were collected from a sample of COPD patients who had been referred to a four-week inpatient PR program at a clinic in Norway. Patients were included if they had been given a diagnosis of COPD from their regular physician before entering the clinic, and were excluded if they were known to have any known serious somatic or psychological problems in addition to their COPD. Patients older than 70-years and patients using long term oxygen therapy (LTOT) were also excluded. Patients completed questionnaires at home: two weeks before and two weeks after the rehabilitation program. Lung function measurements and walking tests were performed at the clinic, during the first and the last week of the rehabilitation program. For purposes of analysis, we included only patients who had completed all questionnaires and performed all walking tests and lung function tests. A total of 95 patients fulfilled these criteria. Subsequently, three patients were excluded because their diagnosis was changed from COPD to asthma during their stay at the clinic, thus leaving a sample of 92 patients.

Patients were informed that participation in the research project was voluntary and that information would be treated confidentially. Those who wanted to participate gave their written consent. The regional ethical committee had approved the study.

Rehabilitation program

Patients participated in a four weeks multidisciplinary PR program, in which the central elements were physical exercise, educational lectures, lifestyle change support and social sharing with other COPD patients. The program consisted of three to four 45 min educational or exercise group sessions all weekdays. Patients were seen at least weekly by their attending physician, and issues such as medication or nutrition were followed up regularly by nurses. All patients were given individual appointments with a physiotherapist. Individual appointments with a social worker, occupational therapist, nutritional adviser and psychologist were given as needed.

Measures

Quality of life

Quality of life was measured by the Perceived Quality of Life Scale (PQoL). The PQoL is a generic, not health-related, instrument (Patrick 2004) including 19 items in which the participants rate their satisfaction with different aspects of life on an 11-point end-anchored scale from 0 ("extremely dissatisfied") to 10 ("extremely satisfied"), plus one extra item that measure happiness. The PQoL total score (PQoL tot) was calculated as the mean of the first nineteen different items. Two subscores were calculated: A physical score (PQoL phys) and a social score (PQoL social). All PQoL scores had a possible range from 0,0 to 10,0. Higher PQoL scores mean better perceived quality of life.

Health status

Perceived and disease-specific health status was measured by the short version of the Breathing Problems Questionnaire (BPQ), in which the patients describe how their breathing problems influence different aspects and functions of daily life. The BPQ short version (Hyland et al 1998) has 10 items, each with a scoring range 0–3, which can be added to a BPQ total score (BPQ total) that ranges from 0 to 30. In addition to the total score, a BPQ physical subscore (BPQ phys) and a BPQ emotional subscore (BPQ emo) was calculated, both with a score range from 0 to 12. Higher BPQ scores mean worse perceived health status.

Anxiety

Anxiety was measured by the trait part of Spielberger's state/trait anxiety inventory (STAI) (Håseth et al 1993). The scale consists of 20 questions, each with a scoring range 1–4, some of them in reversed order, which can be added to calculate a trait anxiety total score that ranges from 20 to 80. Higher STAI scores mean higher anxiety levels.

Lung function

Lung function was measured as forced expiratory volume in 1 s (FEV_1) recorded from the better of two flow-volume curves (Jaeger, Masterlab) and presented as percent of expected values, adjusted for age, gender and height (FEV_1%)

(Quanjer et al 1993). Higher FEV_1% scores mean better lung function.

Exercise capacity

Exercise capacity was measured by 6-minute walking tests (6MWD) according to ATS guidelines (Nici 2002). All tests were conducted indoors, along flat, straight corridors with 30 meters marked walking courses. In the instruction, patients were instructed to walk as far as possible for 6 minutes, but permitted to slow down, to stop, and to rest as necessary. Standard phrases of encouragement such as "you are doing well" and "keep up the good work" were given once every minute. The results on the 6MWD were reported in meters; higher 6MWD scores mean better test results.

Statistics

T-tests for paired samples were used to analyze changes in scores over time. Cohen's d was used as an estimate of effect size, and was calculated by dividing the mean change score for a variable with the pooled standard deviation of raw scores on the same variable, from before to after rehabilitation. Values of d were interpreted as follows: $d < 0.2$ = small effects, $0.2 \leq d < 0.5$ = medium effects, $d \geq 0.5$ = large effects.

Pearson parametric correlation coefficients were calculated to analyze cross-sectional correlations between the main variables in the study. However, since change scores tend to have low reliability, correlations between such variables were not calculated. For the purpose of analyzing associations between variable changes, we did as follows. Using the criterion of change in walking tests (Δ6MWD), patients were allocated into one of three groups: Group 1 = worsening or no improvement (Δ6MWD ≤ 0), N = 29; Group 2 = small or moderate improvement (0 < Δ6MWD ≤ 40), N = 32; Group 3 = large improvement (Δ6MWD > 40), N = 31. Then, these three groups of patients were tested for changes over time on other variables by repeated measures ANOVAs. Age and gender were used as covariates in these analyses. In addition to this, we counted how many of the 92 patients had improved their scores from before to after rehabilitation; on separate variables and on combination of variables. SPSS version 15.0.1 was used for all statistical analyses.

Results

The sample consisted of 50 women and 42 men. Mean age was 59.2 years (S.D. = 5.7, range = 42–69), showing that ours was a relatively young sample of COPD patients. At the start of the PR program, mean FEV_1% for the sample was 50.8 (S.D. = 18.9, range 19–97), showing that our sample of patients could be characterized as moderate to severe COPD.

Table 1 shows the cross-sectional correlation coefficients between outcome variables assessed before the rehabilitation program. Walking distance was moderately and significantly correlated to lung function and HS, less to QoL and near zero to anxiety. Lung function was also significantly correlated to HS, but not to QoL or anxiety. HS, QoL and anxiety were all significantly correlated to each other, and the strongest correlations were observed between QoL and anxiety.

Scores before and after rehabilitation, t-values, significance levels and effect sizes are shown in Table 2. All variables changed in a positive direction, and all, except for trait anxiety, the emotional subscale of the BPQ and the social subscale of the PQoL, were significant. Effect sizes were small or moderate. Walking distance and the physically related HS and QoL subscores showed the largest improvements.

53 patients improved on the BPQ total, 58 patients improved on the PQoL total, but only 37 patients improved on both these variables. 27 patients improved on the combination of 6MWD, BPQ total and PQoL total, and as few as 11 patients improved on all five main variables (6MWD, BPQ total, PQoL total, FEV_1% and STAI).

Table 3 shows the mean score on outcome variables after classifying patients in terms of their degree of improvement of the 6MWD. There were no significant effects, showing that change in 6MWD was unrelated to change in any other outcome variable.

Discussion

In this study of PR, we found that the longitudinal association between exercise capacity and other outcome variables was poor. While the 6MWD was significantly correlated to other variables cross-sectionally, changes in walking distance were largely unrelated to changes in the other outcome variables. The degree of increased walking distance was not accompanied by comparable degrees of improvements on HS, QoL or lung function. Contrary to our expectation we found no relation

Table 1 Correlations coefficients between main variables before the rehabilitation program, N = 92

	FEV_1%	BPQ total	PQoL total	STAI
6MWD	0.57**	–0.55**	0.26	–0.02
FEV_1%	–	–0.42**	0.16	–0.09
BPQ total		–	–0.58**	0.48**
PQoL total			–	–0.69**

Note: *$p < 0.01$, **$p < 0.001$.

Table 2 Scores before and after the rehabilitation program, N = 92

Variables	Scores before rehabilitation: Means (SD)	Scores after rehabilitation: Means (SD)	p-values	Effect size Cohen's d
FEV_1%	50.78 (18.92)	53.23 (19.41)	p = 0.001	0.13
6MWD	500.54 (114.61)	528.42 (123.85)	p < 0.001	0.23
BPQ total	10.83 (5.39)	9.99 (5.71)	p = 0.006	0.15
BPQ phys	4.30 (2.35)	3.88(2.40)	p = 0.001	0.18
BPQ emo	3.60 (2.49)	3.39(2.57)	p = 0.236	0.08
PQoL total	5.06 (1.67)	5.36 (1.70)	p = 0.014	0.18
PQoL phys	4.62 (1.94)	5.15 (1.88)	p = 0.001	0.28
PQoL social	5.10 (1.76)	5.31 (1.79)	p = 0.072	0.12
STAI	42.73 (10.77)	42.38 (11.61)	p = 0.610	0.03

Notes: FEV_1%: forced expiratory volume in one second presented as percent of expected values, adjusted for age, gender and height.
Abbreviations: 6MWD, 6 minutes walking test presented in meters; BPQ total, total score on the Breathing Problems Questionnaire; BPQ phys, physical subscore on the Breathing Problems Questionnaire; BPQ emo, emotional subscore on the Breathing Problems Questionnaire; PQoL total, total score on the Perceived Quality of Life Scale; PQoL phys, physical subscore on the Perceived Quality of Life Scale; PQoL social, social subscore on the Perceived Quality of Life Scale; STAI, trait anxiety score on the Spielberger state/trait anxiety scale.

between changes in walking distance and changes in the physically related subscores of HS and QoL. These results suggest that COPD patients do not respond uniformly to a PR program, or to different parts of a PR program. For example; patients who have not managed to increase their exercise capacity during the 4-weeks of rehabilitation, may still have made significant progress pertaining to how they think and feel about their health status, daily functioning or satisfaction with life. It seems reasonable to consider both subjective and objective improvements as important outcomes, and it underscores the importance of using a battery of instruments and tests for evaluation purposes (Engstrom et al 2001). Results in line with ours were reported in a study correlating 6MWD change scores with change scores for other variables (de Torres et al 2002).

The cross-sectional patterns of associations between outcome variable in this study were consistent with previous research, as both walking distance and HS were significantly associated with lung function (Antonelli-Inc R et al 2003; Carter et al 2003), while associations between lung function and more general QoL were nonsignificant or low (Monso et al 1998). Walking distance was associated with HS but more weakly associated with generic QoL (Singh et al 2001; Katsura e al 2003). Finally, HS, QoL and anxiety were significantly associated to each other at both times of measurement (Andenaes et al 2004).

The greatest improvements after the PR program were those of physical performance and perceived physical functioning; walking distance and the physical subscores of BPQ and PQoL changed most, and this may be attributable to the physical orientation of this PR program. However, since the emotional and social subscores were lower at baseline, the potential for improvement was probably smaller on these scales. The increase in walking distance has been reported in many previous studies (Strijbos et al 1996; Engstrom et al 1999; Griffiths et al 2000; Guell et al 2000). A significant improvement in lung function was unexpected, however, since other rehabilitation studies do not tend to find such effects (Fuchs-Climent et al 2001; Trappenburg et al 2005). One study discovered FEV_1% improvements at discharge, and attributed the effect to better compliance (Buchi et al 1997). Similar mechanisms may have been responsible for the improvements in our sample. We found no reduction

Table 3 Changes in walking distance related to changes in the other main variables

Variables		Group 1: Worsening or no improvement on the 6MWD N = 29	Group 2: Small or moderate improvement on the 6MWD N = 32	Group 3: Large improvement on the 6MWD N = 31	Group × time p Value
BPQ tot	t1	11.8 (5.3)	10.2 (6.2)	10.5 (4.6)	p = 0.650
	t2	10.5 (5.6)	9.5 (6.6)	10.0 (4.9)	
BPQ phys	t1	4.7 (2.4)	4.1 (2.5)	4.2 (2.1)	p = 0.900
	t2	4.1 (2.4)	3.7 (2.7)	3.9 (2.1)	
PQoL tot	t1	4.7 (1.6)	5.2 (1.7)	5.2 (1.7)	p = 0.586
	t2	5.2 (1.7)	5.4 (1.9)	5.5 (1.6)	
PQoL phys	t1	4.1 (1.9)	4.9 (1.9)	4.9 (1.9)	p = 0.507
	t2	4.8 (1.7)	5.2 (2.2)	5.4 (1.6)	
STAI	t1	44.4 (12.2)	42.2 (9.5)	41.6 (10.8)	p = 0.366
	t2	44.0 (12.8)	43.1 (12.3)	40.2 (9.6)	
FEV_1%	t1	51.1 (21.2)	48.7 (16.9)	52.7 (19.0)	p = 0.925
	t2	53.4 (22.2)	50.8 (17.7)	55.6 (18.7)	

Group1: (Δ6MWD $\leq$ 0 meters), Group 2 : (0 < Δ6MWD $\leq$ 40 meters), Group 3 : (Δ6MWD > 40 meters).

in anxiety levels, but two studies using cognitive therapy (de Godoy and de Godoy 2003) and cognitive behavioral therapy (Kunik et al 2001) showed anxiety reduction among COPD patients. Such elements, however, were not systematically included in our PR program. The content and durations of PR programs are controversial. Some believe that while a PR program of 4–10 weeks may improve physical function, modification of coping styles and emotional states may take months (Wempe and Wijkstra 2004). Our results could be relevant to this discussion, since they demonstrated that a relatively short PR program with a main focus on physical exercise and educational sessions could not produce significant emotional improvements for COPD patients.

There were limitations to our study. Questionnaires were completed two weeks before and two weeks after the PR program while walking tests and lung function tests were performed at the clinic. Furthermore, measurements based on self-report are qualitatively different from tests of physical performance, which may have explained some of the divergences between indicators. Finally, as regards the effects of PR; this study did not include a control group, hence effects of the program must be considered with caution. Nevertheless, these results added to the total picture of effects of PR on COPD.

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