Are Patients With COPD More Active After Pulmonary Rehabilitation?

Fábio Pitta, Thierry Troosters, Vanessa S. Probst, Daniel Langer, Marc Decramer and Rik Gosselink

Chest 2008;134;273-280; Prepublished online April 10, 2008; DOI 10.1378/chest.07-2655

The online version of this article, along with updated information and services can be found online on the World Wide Web at: http://www.chestjournal.org/content/134/2/273.full.html
Are Patients With COPD More Active After Pulmonary Rehabilitation?*

Fábio Pitta, PhD; Thierry Troosters, PhD; Vanessa S. Probst, PhD; Daniel Langer, MSc; Marc Decramer, PhD; and Rik Gosselink, PhD

Background: Despite a variety of benefits brought by pulmonary rehabilitation to patients with COPD, it is unclear whether these patients are more active during daily life after the program.

Methods: Physical activities in daily life (activity monitoring), pulmonary function (spirometry), exercise capacity (incremental cycle-ergometer testing and 6-min walk distance testing), muscle force (quadriceps and handgrip force, and inspiratory and expiratory maximal pressures), quality of life (chronic respiratory disease questionnaire), and functional status (pulmonary functional status and dyspnea questionnaire-modified version) were assessed at baseline, after 3 months of a multidisciplinary rehabilitation program, and at the end of a 6-month multidisciplinary rehabilitation program in 29 patients (mean age, 67 ± 8 years; FEV1, 46 ± 16% predicted).

Results: Exercise capacity, muscle force, quality of life, and functional status improved significantly after 3 months of pulmonary rehabilitation (all p < 0.05), with further improvements in muscle force, functional status, and quality of life at 6 months. Movement intensity during walking improved significantly after 3 months (p = 0.046) with further improvements after 6 months (p = 0.0002). Walking time in daily life did not improve significantly at 3 months (mean improvement, 7 ± 35%; p = 0.21), but only after 6 months (mean improvement, 20 ± 36%; p = 0.008). No significant changes occurred in other activities or in the pattern of the time spent walking in daily life. Changes in dyspnea after the program were significantly related to changes in walking time in daily life (r = 0.43; p = 0.02).

Conclusion: If one aims at changing physical activity habits in the daily life of COPD patients, the contribution of long-lasting programs might be important.

(CHEST 2008; 134:273–280)

Key words: COPD; exercise; physical activity; pulmonary rehabilitation

Abbreviations: ANOVA = analysis of variance; CI = confidence interval; CRDQ = chronic respiratory disease questionnaire; DAM = DynaPort activity monitor; PFSDQ-M = pulmonary functional status and dyspnea questionnaire-modified version; 6MWT = 6-min walk time

There is a large body of evidence showing that pulmonary rehabilitation programs are beneficial to patients with COPD in order to improve exercise capacity, muscle force, symptoms, and health-related quality of life. However, evidence is scarce concerning the translation of these improvements into a more active lifestyle after the program. It is known that patients with COPD are significantly less active in daily life than healthy elderly persons, and their activity level is further reduced by acute exacerbations. Therefore, an active lifestyle should be considered as a therapeutic priority in this population since it has been shown that patients with COPD who perform some level of regular physical activity have a lower risk of both COPD admissions and mortality.

Technological advances have resulted in the use of motion sensors to investigate the effects of pulmonary rehabilitation programs on daily physical activity during long-term assessments in the patients’ own environment. However, previous studies that have sought to investigate the effects of pulmonary rehabilitation on daily physical activity using motion sensors in COPD patients have produced conflicting results. Furthermore, a limitation of the available studies is that none of them involved rehabilitation programs longer than 8 weeks. Longer interventions might be necessary to result in larger improvements, as has been suggested for patients with chronic heart failure.
The primary aims of the present study were as follows: to investigate the effects of 3 and 6 months of pulmonary rehabilitation on the time spent by COPD patients in different activities and body postures in daily life, as well as on the intensity at which the physical activity was performed; and to examine whether pulmonary rehabilitation leads to a change in the duration of bouts of continuous walking. Secondary aims were to determine the predictors of changes in physical activities in daily life after the program and to analyze whether the occurrence of an acute exacerbation during the program had any influence on the changes in the time spent walking in daily life. Preliminary results of this study have been previously reported in the form of abstracts.11,12

Materials and Methods

Study Design

In this longitudinal study, physical activities in daily life, pulmonary function, submaximal exercise capacity (6-min walk test [6MWT]), maximal exercise capacity (cycling), respiratory and peripheral muscle force, functional status, and health-related quality of life were assessed before, 3 months after, and 6 months after attending a multidisciplinary pulmonary rehabilitation program. An analysis of the duration of continuously active periods was performed at baseline and at the end of the program.

Subjects

Forty-one consecutive patients (31 men; mean [± SD] age, 66 ± 8 years; mean FEV₁, 45 ± 16% predicted; mean body mass index, 25 ± 6 kg/m²) were initially included in the study. The admission of patients to the study was done throughout the whole year to avoid seasonal bias in the assessments. None of the individuals had been engaged in any exercise-training program at home. All individuals gave informed consent, and all procedures were performed according to the research ethics guidelines of the Declaration of Helsinki.14 Baseline data from 19 patients included in the present sample had been used in a previous publication from our group.5

Pulmonary Rehabilitation Program

Patients participated in a 6-month outpatient multidisciplinary pulmonary rehabilitation program that consisted of the following two periods: in the first 3 months, patients exercised three times per week; and in the last 3 months, they exercised two times per week. Although the program did not include home exercise training, patients received education sessions and occupational therapy counseling regarding the importance of exercising regularly, and were taught how to incorporate a more active routine in their daily lives. Detailed information on the content and characteristics of the program are provided in the online data supplement, as well as information on how the management of acute exacerbations of COPD that occurred during the program was handled.

Methods

Spirometry was performed using the pneumotachograph of a constant-volume plethysmograph (Vmax Autobox; SensorMedics; Bilthoven, the Netherlands), according to international standards.15 In addition, the diffusing capacity of the lung for carbon monoxide was measured by the single-breath method (V6200 Autobox; SensorMedics). The results were referred to the predicted values reported by Quanjer et al.16 Isometric quadriceps force was measured using a dynamometer (Cybex Norm Dynamometer; Enraf Nonius; Delft, the Netherlands). Peak extension torque was measured at the dominant side and was evaluated at 90° of knee flexion. Reference values for quadriceps force were developed in our laboratory.15 Isometric handgrip force was measured with a hydraulic hand dynamometer (Jamar dynamometer; J.A. Preston Corporation; Jackson, MI). Peak handgrip force was assessed at the dominant side with the elbow at 90° of flexion, and the forearm and wrist in a neutral position. The reference values used were those from the study by Mathiowetz et al.15 Inspiratory and expiratory maximal respiratory pressures were measured according to the method of Black and Hyatt.19 The reference values were described by Rochester and Arora.20 Maximal exercise capacity was assessed by an incremental cycle ergometer test (Ergoline 900; Ergoline; Bülthoven, Germany) according to the standard of the European Thoracic Society/American College of Chest Physicians statement on cardiopulmonary exercise testing.21 Peak oxygen consumption, ventilation, and carbon dioxide output were measured breath by breath (model 6200; SensorMedics), and heart rate was monitored continuously by a 12-lead ECG. The values of peak oxygen consumption were related to the normal values by Jones et al.22 Functional exercise capacity was assessed by the 6MWT according to the American Thoracic Society recommendations.23 The largest distance of two tests was used in the analysis, and normal values were those described by Troosters et al.24

The individualized chronic respiratory disease questionnaire (CRDQ)25 and the pulmonary functional status and dyspnea questionnaire-modified version (PPFSDQ-M)26 were used to assess health-related quality of life and functional status, respec-
Assessment of Physical Activities in Daily Life (Activity Monitoring)

The assessment was performed with an accelerometer-based activity monitor (DynaPort activity monitor [DAM]; McRoberts BV; The Hague, the Netherlands). It consists of a small, lightweight box enclosed in a belt worn around the waist and a leg sensor (total weight, 375 g). The DAM has been validated in patients with COPD. It measures the time spent in walking, cycling, standing, sitting, or lying, as well as movement intensity during walking and is as accurate as video recordings. The technical specifications for the DAM can be found elsewhere. Assessments were performed on 5 consecutive weekdays (Monday to Friday) for 12 h per day (from wake-up time to 12 h after awaking). However, due to logistic limitations (eg, the unavailability of activity monitors, schedule constraints, personal request from the patients, misplacement of the device by the patient, or technical problems with the measurements), not all patients had 5 valid days of assessment. Of the 41 patients included in the study, 28 (68%) had 5 assessment days, and none of the remaining patients had < 2 days of assessment. A similar percentage of valid assessment days was obtained when patients were assessed after 3 months and after 6 months of pulmonary rehabilitation. We have previously shown that a minimum of 2 days of assessment provide an acceptable intraclass reliability coefficient in order to monitor physical activities in daily life in patients with COPD. \(^{27}\) Regardless of the number of valid assessment days in each assessment moment (ie, at baseline, and after 3 and 6 months of rehabilitation) for a given patient, the results were averaged for analysis.

Pattern of Time Spent Walking in Daily Life

Using the DAM software, the periods of time spent continuously walking were counted in each valid assessment day at baseline and after 6 months of pulmonary rehabilitation. Any period of walking time was incorporated into the analysis. Periods of continuous walking were categorized from 1 s to 1 min (< 1 min), from 1 to 2 min, from 2 to 3 min, and so on up to 10 min; longer periods were categorized as > 10 min. Periods in each category were calculated as the average number of periods per day.

Statistical Analysis

Statistical analysis was performed using a statistical software package (SAS, version 8; SAS Institute; Cary, NC; and GraphPad Prism 3; GraphPad Software; San Diego, CA). Normal distribution was checked with the Kolmogorov-Smirnov test. The results were described as the mean ± SD, except for cycling time in daily life, which was shown as the median (interquartile range) due to the nonnormal distribution of the data.

Comparison of the outcomes in the three assessment moments (ie, at baseline, and after 3 and 6 months of rehabilitation) was performed with repeated-measures analysis of variance (ANOVA) except for the cycling time in daily life, which was analyzed with the equivalent nonparametric test (Friedman test). The Pearson correlation coefficient was used for the single correlation between improvements in walking time in daily life and the other variables. The level of significance was set at \(p < 0.05\) for all of the analyses.

RESULTS

Dropouts

Twelve patients (29%) dropped out of the rehabilitation program due to a lack of motivation or personal reasons (n = 7), unrelated problems (ie, orthopedic or GI; n = 4), or a sequence of three consecutive severe acute exacerbations requiring long-term hospitalization (n = 1). There were no statistically significant differences at baseline between the group of patients who dropped out (n = 12) and the group of patients who completed the program (n = 29), including measurements of physical activities in daily life. More details are described in the online data supplement.

General Results

The mean attendance for the program in the 29 patients (23 men) who completed the study was 55 ± 5 sessions (92 ± 8% of expected). The general characteristics of these patients are summarized in Table 1. The 6-min walk distance, the maximal workload, the peak oxygen consumption, and quadriceps force improved significantly after 3 months of training (\(p < 0.05\)), as well as the FEV\(_1\) (\(p < 0.05\)) [see the discussion in the online data supplement] and all the domains of the PFSDQ-M and CRDQ questionnaires (all \(p < 0.0001\)). Further improvements after 6 months of training were observed in functional status, with similar trends for quadriceps force and health-related quality of life (Table 1).

Physical Activities in Daily Life

The mean walking times assessed in daily life were 55 ± 26 min/d at baseline, 59 ± 27 min/d after 3 months of rehabilitation (\(p = 0.21\) vs baseline), and 65 ± 29 min/d after 6 months of rehabilitation (\(p = 0.008\) vs baseline and \(p = 0.10\) vs 3 months; \(p = 0.02\) [ANOVA]). Figure 1 shows that the mean improvement in walking time after 3 months of pulmonary rehabilitation was 7%, whereas it was 20% after 6 months.

Assessment at baseline showed that patients spent a mean duration of 227 ± 92 min/d standing, 355 ± 121 min/d sitting, and 77 ± 87 min/d lying down. There were no significant changes in these outcomes both after 3 months and after 6 months of training (\(p > 0.14\) for all [ANOVA]; Fig 2). The mean movement intensity during walking increased significantly after 3 months (from 1.81 ± 0.24 to 1.85 ± 0.30 m/s\(^2\); \(p = 0.046\)). After 6 months of training, the mean movement intensity during walking (1.94 ± 0.30 m/s\(^2\)) was significantly higher in comparison to baseline (\(p = 0.0002\)), with a strong trend of improvement in comparison to 3 months of training (\(p = 0.07\)). The number of blocks of continuous walking done per day did not change after 6 months of pulmonary rehabilitation (Fig 3 and online data supplement).

www.chestjournal.org
that the vast majority of patients who improved their
daily life were significantly related to changes in the
dyspnea domain of the CRDQ (r = 0.43; p = 0.02) and
the number of sessions completed by the patient
(r = 0.38; p = 0.04). The gray area in Figure 4 shows
that the vast majority of patients who improved their
walking time in daily life decreased their lying time (19
of 23 patients; 83%), which was not observed for sitting
time or standing time.

**Acute Exacerbations and the Rehabilitation Program**

Twelve of the 29 patients who completed the
pulmonary rehabilitation program (41%) were hospi-
talized due to severe acute exacerbation during the
period of the program. Despite the hospitalization,
the mean improvement in walking time after 6

---

**Table 1—General Characteristics of COPD Patients at Baseline, and After 3 and 6 Months of Pulmonary Rehabilitation**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Baseline</th>
<th>3 Mo</th>
<th>6 Mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>67 ± 8</td>
<td>65 ± 5</td>
<td>65 ± 5</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>25 ± 5</td>
<td>25 ± 5</td>
<td>25 ± 5</td>
</tr>
<tr>
<td>Fat free mass, kg (n = 26)</td>
<td>48 ± 8</td>
<td>48 ± 7</td>
<td>47 ± 8</td>
</tr>
<tr>
<td>Pulmonary function, % predicted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEV₁</td>
<td>46 ± 16</td>
<td>50 ± 21†</td>
<td>48 ± 19</td>
</tr>
<tr>
<td>FVC</td>
<td>92 ± 21</td>
<td>92 ± 24</td>
<td>92 ± 19</td>
</tr>
<tr>
<td>FRC</td>
<td>176 ± 42</td>
<td>181 ± 34</td>
<td>186 ± 38</td>
</tr>
<tr>
<td>TLC</td>
<td>114 ± 15</td>
<td>117 ± 12</td>
<td>116 ± 12</td>
</tr>
<tr>
<td>DLCO (n = 28)</td>
<td>51 ± 22</td>
<td>48 ± 19</td>
<td>48 ± 19</td>
</tr>
<tr>
<td>Muscle force</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QF % predicted (n = 27)</td>
<td>70 ± 19</td>
<td>75 ± 16†</td>
<td>78 ± 14‡‡</td>
</tr>
<tr>
<td>Nm (n = 27)</td>
<td>117 ± 31</td>
<td>125 ± 20</td>
<td>132 ± 26‡‡</td>
</tr>
<tr>
<td>HF % predicted (n = 27)</td>
<td>100 ± 19</td>
<td>107 ± 25‡</td>
<td>107 ± 20</td>
</tr>
<tr>
<td>Pimax % predicted</td>
<td>80 ± 29</td>
<td>85 ± 23</td>
<td>84 ± 29</td>
</tr>
<tr>
<td>Pimax % predicted</td>
<td>105 ± 31</td>
<td>109 ± 27</td>
<td>110 ± 29</td>
</tr>
<tr>
<td>Exercise capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6MWD % predicted</td>
<td>68 ± 19</td>
<td>75 ± 18†</td>
<td>76 ± 20‡</td>
</tr>
<tr>
<td>m</td>
<td>436 ± 121</td>
<td>484 ± 120</td>
<td>483 ± 125†</td>
</tr>
<tr>
<td>Wmax % predicted (n = 28)</td>
<td>55 ± 25</td>
<td>65 ± 24†</td>
<td>64 ± 29‖</td>
</tr>
<tr>
<td>W (n = 28)</td>
<td>79 ± 33</td>
<td>92 ± 32†</td>
<td>93 ± 32‖</td>
</tr>
<tr>
<td>Peak VO₂ % predicted (n = 28)</td>
<td>63 ± 30</td>
<td>70 ± 31‡</td>
<td>66 ± 30</td>
</tr>
<tr>
<td>L/min (n = 28)</td>
<td>1.06 ± 0.35</td>
<td>1.18 ± 0.42†</td>
<td>1.10 ± 0.39</td>
</tr>
<tr>
<td>Functional status (n = 26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PF50DQ-M</td>
<td>44 ± 12</td>
<td>35 ± 12†</td>
<td>31 ± 13‖‡</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>44 ± 13</td>
<td>36 ± 12‡</td>
<td>33 ± 14‖</td>
</tr>
<tr>
<td>Fatigue</td>
<td>39 ± 13</td>
<td>31 ± 12‡</td>
<td>28 ± 14‖</td>
</tr>
<tr>
<td>Quality of life (n = 26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRDQ#</td>
<td>14 ± 3</td>
<td>22 ± 7†</td>
<td>23 ± 7†</td>
</tr>
<tr>
<td>Dyspnea (5–35)</td>
<td>15 ± 5</td>
<td>19 ± 4‖</td>
<td>21 ± 4‖</td>
</tr>
<tr>
<td>Fatigue (4–28)</td>
<td>28 ± 8</td>
<td>33 ± 6‖</td>
<td>35 ± 6‖</td>
</tr>
<tr>
<td>Emotional aspect (7–49)</td>
<td>18 ± 6</td>
<td>22 ± 4‖</td>
<td>23 ± 4‖</td>
</tr>
<tr>
<td>Mastery (4–28)</td>
<td>74 ± 20</td>
<td>97 ± 16‖</td>
<td>103 ± 17‖</td>
</tr>
</tbody>
</table>

*Values are given as the mean ± SD. FRC = functional residual capacity; TLC = total lung capacity; DLCO = diffusing capacity of the lung for carbon monoxide; QF = quadriceps force; Nm = Newtonmeters; HF = handgrip force; Pimax = maximal inspiratory pressure; Pimax = maximal expiratory pressure; 6MWD = 6-min walk distance; Wmax = maximal workload; peak VO₂ = peak oxygen uptake.
†p < 0.05 vs baseline.
‡p > 0.05 and > 0.10 vs 3 mo.
§p > 0.05 and > 0.10 vs baseline
¶Values range from 0 to 100; lower values mean better functional status.
‖p < 0.05 vs 3 mo.
‡‡Higher values mean better health-related quality of life.

**Correlates of Improvement in Walking Time in Daily Life**

Changes in walking time in daily life after 6 months of pulmonary rehabilitation were not correlated to any of the baseline characteristics. Changes in walking time in daily life were significantly related to changes in the dyspnea domain of the CRDQ (r = 0.43; p = 0.02) and the number of sessions completed by the patient (r = 0.38; p = 0.04). The gray area in Figure 4 shows that the vast majority of patients who improved their
months in these patients (10 ± 25 min) was not different from the improvement observed in patients who did not have an acute exacerbation during the program (11 ± 16 min; p = 0.91). Furthermore, there was no difference concerning the changes in the 6MWT at the end of the program between patients who experienced an exacerbation and patients who did not (+ 7% vs + 9% predicted, respectively; p = 0.51). More details are described in the online data supplement.

**Discussion**

The present study showed that exercise performance, muscle force, health-related quality of life, and functional status improved after 3 months of multidisciplinary pulmonary rehabilitation in COPD patients. However, the changes in physical activities in daily life in this period were limited to an improvement in movement intensity during walking in daily life. Improvement in the time spent walking in daily life was only obtained after 6 months of rehabilitation, together with a trend for further improvement in movement intensity. Improvement in the time spent walking was not due to the exchange of shorter periods of walking for longer periods, but likely was due to the slight increase in bouts of walking of < 1 min. The majority of
patients who improved their walking time had a decrease in lying time, and patients who were more adherent to the training sessions showed a larger improvement in walking time in daily life. Improvements in walking time in daily life could not be significantly predicted by any variable at baseline, but only by changes in dyspnea after the program, as assessed by the CRDQ. Finally, the present study has also shown that the occurrence of a severe acute exacerbation of COPD requiring hospitalization did not jeopardize the improvements obtained with the 6-month rehabilitation program in terms of walking time in daily life and 6MWT. For a detailed discussion on topics such as the capacity to predict improvement in walking time in daily life, the relationship between physical activity in daily life and the activities of daily living, and the impact of acute exacerbations during the rehabilitation program, please see the online data supplement.

Previous studies have shown conflicting results concerning improvements in physical activities in daily life after short-term pulmonary rehabilitation programs (ie, ≤2 months). These studies used devices with outputs that are largely dependent on the intensity at which movements are performed rather than the time spent in different activities in daily life (eg, vector magnitude units, counts above a determined intensity threshold, and the percentage of activity energy expenditure to the resting energy expenditure). Results varied from very modest and nonsignificant improvements (approximately 1 to 6%) to significant improvements (approximately 19 to 40%). Our results showed that after 3 months of pulmonary rehabilitation, the improvement in movement intensity during walking was consistent but modest, and just reached statistical significance (p = 0.046). This borderline result may illustrate the fact that some studies have found statistically significant improvement in this outcome and others have not. In other words, an improvement in activity-monitoring outcomes related to movement intensity after short duration rehabilitation programs has not been a consistent finding in studies that have examined this issue, most likely reflecting methodological issues such as the sensitivity of the activity monitor, the characteristics of the training program, study power, and the characteristics of the study sample. Attention must also be given to the fact that differences in output from device to device require caution when interpreting the results from different studies.

Changes in Walking Time in Daily Life After 3 and 6 Months of Rehabilitation: Possible Explanations

Although patients achieved improvements in movement intensity after 3 months of pulmonary rehabilitation (ie, walking faster), more time was needed to induce the important lifestyle change of spending more time actively. Therefore, the transfer of the well-documented improvements in exercise performance, functional status, and quality of life to an increased amount of daily life physical activity is limited and takes longer than these traditional outcomes of pulmonary rehabilitation to be obtained. The lack of improvement in walking time in daily life after 3 months cannot be explained by the lack of improvement in functional exercise capacity and functional status since the 6MWT (the best predictor of walking time in daily life) and the PFSDQ-M score improved significantly over this period of time. Therefore, on one hand, the rehabilitation program used in the current trial was adequate to improve the capacity to walk and reduce the symptoms and perceived difficulties to perform activities of daily living after 3 months. However, on the other hand, these gains obtained in the short term were not translated immediately into a significant increase in walking time in daily life, showing that augmenting the functional exercise capacity and functional status does not suffice to induce a more active lifestyle. From the present data, it could be hypothesized that patients with COPD require rehabilitation programs that last >3 months in order to increase their time spent actively, as has been suggested for patients with chronic heart failure. The absence of strong relationships between the change in walking time in daily life and the changes in exercise capacity, functional status, and symptoms suggest that the long-lasting rehabilitation program was the major contributing factor to the changes in physical activity habits in everyday life that were observed in the present study. Furthermore, some psychological and environmental factors not investigated in detail in the present study (eg, depression, anxiety, motivation, feelings of self-efficacy, assumed obstacles, lack of interest, assumed benefits, support by others, and the possibility of walking in the neighborhood) may have played a role in the results. In addition, it also has to be underlined that the sample size calculation for the present study took into account the detection of the change in walking time after 6 months of rehabilitation. Therefore, it may not be ruled out that the lack of statistically significant improvement in walking time after 3 months of rehabilitation may be, at least in part, linked to a type II error. The effect size for walking time after 3 months was 0.24 (95% confidence interval [CI], –0.32 to 0.79), after 6 months was 0.53 (95% CI, 0.00 to 1.05), and from 3 months to 6 months was 0.32 (95% CI, –0.24 to 0.87). Standing time and sitting time remained practically unchanged after 6 months of pulmonary rehabilitation, in contrast to the gradual decline in lying.
time. This decline in lying time did not reach statistical significance, possibly due to the large SD. Interestingly, improvement in walking time tended to be correlated with a decrease in lying time in daily life (Fig 4), but was not correlated to changes in sitting or standing time. In fact, the gray area in Figure 4 shows that 83% of the patients who improved their walking time decreased their lying time. This is obviously a favorable transition as patients are not only walking more, but are likely doing that at the expense of a decrease in time spent in the least active position (lying).

Changes in the Pattern of Time Spent Walking in Daily Life

The present study showed that the patients’ pattern of walking did not change after 6 months. As a result, the increase in daily walking time was due to a slight increase of the number of very short bouts of walking (ie, bouts up to 1 min in length). These results do not confirm the expectation that patients would exchange shorter periods of walking for longer periods. As extended activities of moderate intensity are important to maintain the effects of rehabilitation, it is essential to make patients aware of the importance of walking for longer periods of time. Further studies looking at strategies to enhance periods of continuous physical activity are imperative.

Practical Implications

First, this study underscores the importance of longer programs to effectively increase the time spent walking in daily life in COPD patients, despite the improvement in movement intensity at 3 months. This is relevant information since walking is considered to be the most common and important type of physical activity among older adults, and its regular performance is related to reduced morbidity and mortality. However, the present study was not aimed at defining how the long-term program should be set up. Furthermore, short-term pulmonary rehabilitation programs that are not currently focusing on improving the time spent walking in daily life may fail to achieve this important objective. Making the patient more active in daily life should be a goal of pulmonary rehabilitation programs, and strategies specifically aimed at improving active time (eg, behavioral strategies) should be considered as components to be added to the program. Second, by demonstrating further improvements in functional status and similar statistical trends of improvement in muscle force and quality of life after 6 months, the present study reinforced previous reports showing that long-term pulmonary rehabilitation programs result in additional effects to those obtained with short-term programs. Third, health professionals should encourage COPD patients as much as possible to adhere to the rehabilitation program and to resume training after an acute exacerbation, since the improvement in walking time and 6MWT were not hindered by the occurrence of hospitalization for severe exacerbations of COPD.

Limitations

Since there was no long-term follow-up, it is unknown how long the patients will continue to be more active. Further research into this issue is required. Furthermore, it can be argued that the present study does not have a control group. However, it has been previously shown that COPD patients who are not following a pulmonary rehabilitation program decrease their daily physical activity over time. In addition, since it has been convincingly shown that pulmonary rehabilitation is beneficial to COPD patients, it might be considered unethical to perform randomized controlled trials involving pulmonary rehabilitation programs.

Summary

In summary, although 3 months of multidisciplinary pulmonary rehabilitation improved a variety of outcomes in patients with COPD, patients were not yet spending more time walking in daily life. Significant improvements in walking time in daily life without changing the pattern of time spent walking were observed only after 6 months of pulmonary rehabilitation. If one aims at changing physical activity habits in the daily life of COPD patients, the contribution of long-lasting programs might be important.

ACKNOWLEDGMENT: The authors thank the following professionals for their contribution to the present study: Iris Coosemans, Veronica Barbier, Ilse Muylaert, Chris Burtin, Anne Cattaert, Paul Baten, Rina Droogmans, Linda Stans, Dirk Delva, Stefaan Ledeganck, and Maarten Govaert.

REFERENCES

26 Lareau SC, Meek PM, Roos PJ. Development and testing of the modified version of the pulmonary functional status and dyspnea questionnaire (PFSDQ-M). Heart Lung 1998; 27:159–168
37 Schutz Y, Weinsier RL, Hunter GR. Assessment of free-living physical activity in humans: an overview of currently available
Are Patients With COPD More Active After Pulmonary Rehabilitation?*
Fábio Pitta, Thierry Troosters, Vanessa S. Probst, Daniel Langer, Marc
Decramer and Rik Gosselink
Chest 2008;134; 273-280; Prepublished online April 10, 2008;
DOI 10.1378/chest.07-2655

This information is current as of July 14, 2009

<table>
<thead>
<tr>
<th>Updated Information &amp; Services</th>
<th>Updated Information and services, including high-resolution figures, can be found at: <a href="http://www.chestjournal.org/content/134/2/273.full.html">http://www.chestjournal.org/content/134/2/273.full.html</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>This article cites 36 articles, 18 of which can be accessed free at: <a href="http://www.chestjournal.org/content/134/2/273.full.html#ref-list-1">http://www.chestjournal.org/content/134/2/273.full.html#ref-list-1</a></td>
</tr>
<tr>
<td>Open Access</td>
<td>Freely available online through CHEST open access option</td>
</tr>
<tr>
<td>Permissions &amp; Licensing</td>
<td>Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="http://www.chestjournal.org/site/misc/reprints.xhtml">http://www.chestjournal.org/site/misc/reprints.xhtml</a></td>
</tr>
<tr>
<td>Reprints</td>
<td>Information about ordering reprints can be found online: <a href="http://www.chestjournal.org/site/misc/reprints.xhtml">http://www.chestjournal.org/site/misc/reprints.xhtml</a></td>
</tr>
<tr>
<td>Email alerting service</td>
<td>Receive free email alerts when new articles cit this article. sign up in the box at the top right corner of the online article.</td>
</tr>
<tr>
<td>Images in PowerPoint format</td>
<td>Figures that appear in CHEST articles can be downloaded for teaching purposes in PowerPoint slide format. See any online article figure for directions.</td>
</tr>
</tbody>
</table>