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BRIEF REPORT

Six-Minute Walk Test as an Outcome Measure

Are Two Six-Minute Walk Tests Necessary Immediately After Pulmonary Rehabilitation and at Three-Month Follow-up?

ABSTRACT

Spencer LM, Alison JA, McKeough ZJ: Six-minute walk test as an outcome measure: are two six-minute walk tests necessary immediately after pulmonary rehabilitation and at three-month follow-up? Am J Phys Med Rehabil 2008;87:224–228.

A 3-mo prospective, longitudinal, repeated-measures study was undertaken in subjects with chronic obstructive pulmonary disease (COPD). The study aimed to determine whether there was a difference in 6-min walk distance (6MWD) when two 6-min walk tests were performed after pulmonary rehabilitation ($n = 44$) and at 3-mo follow-up ($n = 40$), and whether the results reflected the program outcomes. There was a significant increase in 6MWD between two 6-min walk tests before rehabilitation ($P < 0.001$), and at 3-mo follow-up ($P < 0.001$), but not immediately after rehabilitation ($P = 0.1$). In terms of program outcomes, there was an increase in 6MWD from before to after pulmonary rehabilitation ($P < 0.001$); however, the increase was greater if the better of two tests was reported. Six-minute walk tests performed twice before and after pulmonary rehabilitation programs and at 3-mo follow-up assessments ensure accuracy of measurement of the 6MWD and program outcomes.

Key Words: COPD, Six-Minute Walk Test, Pulmonary Rehabilitation, Follow-up Assessment

The 6-min walk test (6MWT) is a simple, inexpensive, and reliable measure of functional exercise capacity.[1] It is used in both clinical practice and studies of lung disease[2] and relates better with symptoms and quality of life than do maximum exercise tests.[1] The 6MWT is widely used in pulmonary rehabilitation programs as an outcome measure to determine the effects of exercise training on functional exercise capacity.[2,3]

The 6MWT should be standardized[2–5] to ensure accurate assessment of the distance walked both before and after a pulmonary rehabilitation program.[1] Factors that have been shown to affect 6-min walk distance (6MWD) include the number of walk tests performed,[2,6,7] encouragement,[3] layout of the walking track,[2] administration of bronchodilators before the test,[8] and use of supplemental oxygen during the test.[9]

Studies have reported a significant increase in walk distance when a second 6MWT is performed before pulmonary rehabilitation.[2,6] The increase in 6MWD

observed between the first and second walk tests before pulmonary rehabilitation has been reported to range from 7%[2] to 14.9%.[9] In studies where more than two 6MWTs were performed, the largest increase in distance walked was seen between the first two walks, with the improvement in distance walked decreasing with subsequent 6MWTs.[7] The increase in distance walked when a second walk test is performed is believed to be attributable to factors such as subject motivation,[7,10,11] familiarity with the walking track, overcoming anxiety, feeling more confident, improved coordination, and adjusting to levels of dyspnea,[1] and is referred to as a learning effect.

It is unknown whether a learning effect for the 6MWT still exists at the completion of a pulmonary rehabilitation program or at follow-up assessments. Therefore, the primary aim of this study was to determine whether there was a significant difference between two 6MWTs performed after an 8-wk pulmonary rehabilitation program and at 3-mo follow-up assessment. The secondary aim was to determine whether a second 6MWT performed after pulmonary rehabilitation was required to adequately measure program outcomes.

METHOD

Subjects

Subjects diagnosed with chronic obstructive pulmonary disease (COPD) were recruited from referrals to the pulmonary rehabilitation program at Royal Prince Alfred Hospital, Sydney, Australia. Subjects were excluded if they had experienced an exacerbation in the last month, required supplemental oxygen, or had any comorbidities, such as severe cardiovascular, neurological, or musculoskeletal disease, that would prevent them from performing a 6MWT. Informed written consent was obtained from all subjects. The study was approved by the ethics committee of Sydney South West Area Health Service (Royal Prince Alfred Hospital zone).

Study Protocol

All subjects performed two 6MWTs before pulmonary rehabilitation (walk 1 and walk 2), two 6MWTs immediately after 8 wks of pulmonary rehabilitation (walk 3 and walk 4), and two 6MWTs at 3-mo follow-up assessment (walk 5 and walk 6).

Six-Minute Walk Test

Two 6MWTs were performed at a similar time of day either on consecutive attendances (walks 1 and 2) or on the same day (walks 3 and 4; walks 5 and 6). The time between testing for consecutive attendances was a minimum of 2 days and a maximum of 5 days. On all testing occasions, subjects rested for at least 10 mins before performing the first 6MWT and for a minimum of 30 mins between tests or until oxygen saturation, dyspnea, and heart rate returned to resting levels (within 2%, one point [Borg scale], and 2 bpm, respectively). All 6MWTs were performed in the physiotherapy gymnasium on a continuous 32-m track marked with black tape for easy visibility. Standardized instructions were given before each test, with encouragement given each minute throughout the test.[4] Actual instructions can be viewed at www.pulmonaryrehab.com.au. The same investigator carried out all tests.

Subjects were asked to walk as far as they could in six minutes, to do the best they could, and to cover as much ground as possible. Every minute, subjects were made aware of the time and were given standardized encouragement, such as *you are doing well—you have 5 mins to go!* This was alternated each minute with *keep up the good work—you have 4 mins remaining!* If the subjects needed to stop, they could do so, but were asked every 15 secs to commence walking as soon as they felt able.

Before and immediately after the 6MWT, oxygen saturation and heart rate were monitored using a portable saturation monitor (RAD-5v Masimo Corp, Irvine, CA), and dyspnea was measured using the modified Borg scale (0–10).[12] The Borg scale was printed on an A3 laminated sheet and was explained to the subject before the test. The test was terminated if subjects experienced chest pain, evolving mental confusion, lack of coordination or light-headedness, intolerable dyspnea, or extreme fatigue.

Lung Function Tests

Spirometry was measured using a spirometer (Niche EasyOne handheld spirometer, Device Medical Technologies, Zurich, Switzerland) according to standard procedures[13] on each test day, and results were compared with normal values.[14]

Pulmonary Rehabilitation

All subjects completed 8 wks of exercise training as part of the pulmonary rehabilitation program. The training was supervised by physiotherapists and consisted of lower-limb endurance training (20 mins of stationary cycling, 20 mins of walking on the same track used for the 6MWT), upper-limb endurance training (arm cycle ergometry and unsupported arm exercises), and strength training exercises for the upper and lower limbs. The total time subjects exercised was at least 60 mins, twice a week, for 8 wks (16 sessions). All subjects were encouraged to perform unsupervised home exercise on at least three other days. This consisted of walking for at least 30 mins plus upper- and lower-limb muscle endurance and strengthening exercises. In the 3 mos after pulmonary rehabilitation, subjects performed either home

exercise 5 days/wk ($n = 21$), or supervised exercise once per week (at the same pulmonary rehabilitation program) plus home exercise the other 4 days ($n = 19$).

Statistical Analysis

All data are presented as the mean and standard deviation (SD). 6MWD was recorded for all walk tests. In addition, the better prerehabilitation walk distance (*better pre walk*) and the better postrehabilitation walk distance (*better post walk*) for each subject was recorded. The differences in 6MWD between walk 1 and walk 2, walk 3 and walk 4, and walk 5 and walk 6 were analyzed using repeated-measures analysis of variance with planned comparisons. Data were analyzed using Statview (version 4.57, 1992–1996, Abacus Concepts Inc., Berkeley, CA).

The program outcomes were analyzed three ways using repeated-measures analysis of variance with planned comparisons to examine (1) walk 1 and walk 3, (2) *better pre walk* and walk 3, and (3) *better pre walk* and *better post walk*. For all analyses, a P value of <0.05 was taken to be statistically significant.

RESULTS

Forty-four subjects (22 males) diagnosed with COPD, mean age 66 yrs (SD 8), mean BMI 26 kg/m^2 (SD 6), mean FEV_1% predicted 56% (SD 19), completed walk 1, walk 2, walk 3, and walk 4, and 40 subjects (18 males) completed walk 5 and walk 6. Of the four subjects who were not assessed at 3-mo follow-up, the reasons given were exacerbation (1), work commitments (2), and lost to follow-up (1).

Results of mean distances walked on each walk test are presented in Table 1. There was a significant increase in 6MWD from walk 1 to walk 2 of 27 m (SD 50; 95% CI: 12–42 m; Table 2); however, the increase in 6MWD from walk 3 to walk 4 of 10 m (SD 38; 95% CI: −2 to 21 m) was not significant (Table 2). Seventy percent of the subjects walked farther in walk 2 than in walk 1 and 50% of subjects walked farther on walk 4 than in walk 3. Three months after pulmonary rehabilitation, there was a significant increase in 6MWD between walk 5 and walk 6 of 16 m (SD 25; 95% CI: 8–25 m; Table 2). Of the 40 subjects assessed at 3 mos, 78% walked farther in walk 6 than in walk 5. Analysis of program outcomes indicated that there was a significant improvement in walk distance from before to after rehabilitation for all three forms of analysis (Table 2).

DISCUSSION

The findings from this study show that there was no significant difference in 6MWD when two 6MWTs were performed immediately after pulmonary rehabilitation; however, at 3 mos after rehabilitation, a significance difference was found. Program outcomes were improved when the better of two walk tests was used to evaluate the effect of pulmonary rehabilitation on 6MWD.

The nonsignificant difference between walks 3 and 4 after pulmonary rehabilitation may have been caused by subjects becoming familiar with

TABLE 1 Results of 6-min walk test (6MWT) in chronic obstructive pulmonary disease subjects before pulmonary rehabilitation, 8 wks after pulmonary rehabilitation, and 3 mos after pulmonary rehabilitation

	Before Rehab ($n = 44$)			After Rehab ($n = 44$)			3 mos After rehab ($n = 40$)		
	W1	W2	Better	W3	W4	Better	W5	W6	Better
Distance, m (SD)	456 (76)	483 (86)	491 (82)	533 (90)	542 (102)	552 (96)	520 (96)	537 (92)	541 (93)
6MWD, % pred (SD)			71 (10)			80 (12)			77 (17)
Dyspnea (SD)	2.9 (0.4)	2.9 (1.3)		3.0 (1.6)	3.2 (1.8)		2.9 (1.4)	3.0 (1.9)	
HR rest, bpm (SD)	85 (15)	87 (14)		86 (15)	84 (15)		86 (15)	85 (15)	
HR end X, bpm (SD)	101 (19)	103 (20)		106 (17)	107 (19)		108 (20)	109 (19)	
SpO_2 rest, % (SD)	94 (1)	96 (2)		95 (3)	96 (2)		95 (2)	95 (2)	
SpO_2 end X, % (SD)	94 (4)	94 (4)		92 (4)	92 (5)		92 (5)	91 (5)	

Data are means and standard deviations (SD).

HR, heart rate; 6MWD, 6-min walk distance; end X, end of exercise; better, the longer 6MWD of the two 6MWTs; W1, walk 1; W2, walk 2; W3, walk 3; W4, walk 4; W5, walk 5; W6, walk 6.

TABLE 2 Comparison of walk tests and program outcomes

6MWT	Δ Distance (SD) (m)	% Δ (SD)	95% CI (m)	*P* Value
W1 to W2	27 (50)	7 (12)	12 to 42	0.0009
W3 to W4	10 (38)	2 (8)	−2 to 21	0.1
W5 to W6	16 (25)	4 (6)	8 to 25	0.0003
Program outcomes				
Better pre to W3	42 (51)	9 (12)	27 to 57	<0.0001
Better pre to better post	61 (49)	13 (12)	46 to 76	<0.0001

Data are means and standard deviations (SD). 6MWT, 6-min walk test; W, walk; better pre, longer 6MWD of walk 1 and 2; better post, longer 6MWD of walk 3 and 4; Δ: change; %Δ, percent change; 95% CI, 95% confidence interval of data, in meters.

walking on the test track during the pulmonary rehabilitation program, thus diminishing the learning effect and making it unnecessary to perform two 6MWTs after pulmonary rehabilitation. Despite this, 50% subjects still walked farther in walk 4 than in walk 3, making the authors conclude that two tests after rehabilitation are preferable in both clinical and research settings. To our knowledge, only one previous study[15] has reported performing two 6MWTs at the completion of a pulmonary rehabilitation program. However, no data were published to examine the change in 6MWD.

There was a significant increase in 6MWD between walk 5 and walk 6 at 3 mos after pulmonary rehabilitation. Despite some subjects attending pulmonary rehabilitation once per week, 78% of total subjects walked farther in walk 6 than in walk 5. Consequently, once subjects were no longer supervised twice a week and had become unfamiliar with the test track, two 6MWTs were needed at follow-up assessments (3 mos after the previous 6MWT) to account for a learning effect. At the commencement of pulmonary rehabilitation, the significant increase between walk 1 and walk 2 was consistent with other studies[2,6,7] and is attributed to a learning effect.

Despite finding no significant difference between walk tests immediately after rehabilitation, the size of the effect of pulmonary rehabilitation in terms of distance walked was found to vary depending on the number of 6MWTs performed. The program outcomes were greater when the *better pre walk* was compared with the *better post walk* (Table 2). If only one walk test had been performed after pulmonary rehabilitation (i.e., walk 3), the real effectiveness of the program would have been underreported. In addition, if only one 6MWT had been performed before and after pulmonary rehabilitation (walk 1 compared with walk 3), the mean increase in 6MWD of 77 m (SD 56) would not have taken into account the initial change in 6MWD between walk 1 and walk 2 and, thus, would not be an accurate assessment of the program outcomes as it included the learning effect of the 6MWT, thus overstating the response to exercise training.

It was observed that the end-exercise heart rate and dyspnea were low for this patient population. This is difficult to explain, because the instructions and encouragement were to ensure maximal effort from the subjects. In addition, end-exercise measurements were taken as soon as subjects stopped the test. In some individuals, delay in gaining an immediate output from the pulse oximeter may have contributed to lower values.

Further study is needed to determine whether there would be a larger difference between walk 3 and walk 4 after pulmonary rehabilitation if different tracks were used for training and testing.

After rehabilitation and at 3-mo follow-up, subjects performed walking tests on the same days; however, before rehabilitation, walk tests were performed on consecutive days to account for fatigue in untrained subjects. The authors did not feel that this affected the results of the study, because the main aim was to examine walk tests after rehabilitation and at 3-mo follow-up.

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