Quality of Life Measured With a Generic Instrument (Short Form-36) Improves Following Pulmonary Rehabilitation in Patients With COPD

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Study objectives: The purpose of this study was to evaluate the effects of a 3-week comprehensive pulmonary rehabilitation program on quality of life as measured by the Short Form-36 (SF-36) in patients with COPD.

Design and setting: We report on the outcomes of 37 consecutive patients referred for pulmonary rehabilitation at a respiratory specialty medical center.

Patients: Thirty-seven patients (mean age, 66 years) with COPD and severe airflow limitation (mean ± SE FEV₁, 29.6 ± 1.8% of predicted) were studied.

Interventions: Rehabilitation consisted of a 3-week pulmonary rehabilitation program incorporating 12 exercise sessions, each of which included bicycle ergometer exercise training, upper-extremity training, strength training, and stretching, along with psychosocial counseling and education.

Measurements and results: The Health Status Index (SF-36) and 6-min walk test were completed before and after rehabilitation. There was an improvement in five of the nine quality-of-life subscales of the SF-36 following pulmonary rehabilitation. Although there was an improvement in functional capacity as measured by the 6-min walk, there was no correlation between improvement in quality of life and improvement in functional capacity. There was no correlation between FEV₁ and improvement in walk distance, but there was a correlation between FEV₁ and improvement in SF-36 physical function and energy/fatigue subscales.

Conclusion: Health-related quality of life assessed by the SF-36, a general measure of quality of life, improves following an intensive 3-week pulmonary rehabilitation program. Use of the SF-36 allows comparison of the results of pulmonary rehabilitation to therapeutic interventions in patients with other medical disorders.

Key words: 6-min walk; COPD; pulmonary rehabilitation; quality of life; Short Form-36

Abbreviations: CRQ = Chronic Respiratory Questionnaire; HQL = health-related quality of life; SF-36 = Short Form-36; QWB = Quality of Well-being

COPD is characterized by airflow limitation leading to reduced ventilatory capacity and is associated with shortness of breath. In patients with severe airflow limitation, these factors lead to reduced capacity for functional activities, such as walking; decreased performance of daily activities; and, ultimately, impaired quality of life.

Since medications do not eliminate all of the symptoms of COPD and a cure of the illness is not possible, pulmonary rehabilitation has been employed to improve exercise tolerance, functional capacity for daily activities, and quality of life. Several publications1–3 have reviewed the results of investigations of pulmonary rehabilitation and have concluded that there is substantial evidence that pulmonary rehabilitation improves exercise capacity and shortness of breath. Traditional perspectives of defining benefits only in terms of biomedical results are increasingly being supplemented with other end points, such as patient perception of health-related quality of life (HQL). In patients with COPD who...
have impaired quality of life, such outcomes may be particularly valuable in assessment of therapeutic interventions, such as pulmonary rehabilitation. However, there are limited data on the effects of pulmonary rehabilitation on quality of life, and not all studies have shown improvement after rehabilitation.1

Previous studies of the effects of pulmonary rehabilitation on HQL have used disease-specific questionnaires designed for patients with COPD.4–6 Since these tools make it difficult to compare outcomes in studies of COPD to patients with other nonpulmonary disorders and some require administration by a trained interviewer, we investigated the utility of the Short Form-36 (SF-36) to assess HQL following pulmonary rehabilitation. The SF-36 is a self-administered questionnaire designed to assess generic quality of life in a brief, comprehensive, and psychometrically sound manner.7,8 It is suitable for use in clinical practice and research, and the concepts measured are not specific to any age, disease, or treatment group, thus allowing comparisons of the relative burden of different diseases and the relative benefits of different treatments. The present study was designed to evaluate the effects of pulmonary rehabilitation on HQL measured by the SF-36, and to relate the improvement in HQL to increases in functional capacity as measured by the 6-min walk test in a population of patients with COPD.

MATERIALS AND METHODS

Study Design

We prospectively evaluated the effects of a comprehensive 3-week pulmonary rehabilitation program on quality of life and 6-min walk test in 37 patients with COPD. Patients were referred to the Pulmonary Rehabilitation Program at the National Jewish Medical and Research Center, Denver, CO. Consecutive patients with a primary diagnosis of COPD referred over a 10-month period and who agreed to participate were included in the study.

Most patients (32 of 37) underwent pulmonary function testing at the National Jewish Medical and Research Center prior to rehabilitation. An exercise test was performed to screen for coronary artery disease and to set the initial prescription for lower-extremity exercise training. The 6-min walk test and the SF-36 questionnaire were administered to all patients before and immediately after rehabilitation as part of this study. The protocol was approved by the human studies committee of the institution, and informed consent was obtained.

Pulmonary Rehabilitation Program

The program was 3 weeks in duration and included physician assessment and other medical tests as clinically indicated. There were 12 exercise sessions, which included bicycle ergometer exercise training, upper-extremity training, strength training, and stretching. Patients used an electronically braked bicycle ergometer and started training at 50% of the maximum workload achieved during the prerehabilitation exercise test. The goal of cycle ergometry was to maintain a training duration of 20 min; when patients were able to cycle for 20 min, the work on the cycle was increased. Supplemental oxygen was used if necessary to maintain an oxygen saturation of >90% during all exercise sessions. As part of the program, patients also had psychosocial counseling and group and individual education to address appropriate use of medications, oxygen, and collaborative self-management of their lung disease.

Upper-extremity training was performed by repetitively raising and lowering a dowel from the height of the waist to the height of the shoulders (using an interval-training regimen with repetitive periods of exercise and rest as tolerated by the patient; for example, 2 min of exercise and 1 min of rest). When patients were able to perform the upper-extremity exercise for 10 min, a weight of 0.5 lb was added to each arm.9 Free weights (dumbbells, cuff weights) and elastic resistance (Thera-Band; Hygenic; Akron, OH) were used for strength training, for a total duration of up to 30 min as tolerated. Six to 10 upper-body and lower-body strength exercises were used based on demonstrated weakness and fatigue in each individual subject. Stretching of hamstrings, quadriceps, calves, shoulders, neck, and lower back was performed after each exercise session.

Classes and reading material were used to teach and enhance problem solving. Patients were provided ample opportunity to ask questions and raise concerns related to their lung disease and disability. Subjects were encouraged to attend the following nine group classes: understanding COPD, self-management of COPD, nutrition, stress management, breathing techniques, importance of regular exercise, respiratory medications, oxygen therapy, and sexuality. During individual and group sessions with a social worker, the patient and family addressed psychological aspects of COPD, such as the fear of death, feelings of guilt, depression, anxiety, and relationships with spouse and children.

Walk Test

During the 6-min walk test, an index of functional capacity, subjects were asked to walk as far as they could in 6 min. The test was performed on a continuous rectangular hospital corridor. The patient was encouraged during the test with one of three standardized phrases used by the therapist every minute.10 If the patient was receiving oxygen therapy, the therapist carried the oxygen. The test was performed twice to eliminate any potential learning effect. Walks were conducted on the same day, with at least a 30-min rest period between tests. The second of the two walk distances was recorded.

Pulmonary Function Testing

Spirometry and lung volumes by body plethysmography were performed prior to rehabilitation according to accepted methods.11

Quality-of-Life Questionnaire

The Health Status Index (SF-36) was used to measure HQL. The SF-36 incorporates 36 items and yields eight separate subscales.8 The questionnaire contains 10 questions related to physical functioning, 2 about social functioning, 4 about role limitations due to physical problems, 3 about role limitations relating to emotional problems, 5 about mental health, 4 about vitality (energy/fatigue), 2 related to pain, 5 about general health perceptions, and 1 about change in health. Each subscale score ranges from 0 to 100, with 100 representing the most desirable score.12 The self-administered SF-36 required about 10 min of the patient’s time and was administered during the initial patient
evaluation prior to the start of pulmonary rehabilitation and at the end of 3 weeks during the final visit with the patient.

Study Population

The study population consisted of 28 women and 9 men with COPD, with an average (± SE) age of 66 ± 1.2 years. Patients had severe airflow limitation with a FEV₁ of 29.6 ± 1.8% of predicted and total lung capacity of 138.9 ± 4.9% of predicted.

Statistical Analysis

Continuous approximately symmetrically distributed data were summarized with means and SEs, while skewed distributions were summarized by medians and interquartile ranges. Paired t tests were used to determine if the SF-36 scores and distance walked in 6 min differed before and after rehabilitation. One-sample t tests were used to determine if the prerehabilitation SF-36 scores differed from published mean values. Pearson correlation coefficients were used to assess the strength of linear relationships between pairs of variable of interest. All tests were two sided and were conducted at the 5% significance level.

RESULTS

SF-36 Before Rehabilitation

Figure 1 illustrates the SF-36 subscales as measured before rehabilitation in the COPD patients in this study, compared to published values for healthy adults. 7 Six of the eight subscales (physical function, role physical, general health, vitality, social function, and role emotion) were significantly lower in COPD patients than in healthy individuals. The body pain and the mental health scores for the study group were similar to values published for healthy adults. 8 The mean values for this COPD group were similar to those published by Mahler and Mackiowiak. 13

Change in SF-36 After Rehabilitation

Following rehabilitation, five of the nine SF-36 subscales (physical function, vitality, role emotional, mental health, and health change) showed significant improvement (Table 1). The role physical, body pain, general health, and social function did not change significantly following rehabilitation. The change in physical function is displayed in Figure 2. Although most subjects improved, 7 of the 37 had a lower physical score after rehabilitation. Three of these patients had decreases of > 25 points, and these patients also had decreases in other SF-36 scales after rehabilitation. Four patients had small decreases (5 to 10 points) in physical function after rehabilitation. There were no characteristics that differentiated the patients who had large declines in the SF-36 physical score from patients who had improvement in physical function after rehabilitation.

Change in 6-min Walk After Rehabilitation

Only 26 of the 37 patients had both prerehabilitation and postrehabilitation walk tests available for analysis. Following pulmonary rehabilitation, there was a significant increase in the 6-min walk distance (Fig 3), with a mean improvement of 67.6 ± 15.2 m (221.8 feet; p < 0.001) among those who did the walk test both before and after rehabilitation. Twenty of the 26 patients (77%) with both prerehabilitation and postrehabilitation testing had an increase in walk distance of > 30 m, the distance that has been suggested as the minimum change for a clinical improvement. 14

Of the 11 patients who had missing walk-test data, 6 patients had no prerehabilitation walk distance because they believed they were too functionally limited to complete the test. Five of the subjects were missing postrehabilitation walk data due to scheduling difficulties. Because scheduling difficulties are likely unrelated to the outcome, one might assume that the postrehabilitation data for these five subjects were missing at random. However, in order to determine if subjects who had both prerehabilitation and postrehabilitation walk tests differed from those who did not complete both walks, two-sample t tests were used to compare mean baseline characteristics for those with and without complete walk test data. All SF-36 variables were compared for the two groups, as were age, gender, pulmonary function measures, and exercise test parameters. These two groups did not differ in a statistically significant manner for any of the SF-36 variables, although there was a trend for the group with incomplete walk test data to report higher general health scores (mean ± SE of 39.7 ± 4.0 for those with complete walk data compared with 54.4 ± 6.3 for those with incomplete data).
incomplete data; \( p = 0.054 \). Conversely, mean percent predicted residual volume values were higher for those with incomplete data than for those with complete data (337.8 ± 31.0 vs 247.1 ± 14.5; \( p = 0.006 \)). The SF-36 general health scale suggests that those with incomplete walk data may have had better quality of life at baseline, while the residual volumes suggest they had more air trapping and were thus sicker. These two conflicting results could be spurious especially given the numerous other variables compared, for which there were no differences. However to be cautious, the significance of change in 6-min walk distance should be verified in future studies.

Relationship Among Prerehabilitation Quality of Life, Functional Capacity, and Airflow Limitation

To determine if there was a relationship among the three major aspects (functional capacity, quality of life, and airflow limitation) of the COPD patients evaluated in this study, we performed correlations among the prerehabilitation FEV\(_1\) (percent predicted), prerehabilitation SF-36 subscale scores, and prerehabilitation walk distance. There was no significant correlation between percent-predicted FEV\(_1\) and SF-36 subscales. There was a significant correlation between the 6-min walk and three of the SF-36 scales: physical function, pain, and general health (Table 2). However, the correlation was strongly positive only for the physical subscale \((r = 0.70\) and \( p = 0.001 \)).

Relationship of Airflow Limitation With Functional Capacity and Quality-of-Life Improvements After Rehabilitation

To determine whether the degree of airflow limitation might be used to predict which patients would have positive outcomes after pulmonary rehabilitation, we analyzed the correlation between the change in SF-36 and change in 6-min walk test and baseline FEV\(_1\). There was a significant correlation between prerehabilitation FEV\(_1\) and the improvement in physical function scale of the SF-36 \((r = 0.41\) and \( p = 0.019 \)), and between FEV\(_1\) and the improvement in energy/fatigue \((r = 0.51\) and

<table>
<thead>
<tr>
<th>SF-36 Scale</th>
<th>Before Rehabilitation</th>
<th>After Rehabilitation</th>
<th>p Value</th>
</tr>
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<tbody>
<tr>
<td>Physical function</td>
<td>29.5 ± 3.7</td>
<td>38.8 ± 3.7</td>
<td>0.0054</td>
</tr>
<tr>
<td>Role physical</td>
<td>20.2 ± 5.4</td>
<td>36.1 ± 5.9</td>
<td>0.3290</td>
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<tr>
<td>Bodily pain</td>
<td>77.5 ± 4.5</td>
<td>83.2 ± 3.1</td>
<td>0.1000</td>
</tr>
<tr>
<td>General health</td>
<td>44.1 ± 3.5</td>
<td>43.1 ± 3.7</td>
<td>0.7911</td>
</tr>
<tr>
<td>Vitality</td>
<td>43.0 ± 3.3</td>
<td>54.3 ± 2.7</td>
<td>0.0028</td>
</tr>
<tr>
<td>Social function</td>
<td>59.5 ± 4.7</td>
<td>68.5 ± 4.0</td>
<td>0.0068</td>
</tr>
<tr>
<td>Role emotional</td>
<td>66.7 ± 6.5</td>
<td>80.2 ± 5.1</td>
<td>0.0494</td>
</tr>
<tr>
<td>Mental health</td>
<td>70.6 ± 2.7</td>
<td>77.6 ± 2.4</td>
<td>0.0203</td>
</tr>
<tr>
<td>Health change</td>
<td>31.1 ± 4.3</td>
<td>56.1 ± 5.4</td>
<td>0.0001</td>
</tr>
<tr>
<td>6-min walk</td>
<td>1,016.0 ± 70.9</td>
<td>1,237.8 ± 78.0</td>
<td>0.0002</td>
</tr>
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</table>

*Values are expressed as means ± SE.

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**Table 1—SF-36 Scores and 6-min Walk Distance Before and After Rehabilitation**

**Figure 2.** SF-36 physical function scores of individual patients before and after rehabilitation (Rehab).

**Figure 3.** Six-minute walk distances of individual patients before and after rehabilitation. See Figure 2 legend for abbreviation.
Quality of life can be measured in patients with COPD either by disease-specific tools that have been specifically designed for use in patients with respiratory system disorders or by generic quality-of-life tools that can be used across populations with a variety of medical conditions. Examples of disease-specific HQL tools for COPD patients include the Chronic Respiratory Questionnaire (CRQ),15 the St. George’s Respiratory Questionnaire,16 the Pulmonary Functional Status and Dyspnea Questionnaire,17 and the Pulmonary Function Status Scale.18 General HQL instruments that have been used in patients with COPD include the Quality of Well-being (QWB),19 Sickness Impact Profile,20 Nottingham Health Profile,21 and the Health Status Index (SF-36).22 The major advantage of using a disease-specific tool to assess the impact of pulmonary rehabilitation is that these measures address specific issues, such as shortness of breath, which are important to the patient’s primary respiratory disease. However, with a generic quality-of-life measure, more global issues related to quality of life can be assessed, such as social role, mental health, and general well-being. Also, patients with COPD can be compared to patients with other chronic illnesses and healthy populations. The choice of using a disease-specific vs a general quality-of-life tool will depend in part on the objectives of the study.

Three randomized, controlled studies have shown that pulmonary rehabilitation improves quality of life as measured by the CRQ, a disease-specific tool.18–20 Goldstein et al4 showed an improvement in all four components of the CRQ in patients with COPD immediately following rehabilitation. Wijkstra et al23 and Cambach et al24 showed an improvement in the CRQ scores over a 6-month period following rehabilitation.

The QWB is a generic tool that has been used to evaluate HQL in response to pulmonary rehabilitation in several uncontrolled studies.25,26 In the only randomized, controlled study of pulmonary rehabilitation using the QWB as an outcome measure, Ries et al27 found no significant difference in QWB following rehabilitation. One disadvantage in the use of the QWB is the requirement for administration by an experienced interviewer.

The Health Status Index (SF-36) is a generic tool and was used in our study because it is self-administered and has been shown to be a sensitive and promising instrument to measure HQL for general populations, including elderly patients and in response to bronchodilators in patients with COPD.28,29 Mahler and Mackiowiak13 have shown the SF-36 to be a valid instrument to measure quality of life in patients with COPD. The SF-36 is readily

<table>
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<th>SF-36 Scale</th>
<th>Walk Distance</th>
<th>FEV₁ Percent Predicted</th>
</tr>
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<tbody>
<tr>
<td>Physical function</td>
<td>r = 0.70</td>
<td>p = 0.0001</td>
</tr>
<tr>
<td>Role physical</td>
<td>r = 0.38</td>
<td>p = 0.03</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>r = 0.42</td>
<td>p = 0.02</td>
</tr>
<tr>
<td>General health</td>
<td>r = 0.50</td>
<td>p = 0.15</td>
</tr>
<tr>
<td>Vitality</td>
<td>r = 0.30</td>
<td>p = 0.10</td>
</tr>
<tr>
<td>Social function</td>
<td>r = 0.24</td>
<td>p = 0.20</td>
</tr>
<tr>
<td>Role emotional</td>
<td>r = 0.02</td>
<td>p = 0.09</td>
</tr>
<tr>
<td>Mental health</td>
<td>r = 0.03</td>
<td>p = 0.01</td>
</tr>
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*p = 0.003). However, there was no correlation between FEV₁ and change in 6-min walk test (r = 0.010 and p = 0.666).

Relationship Between Improvement in Quality of Life With Improvement in 6-min Walk

We did not find a significant correlation between the improvement in SF-36 physical function score and the 6-min walk distance (r = 0.16 and p = 0.430). There was a trend toward a significant correlation (r = -0.34 and p = 0.094) between improvement in energy/fatigue and improvement in the 6-min walk distance in this small sample.

**DISCUSSION**

This study demonstrates an improvement in HQL using a general tool to measure HQL in patients with COPD following a comprehensive pulmonary rehabilitation program, including medical management, education, exercise training, and psychosocial counseling. Although there was an improvement in 6-min walk distance following rehabilitation, there was not a significant correlation between the improvement in HQL and improvement in walk distance, indicating independence of these measures.
accepted by patients as well; in one study,21 the response to surveys mailed to 1,980 patients was 82%.

The results of this investigation indicate an improvement in HQL measured by the SF-36 in patients with COPD after pulmonary rehabilitation. This improvement is striking in light of the demonstrated decline in all SF-36 scales in a healthy population over 3 years of follow-up26 and in COPD patients over 2 years.30 There are several potential explanations for the improved quality of life using the SF-36 in the current study and the lack of change in quality of life using the QWB in the randomized study of Ries et al.27 First, the SF-36 may be more sensitive to change in response to rehabilitation in patients with COPD than the QWB because of the content of this questions. Second, the pulmonary rehabilitation program employed in the two studies may be different. As contrasted to the study of Ries et al,27 which used an 8-week program, the current study employed a 3-week rehabilitation program, but the total number of rehabilitation sessions in these two studies was similar. The more intense nature of our rehabilitation program that was conducted during 3 weeks may have accounted for the improved HQL in the present study. Third, different patient populations may have been enrolled in the two studies. This is unlikely since patients in both studies had underlying COPD and similar degrees of airflow limitation. Lastly, as in all uncontrolled studies, there is no evidence that the improvement shown by the SF-36 would exceed any seen in a control group. Further studies with control groups are now needed to confirm these findings.

Most pulmonary rehabilitation programs are conducted in the outpatient setting and are usually conducted several times per week for 6 to 12 weeks. For example, in the study of Wijkstra et al.,3 the intervention was a 12-week outpatient rehabilitation program with monthly nurse and physician visits; Cambach et al.24 used an 8-week outpatient rehabilitation program. However, some programs have a longer duration. In the study of Goldstein et al.,4 an 8-week inpatient program was followed by 16 weeks of supervised outpatient rehabilitation. The rehabilitation program used in the current investigation was conducted for only 3 weeks and included a total of 12 exercise sessions. The more intense rehabilitation program in the current study was employed to encourage patients to adopt a change in their daily routine to include regular exercise and for the convenience of patients who resided outside of Denver. However, the short duration of our rehabilitation program and the subsequent need for repeated measurement of quality-of-life assessment at 3 weeks may have led to a recall effect. A randomized design with a control group without pulmonary rehabilitation is recommended to eliminate any potential bias in the present study due to a recall effect on the SF-36.

The SF-36 showed significant improvement in physical function, energy/fatigue, emotional role, mental health, and health change following pulmonary rehabilitation, although following rehabilitation these scores remained below those of healthy adults. This suggests that patients perceived an improvement and that the goal of pulmonary rehabilitation, i.e., to improve the functional capacity and function in the community,28,29 was achieved.

The SF-36 scores of pain, general health, social function, and physical role were not significantly changed after rehabilitation. Bodily pain was similar in our COPD patients to the general population and would not be expected to change since it is not a focus of rehabilitation. Similarly, since rehabilitation does not affect the underlying COPD, it is not unexpected that the patient’s perception of his or her general health would change. The borderline significance of the improvement in social function in the current study may have been due to the small sample size. Alternately, the effects of rehabilitation and improved physical function might be anticipated to require a longer period of time for the patient to readjust his or her role within the family and community. Thus, social function and physical role may require more than the 3-week time period between the administration of the SF-36 in order for the patient to recognize improvement. More likely, the patients’ usual home and social routines were disrupted due to travel to Denver to participate in the rehabilitation program, and the patients were not able to assess the impact of rehabilitation on their social function.

In our study, there was no significant correlation between FEV1 and prerehabilitation SF-36 scores. Mahler et al.22 only noted a correlation between FEV1 and three of the SF-36 subscales (physical function, role function, and general health). However, a later study13 by the same authors found the percent-predicted FEV1 to be significantly correlated with five of the SF-36 scores. Thus, it appears that the degree of airflow limitation may not be the most important determinant of quality of life. Mahler et al.22,30 have suggested that quality of life is more highly correlated with degree of dyspnea than with the severity of airflow limitation.

We found a statistically significant improvement in 6-min walk distance after rehabilitation, which has also been demonstrated in previous studies.4,31,32 The mean improvement in walk distance in the current study (67 m) is more than double the size considered to be clinically significant (30 m) by some
Emphysema Treatment Trial,33 which is using the changes seen in the SF-36. Further information and eliminate the possibility of a recall effect in the findings noted in this nonrandomized investigation and randomized design is required to confirm life following pulmonary rehabilitation, use of a controlled, randomized design is required to confirm the sensitivity noted in this nonrandomized investigation and eliminate the possibility of a recall effect in the changes seen in the SF-36. Further information concerning the sensitivity of the SF-36 to change following pulmonary rehabilitation (and lung volume reduction surgery) may come from the National Emphysema Treatment Trial,33 which is using the SF-36 as an outcome measure. Additional studies are also indicated to assess rehabilitation programs of different designs in other groups of COPD patients before this quality-of-life tool can be widely recommended. In addition, based on these results, it may be important to assess the 6-min walk distance as an important and independent outcome measure of pulmonary rehabilitation, since it may measure different constructs than the SF-36.

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