

## ORIGINAL ARTICLE

# A Comparison of Twice- Versus Once-Weekly Supervision During Pulmonary Rehabilitation in Chronic Obstructive Pulmonary Disease

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**ABSTRACT.** O'Neill B, McKeivitt A, Rafferty S, Bradley JM, Johnston D, Bradbury I, McMahon J. A comparison of twice- versus once-weekly supervision during pulmonary rehabilitation in chronic obstructive pulmonary disease. *Arch Phys Med Rehabil* 2007;88:167-72.

**Objective:** To compare the effects of twice- versus once-weekly supervised pulmonary rehabilitation on exercise capacity and quality of life in patients with chronic obstructive pulmonary disease (COPD).

**Design:** Prospective, randomized, parallel-group study.

**Setting:** Hospital outpatient physiotherapy department.

**Participants:** Patients with COPD.

**Intervention:** Group 1 (n=46) received 1 supervised exercise session a week and 2 unsupervised sessions; group 2 (n=45) received 2 supervised exercise sessions a week and 1 unsupervised session for 6 weeks. Patients were assessed at baseline and at 6 weeks, 2 months, and 6 months.

**Main Outcome Measures:** Incremental (ISWT) and endurance (ESWT) shuttle walk tests and Chronic Respiratory Disease Questionnaire (CRDQ).

**Results:** Sixty-six of 91 patients (group 1, n=34; group 2, n=32) completed the 6-week program. There was no significant difference in key outcome measures between the 2 groups (ISWT, 13.50m; 95% confidence interval [CI], -10.06 to 37.15m; ESWT, 72.64s; 95% CI, -96.01 to 241.29s; CRDQ total score, 2.54; 95% CI, -3.16 to 8.24). The results of the ESWTs suggest there may be an interaction between baseline exercise capacity and benefit of pulmonary rehabilitation, with more disabled patients achieving greater benefit if they are supervised twice weekly. Irrespective of group, allocation benefits after pulmonary rehabilitation had almost dissipated by 6 months.

**Conclusions:** There was no difference in the effectiveness of twice- versus once-weekly supervised pulmonary rehabilitation. This study highlights the need for development of strategies that will maintain the improvement achieved by the initial pulmonary rehabilitation program.

**Key Words:** Exercise; Pulmonary disease, chronic obstructive; Rehabilitation.

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**P**ULMONARY REHABILITATION has been shown to be effective in improving health status and exercise capacity in patients with chronic obstructive pulmonary disease (COPD).<sup>1-4</sup> The benefit of pulmonary rehabilitation may follow a dose-response relation, and the length of programs, frequency of attendance, and amount of supervision may be responsible—at least in part—for the variability in the magnitude of reported treatment effects.<sup>1,4-8</sup>

Few studies have compared different amounts or types of supervision during exercise in COPD. Carrieri-Kohlman et al<sup>9</sup> compared exercise performance, dyspnea, self-efficacy, and anxiety between 2 different types of supervision during exercise. In this randomized controlled parallel-group study, 1 group was coached using methods based on increasing self-efficacy and the other group was monitored during equivalent treadmill training in an outpatient setting; the benefit of exercise training did not differ between the 2 groups.

A randomized controlled parallel-group study by Puente-Maestu et al<sup>8</sup> showed that self-monitored training regimens do not induce the same physiologic improvements elicited by supervised exercise training regimens. Although this study provides support for the delivery of supervised pulmonary rehabilitation programs in preference to self-monitored programs, the training methods differed for the 2 groups of patients, and the total amount of work in the self-monitored group was less than that in the supervised group.

The British Thoracic Society (BTS) statement on pulmonary rehabilitation recommends a 6-week exercise program with 3 exercise sessions per week, 2 of which should be supervised.<sup>10</sup> A recent survey<sup>11</sup> reported that 33% of UK programs provide only 1 supervised exercise session a week and that 58% provide 2 supervised exercise sessions a week. The purpose of this study was to compare the effects of twice- versus once-weekly supervised pulmonary rehabilitation on exercise capacity and quality of life (QOL) in patients with COPD.

## METHODS

### Participants

Patients (N=91) diagnosed with COPD were recruited from the pulmonary rehabilitation outpatient clinic at Belfast City Hospital.<sup>12</sup> Those with cardiovascular instability, musculoskeletal problems that would inhibit exercise, or previous attendance at pulmonary rehabilitation within 2 years were excluded. This was a randomized, parallel-group, single-blind study. Patients were randomized in sets of 12; in each set, half were randomized to group 1 and half were randomized

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to group 2. This was to facilitate the execution of pulmonary rehabilitation classes accommodating approximately 6 patients. Random numbers were generated by an independent researcher using SPSS<sup>a</sup> and stored in sealed envelopes. These envelopes were opened after patient recruitment and baseline assessment, before which time neither the study coordinator, the research team, nor the patient was aware of group allocation: in group 1, 46 patients attended 1 supervised exercise session a week and were instructed to perform their exercises unsupervised at home on 2 other days, and in group 2, 45 patients attended 2 supervised exercise sessions a week and were instructed to perform their exercises unsupervised at home on 1 other day.

The 2 groups attended the pulmonary rehabilitation program independently from each other. The content of the exercise program was the same for both groups (warm-up; circuit of 10 arm, leg, and aerobic exercises progressed to maintain moderate breathlessness; indoor walking). Patients were initially instructed in how to complete each exercise in the circuit, and then they were supervised during the session with a staff-to-patient ratio of 1:4. Adherence with unsupervised session(s) was recorded on a weekly basis using diaries. Each group attended 1 education session a week. Patients attended for a total of 6 weeks; patients who were not able to attend 6 consecutive weeks continued until they had completed the equivalent number of sessions.

At the end of the 6-week pulmonary rehabilitation program and at each follow-up appointment, the importance of independent exercise as prescribed was emphasized.

#### Power Calculation

The sample size was based on a power calculation using incremental shuttle walk test (ISWT) distance as the primary outcome measure (effect size, 1.07<sup>4</sup>; pooled standard deviation [SD], 70<sup>13</sup>). ISWT distance was chosen as the primary outcome measure because it is a valid and reliable measure of disability in COPD and relates to a patient's ability to perform activities of daily living.<sup>3,14</sup> Although the minimally important difference for the ISWT was not known in COPD at initiation of this study, it has been shown to be 40m in patients with cystic fibrosis.<sup>15</sup> Therefore, the estimated number of patients required in each group to detect a difference in ISWT performance with 80% power, a 1-tailed test, and an  $\alpha$  level of  $P$  less than .05 was 39 patients. To allow for a 10% dropout rate, additional patients were recruited.

#### Outcome Measures

Outcome measures included the ISWT, endurance shuttle walk test (ESWT), Chronic Respiratory Disease Questionnaire (CRDQ), London Chest Activities of Daily Living (LCADL) Scale, and Hospital Anxiety and Depression Scale (HADS).<sup>14,16-19</sup> Outcome measures were taken before and after the 6-week program and at 2 and 6 months after completion of pulmonary rehabilitation. All outcome measures were performed by an independent blinded assessor except the CRDQ. The assessor for the CRDQ was not involved in the prescription of exercise during the program. All measurements were collected according to recommended protocols, using a standardized order and with adequate practice walks and rest periods between exercise tests.<sup>14,16-19</sup>

Ethics approval for the study was obtained from the University of Ulster ethics committee, and all patients gave written informed consent to participate.

#### Data Analysis

Statistical analyses were performed with the SPSS.<sup>a</sup> Baseline values are reported as mean and SD unless otherwise indicated.

An unpaired  $t$  test was performed to compare patients who dropped out with those who completed the study. Between-group differences were analyzed with univariate analysis of covariance (ANCOVA). The posttreatment value was used as the response and the corresponding pretreatment value as the covariate. Before ANCOVA a plot of pretreatment versus posttreatment values was inspected to ensure that the slope of the relation between them was equal in the 2 groups, and if appropriate, a group by baseline (pretreatment) interaction was included in the model.

For patients who dropped out between the end of the 6-week program and the follow-up at 2 and 6 months, we entered the last observation carried forward. Repeated-measures analysis of variance was used to compare groups at the different time points after pulmonary rehabilitation and between groups. A  $P$  value of .05 was considered statistically significant.

## RESULTS

The study design is outlined in figure 1. There were 91 patients (61 men) recruited to this study: 46 (29 men) in group 1 and 45 (32 men) in group 2. The 6-week pulmonary rehabilitation program was completed by 66 patients (group 1,  $n=34$  [22 men]; group 2,  $n=32$  [24 men]) (table 1). The number of dropouts (28%) exceeded the estimated 10% that we had required in each group to detect a difference in ISWT performance. There were similar numbers of dropouts in each group (group 1,  $n=12$ ; group 2,  $n=13$ ), and the main reason for dropping out was illness. Despite similar mean age and baseline spirometry, there was a significant difference in the ma-

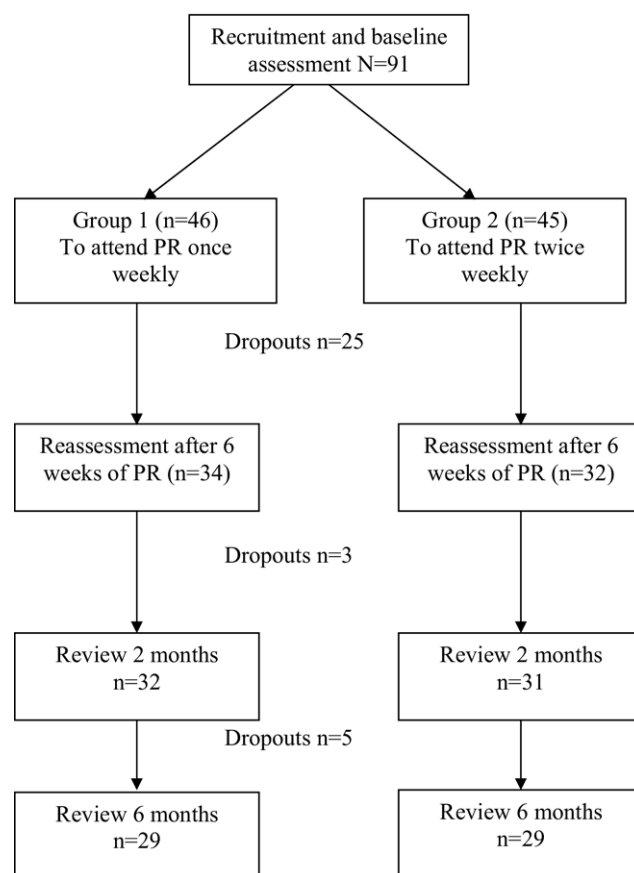


Fig 1. Study design. Abbreviation: PR, pulmonary rehabilitation.

**Table 1: Baseline Measurements for Group 1 and Group 2 who Completed the 6-Week Pulmonary Rehabilitation Program (n=66)**

Measurements	Group 1 (n=34; 22 men)	Group 2 (n=32; 24 men)
Age (y)	69.3±8.4	67.7±7.3
FEV <sub>1</sub> (L)	0.91±0.37	1.10±0.54
FEV <sub>1</sub> (% predicted)	39.0±18.2	43.8±17.3
ISWT (m) (range, 0–750m)	137.0±81.6	164.0±87.9
ESWT (s) (range, 0–1200s)	286±255	443±367
CRDQ total (range, 20–140)	70.3±19.0	75.0±18.0
LCADL (range, 0–75)	32.8±14.0	30.4±11.2
HADS anxiety (range, 0–21)	8.16±3.98	8.34±3.94
HADS depression (range, 0–21)	7.31±3.45	6.12±3.17

NOTE. Values are mean ± SD.

Abbreviation: FEV<sub>1</sub>, forced expiratory volume in 1 second.

majority of baseline outcome measures in those patients who dropped out (n=25) compared with those patients who completed the 6-week pulmonary rehabilitation program (n=66). For example, for patients who dropped out, the mean ISWT score (78.96±66.47m), ESWT score (186.32±168.98s), and CRDQ score (57.17±14.56) were significantly less ( $P<.01$ ) than those for patients who completed the 6-week pulmonary rehabilitation program (ISWT score, 150.42±85.20m; ESWT score, 362.06±321.92s; CRDQ score, 72.63±18.52).

### Results at 6 Weeks

For all outcome measures except the ESWT, the assumptions for ANCOVA were met, and there were no significant between-group differences in the change from baseline between the 2 groups after 6 weeks of pulmonary rehabilitation (table 2). For the ESWT the assumptions for ANCOVA were not met. The interaction between the baseline exercise time and the treatment was significant ( $P=.01$ ), suggesting that it would be unreasonable to perform a simple ANCOVA. The results suggested that patients who walked for a shorter time on their baseline ESWT in group 2 (attending twice a week) were more likely to improve than those who were less disabled; patients who walked for a shorter time in group 1 (attending once a week) were less likely to improve.

At the end of the pulmonary rehabilitation program, there was no significant difference between the groups in the length of time spent completing the exercise circuit during the supervised session(s) (mean difference, 4.62s; 95% confidence interval [CI], -12.24 to 21.48;  $P=.59$ ), and both groups reached a critical level of adherence to the home exercises (ie, at least 80% adherence to unsupervised home exercise sessions) over the 6 weeks.

### Results at 2 and 6 Months

Of the 66 patients who completed the pulmonary rehabilitation program, 63 attended follow-up at 2 months and 58 attended follow-up at 6 months (see fig 1). Self-reported adherence to the advice to continue independent exercise as prescribed was low. There was no significant overall difference between the groups in any outcome measure except the ESWT ( $P=.03$ ). There was some evidence that the groups were different from one another with the ESWT; this difference was there at baseline (mean difference, -157s;  $P=.047$ ; ie, group 2

walked for longer than group 1); it increased after 6 weeks of pulmonary rehabilitation (mean difference, -202s;  $P=.049$ ) and then narrowed again by 2 months (mean difference, -170.76s;  $P=.08$ ) and 6 months (mean difference, -179.36s;  $P=.062$ ).

There was a significant change over time in all outcomes, and the overall results are consistent whether the groups are considered separately (group 1, n=29; group 2, n=29) (fig 2) or when the groups are combined (n=58) (table 3). In most outcome measures, there was a significant improvement after 6 weeks of pulmonary rehabilitation. This improvement was somewhat sustained at 2 months and in some cases still statistically significant; but values had returned to near baseline levels at 6 months, with only components of the QOL score (CRDQ dyspnea,  $P=.000$ ; CRDQ mastery,  $P=.046$ ) still statistically significant (see table 3). Regardless of group allocation, patients showed a decline of the initial training effect (see table 3).

## DISCUSSION

In this study we were unable to show a difference after pulmonary rehabilitation between group 2 (supervised twice a week) and group 1 (supervised once a week).

Previous studies have examined some components of pulmonary rehabilitation, such as the length of program and the type and location of exercise training, and despite the variation in these components most have reported a similar overall response to pulmonary rehabilitation.<sup>6,7,20-22</sup> It remains unclear how much supervision is necessary for these benefits to be achieved. Although self-monitored exercise may lead to health benefits, the physiologic benefits exhibited with supervised high-intensity exercise or with individualized exercise protocols may be superior.<sup>8,20,21</sup> It has been hypothesized that greater long-term improvements in a home-based pulmonary rehabilitation program compared with a hospital outpatient program could be attributed to the promotion of greater patient adherence by exercising in a familiar environment; this would result in less reliance on supervision from health care professionals.<sup>22</sup> If a threshold exists from which there is no added

**Table 2: Between-Group Differences in the Change From Baseline Between the 2 Groups After 6 Weeks of Pulmonary Rehabilitation**

Outcome Measure	F Test (Overall Significance Level)	Mean (95% CI) Difference in Changes Between Groups
ISWT (m)	1.31 ( $P=.26$ )	13.5 (-10.1 to 37.2)
ESWT* (s)	0.74 ( $P=.39$ )	72.6 (-96.0 to 241)
CRDQ total (range, 20–140)	0.80 ( $P=.38$ )	2.54 (-3.16 to 8.24)
CRDQ dyspnea	0.73 ( $P=.40$ )	0.16 (-0.2 to 0.52)
CRDQ fatigue	0.25 ( $P=.62$ )	0.12 (-0.35 to 0.58)
CRDQ emotional function	0.07 ( $P=.79$ )	4.64 <sup>-02</sup> (-0.30 to 0.39)
CRDQ mastery	0.14 ( $P=.91$ )	2.09 <sup>-02</sup> (-0.34 to 0.38)
LCADL (range, 0–75)	0.26 ( $P=.61$ )	-0.81 (-4.02 to 2.39)
HADS anxiety (range 0–21)	0.01 ( $P=.92$ )	-5.71 <sup>-02</sup> (-1.19 to 1.08)
HADS depression (range, 0–21)	0.12 ( $P=.73$ )	-0.176 (-1.19 to 0.83)

NOTE. An increase in the ISWT, ESWT, and CRDQ scores denotes improvement; a decrease in LCADL and HADS scores denotes improvement.

\*For the ESWT, the assumptions of ANCOVA were not met.

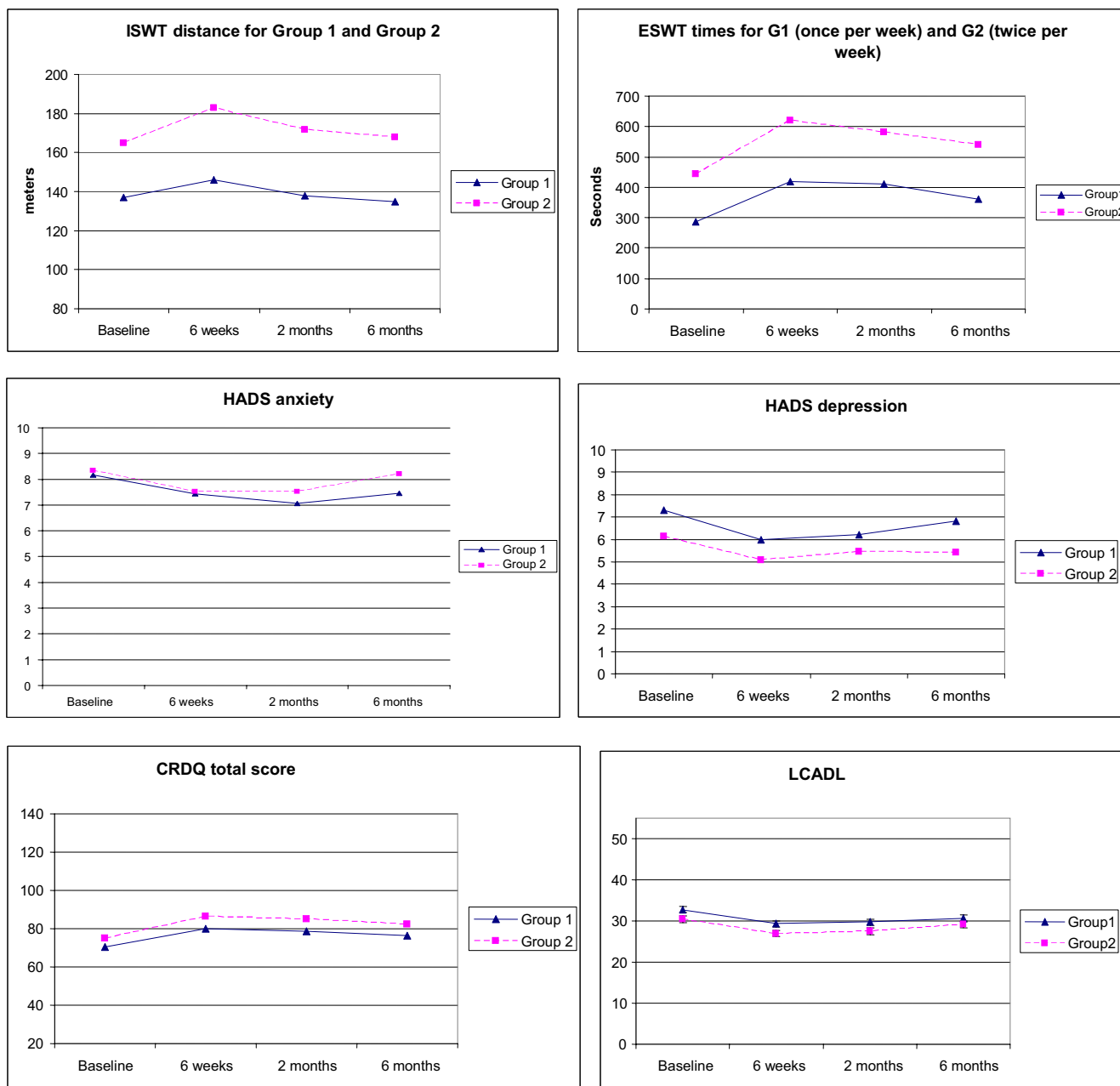


Fig 2. Change in scores in group 1 (once-weekly supervision) and group 2 (twice-weekly supervision) for all outcome measures with time: baseline, after 6 weeks of pulmonary rehabilitation, 2 months after completion of pulmonary rehabilitation, and 6 months after completion of pulmonary rehabilitation.

benefit from attending additional supervised sessions each week, it is essential that patients are offered only the minimal number of pulmonary rehabilitation classes required to achieve an optimal benefit. Promotion of adherence to unsupervised exercise sessions may be more important.

Recruitment and retention is an important issue for pulmonary rehabilitation. Most of the dropouts in this study were due to illness, and patients who failed to complete the program had significantly poorer baseline scores in almost all of the outcome measures relating to disability and handicap compared with those patients who completed the study. This further emphasizes the fact that lung function does not always predict the

response to exercise training. Future research needs to determine how best to deliver pulmonary rehabilitation to this subgroup of patients, including how and whether to restart pulmonary rehabilitation for patients who drop out.

In our study the results of the ESWT suggested that patients with greater disability did better if they were supervised twice weekly. The level of disability at entry into the program may be an important determinant of the frequency of supervision required, and different amounts of supervision may need to be offered for patients with different levels of disability. Further research may need to address the role of patient stratification according to disability.

Table 3: Mean Differences for All Outcome Measure for Patients Who Completed Pulmonary Rehabilitation at Each Time Point

Outcome Measure	Baseline: 6-Week Mean Difference (n=66)	Baseline: 2-Month Mean Difference (n=63)	Baseline: 6-Month Mean Difference (n=58)
ISWT (m)	13.5±6.00	3.91±5.87	0.56±6.11
ESWT (s)	155±39.5 <sup>†</sup>	131±42.7*	86.9±41.6
CRDQ total (range, 20–140)	10.4±1.48 <sup>†</sup>	9.17±2.02 <sup>†</sup>	6.72±2.50
CRDQ dyspnea	2.87±0.45 <sup>†</sup>	2.76±0.50 <sup>†</sup>	2.38±0.51 <sup>†</sup>
CRDQ fatigue	2.20±0.47 <sup>†</sup>	1.89±0.59*	1.13±0.64
CRDQ emotional function	2.83±0.64 <sup>†</sup>	2.52±0.932	1.83±1.08
CRDQ mastery	2.61±0.39 <sup>†</sup>	2.36±0.57 <sup>†</sup>	1.66±0.60*
LCADL (range, 0–75)	–3.46±0.97 <sup>†</sup>	–2.98±1.08*	–1.69±1.05
HADS anxiety (range, 0–21)	–0.77±0.30	–0.95±0.37	–0.41±0.39
HADS depression (range, 0–21)	–1.17±0.29 <sup>†</sup>	–0.88±0.35	–0.61±0.41

NOTE. Values are mean ± standard error. An increase in the ISWT, ESWT, and CRDQ scores denotes improvement; a decrease in LCADL and HADS scores denotes improvement.

\*Significant change at  $P < .05$ .

<sup>†</sup>Significant change at  $P < .001$ .

Irrespective of group allocation, we found that the benefits after 6 weeks of pulmonary rehabilitation were somewhat sustained for 2 months but had almost dissipated by 6 months. It has been reported that the training effect from exercise in healthy people declines at a rate of 1% a week once training ceases.<sup>23</sup> Although the effects of pulmonary rehabilitation also decline over time, long-term benefits have been reported, and the inclusion of a formal maintenance component is not strongly supported by the studies currently available.<sup>24–27</sup> Patients in our study did not attend any formal maintenance program, and although this could have contributed to the decline in benefit at 6 months, it highlights the need to investigate other mechanisms that could promote long-term adherence to exercise. Attempts to address issues of patient adherence and satisfaction with different types of pulmonary rehabilitation should be part of the evaluation process, and a minimum standard for follow-up and maintenance of pulmonary rehabilitation should be identified for future clinical guidelines.

### Study Limitations

Our pulmonary rehabilitation program lasted for 6 weeks, which is the minimum length of time recommended by the BTS guidelines, and the program included recommended elements of individualized aerobic training and upper- and lower-extremity exercise.<sup>10</sup> However, there are some limitations of this study that could affect the validity of our results. The ISWT distance was the primary outcome measure in this study. The study was powered to detect a difference in ISWT performance with 80% power and an  $\alpha$  level of  $P$  less than .05. The number of dropouts, however, exceeded the estimated 10%, and as a result the number of patients who actually completed the 6-week program may have been insufficient to show a between-group difference in this outcome.

### CONCLUSIONS

There was no difference in the effectiveness of twice- versus once-weekly supervised pulmonary rehabilitation. Patients with higher levels of disability probably require more supervision, but some of these more disabled patients may be less likely to complete a hospital-based outpatient pulmonary rehabilitation program. Further research is needed to explore the optimal frequency of supervision in pulmonary rehabilitation according to individual baseline exercise capacity.

A minimum standard for follow-up and maintenance should be identified in future clinical guidelines for pulmonary rehabilitation. Irrespective of the frequency of supervision, patients

in this study lost the benefit from pulmonary rehabilitation after 6 months. This highlights the need to develop strategies that will promote adherence to exercise and maintain the improvement achieved by the initial pulmonary rehabilitation program.

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#### Supplier

- a. Version 11; SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.