Review Article

Six-Minute Walk Test: An Effective and Necessary Tool in Modern Cardiac Rehabilitation

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The six-minute walk test (6MWT) was described by Guyatt et al[1] and is an effective tool for assessing functional capacity in patients with cardiovascular and pulmonary diseases. Today, the 6MWT is a widely used tool for measuring the response to various rehabilitation interventions in cardiovascular and pulmonary diseases, due to its easy implementation and better acceptance[2] by the patients when compared with other field tests, such as the shuttle walking test, and the 200-meter fast walk test, as the workload during the test mimics the normal activities of daily living.[3] Several studies have been published on the reliability and validity of the 6MWT in patients with congestive heart failure (CHF).[4,5]

Description of the 6MWT

During the 6MWT, the distance in meters is the primary measurement. Additional information is obtained about the response of hemodynamic parameters, such as blood pressure and heart rate,[6] together with the patient's self-evaluation of fatigue and dyspnea during the test using the Borg scale.[7] During the 6MWT, encouraging phrases, like "Keep on going like this," or "You are doing well" at intervals of 30 seconds are recommended. It is advisable for the administrator to walk behind the patient, so as not to affect the pace.[8] The increase in blood pressure, heart rate, and plasma catecholamines during the 6MWT is moderate, making it suitable for patients with significantly reduced functional capacity.[9,10]

The influence of the corridor length on the distance covered is well known: at shorter lengths frequent changes of direction are required and this results in additional energy loss.[11] To avoid such an effect it is recommended to perform the test in a corridor with a length not less than 30 m.

The 6MWT allows a global assessment of the response, not only of the cardiovascular and pulmonary systems, but of all other systems associated with gas exchange.[12] The distance covered is considered to be a powerful prognostic indicator for survival of patients with CHF.[13]

Necessary equipment and conditions for performing a 6MWT

1. A smooth walking surface, with a length not less than 30 meters, without obstacles, which needs to be marked at intervals of 1 m.
2. Chairs for rest located within a distance of 15 m.
3. Chronometer.
4. Heart rate monitor.
5. Documentation for the 6MWT.
6. Stethoscope and sphygmomanometer.

Table 1. Indications for the application of the six-minute walk test.

Before and after treatment of:
– CHF
– Lung-reducing surgery
– Pulmonary hypertension
– Pulmonary rehabilitation
– Drug therapy in COPD
– Lung transplantation or resection
To measure the functional status of:
– CHF
– COPD
– Cystic fibrosis
– Elderly patients
Predictor of hospitalization or death from:
– CHF
– COPD
– Pulmonary hypertension

CHF – congestive heart failure; COPD – chronic obstructive pulmonary disease.

7. If required by the patient's clinical condition: telemetry monitoring, additional equipment.

Administration of the 6MWT

The 6MWT is administered by different specialists, who are integrated into cardiac rehabilitation teams when patients are included in a cardiac rehabilitation (CR) program.[14] The physician's presence during the test is not mandatory, as this increases the cost, but every member of the cardiac rehabilitation team must be trained in cardiopulmonary resuscitation (CPR), basic and advanced.[15]

Several studies have pointed out that the instructions given to the patient before the start of the test, the length of the test corridor, the use of encouraging phrases, warning of the minutes remaining, and the positioning of the administrator (walking behind the patient, in the opposite direction, or standing still) can influence the distance covered significantly.[11,16] Following these instructions, the mean increase in six-minute walk distance, published in the Cochrane review for patients with stable CHF, is 40.9 m.[17]

Indications and contraindications for the 6MWT

Indications for the application of the 6MWT are listed in Table 1. Contraindications for the 6MWT cover all persons who have had a myocardial infarction during the last month, and those with high-risk arrhythmia, unstable angina pectoris, uncontrolled hypertension, hypertension with malignant course, or other clinically significant conditions that may limit physical effort, as well as musculoskeletal disorders leading to impaired walking, e.g. joint-muscle pain, arthritis, paralysis and paresis.[18,19]

Safety of the 6MWT

The safety of the 6MWT is a serious issue. It is absolutely contraindicated in patients with unstable angina pectoris or those who have experienced a cardiovascular event during the previous month.

All the members of the CR team administering the test need to be certified in CPR and to have at hand medicines for the treatment of angina pectoris, bronchospasm and severe dyspnea.[20] Relative contraindications for carrying out the test are tachycardia at rest, and a heart rate >120 beats/min. No irreversible cardiovascular events have been recorded in two large scale studies involving thousands of adults who completed the 6MWT.[21,22]

Factors influencing the six-minute walk distance

Tables 2 and 3 list the factors influencing the six-minute walk distance covered. Not surprisingly, older individuals, female individuals, and those who have a shorter step cover a shorter 6-minute walking distance. Overweight individuals with reduced muscle

Table 2. Factors associated with shorter six-minute distance.

– Small stature (short step)
– Elderly people
– Overweight
– Female gender
– Impaired cognitive ability
– Short training corridor <30 m
– COPD
– Pulmonary asthma
– Myocardial infarction or ischemia
– CHF
– Ischemic and hemorrhagic stroke
– Arthritis of the hip, knee, ankle joints
– Loss of muscle mass
– Peripheral vascular disease

Abbreviations as in Table 1.

Table 3. Factors associated with longer six-minute distance.

– Tall stature (long legs)
– Male gender
– High motivation
– Patients who have previously performed the test

mass, and those with reduced motivation or impaired cognitive abilities cover shorter distances. Arthritis and several other musculoskeletal disorders also decrease the 6-minute walk distance. The guidelines of the American Thoracic Society provide standard approaches to the performance of the test.[11]

Use of 6MWT in the clinical setting

The 6MWT is a validated,[23] inexpensive, noninvasive cardiopulmonary test[24] for functional assessment, used in various studies of patients with cardiovascular and pulmonary diseases.[25] In addition to being the equivalent of functional capacity, it is also a powerful prognostic marker for the severity of cardiac and pulmonary diseases.[26] Furthermore, the 6MWT is reproducible, well tolerated, and corresponds to submaximal moderate exercise, being approximately equivalent to the first ventilator threshold in CHF patients.[22,27,28]

For all of the above reasons, the 6MWT is widely used to assess functional capacity and prognosis.[10,13,29] It can also be used with different objectives: to predict aerobic capacity, or as a performance test to measure the response to different CR interventions encountered in everyday life, before and after intervention (CR or drug treatment).

In the study of Nilsson et al,[30] investigating the long-term effects of a group-based high-intensity cardiac rehabilitation model, an average increase of 58 m was reported, and the increase in distance was maintained at 41 m as a trend at one-year follow up. The effect size of 6MWT in this study was 0.87.[31]

Larsen et al[21] reported that the average distance covered in a 6MWT in patients with CHF is 517 m. A survey by Redelmeir indicated that an improvement of 70 m is considered clinically significant.[26] An average increase of 70-170 m (12-40%) in the six-minute distance covered has been reported as the result of various interventions.[32]

Our experience of the discriminating power of 6MWT in CHF patients is as follows.

In a randomized control study conducted at our center, two groups of eligible CHF patients were randomized into two training groups for a 12-week period. One group consisted of 38 patients who did high-intensity aerobic interval training (HIAIT), and the other consisted of 37 patients who underwent moderate continuous training (MCT). Before and after the completion of each CR program, the patients performed the 6MWT and filled in the Minnesota quality of life questionnaire.[33] The corridor used was 30 meters in length, which meets the requirements for proper performance of the 6MWT.[11]

The data from our study indicate that the average distance covered during the 6MWT (6MWD1) in both groups before the start of both CR programs was about 440 m (Figure 1), with no statistically significant differences between them ($p>0.05$). After 12 weeks of training, the mean values of the distance (6MWD2) in both groups (HIAIT and MCT) had increased significantly ($p<0.001$). Furthermore, the increase in the distance covered was significantly greater in the HIAIT group: 63 m (14.53%) in the HIAIT group and 44 m (10.6%) in the MCT group (Table 4). The fact that the participants of the HIAT group covered an average distance greater than 500 m was a clinically significant indicator.[14] According to the guidelines of the American Thoracic Society, the minimal clinically significant difference reported from the 6MWT in patients with CHF is 43 m.[11]

The significant increase of 14.53% in the distance covered by the HIAIT group during the 6MWT in our study was greater (Figure 1) than the 13% increase reported by Nilsson et al.[22] Freyssin et al, who carried out a study with similar design but 4 weeks' shorter duration, reported a 12% increase in the distance covered in the HIAIT group.[34] Current evidence-based analyses show that the average change in the 6MWT in patients with stable CHF included in programs of high intensity interval training is 40.9 m.[17]

Another important finding of our study regarding

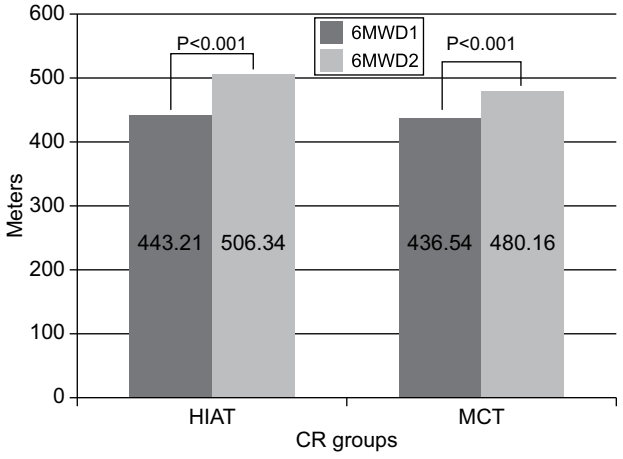

Figure 1. Average distance covered in the studied groups at the beginning and end of two cardiac rehabilitation (CR) interventions. HIAT – high intensity aerobic interval training; MCT – moderate continuous training.

Table 4. Evolution of functional capacity in two cardiac rehabilitation groups over 12 weeks of training (from T1 to T2).

CR Groups	6MWD1 (m)	6MWD2 (m)	Change (%)	VO_{2peak} T1 $mL.kg^{-1}.min^{-1}$	VO_{2peak} T2 $mL.kg^{-1}.min^{-1}$	Change (%)
HIAIT	443.21 ± 42.86	506.34 ± 39.33	14.53 ± 4.65	13.49 ± 3.78	16.97 ± 3.65	29.16 ± 21.77
MCT	436.54 ± 41.91	480.16 ± 43.93	10.06 ± 2.62	12.51 ± 3.56	14.53 ± 3.09	19.68 ± 21.69

CR – cardiac rehabilitation; 6MWD – six-minute walk distance; VO_{2peak} – peak oxygen consumption; HIAIT – high-intensity aerobic interval training; MCT – moderate continuous training.

the use of 6MWT in CHF patients was the discriminating power of 6MWD1. The discriminating distance was 439.3 ± 42.2 m: the average distance covered by the patients upon their enrollment in the rehabilitation intervention groups. Those who covered ≤439 m had a significantly lower physical capacity (peak oxygen uptake 12.1 ± 2.9 vs. 13.7 ± 4.0 $mL.kg^{-1}.min^{-1}$, p=0.05) and belonged to a less favorable NYHA functional class (2.3 ± 0.4 vs. 2.1 ± 0.3, p=0.05). No age and anthropometric differences were found between these two functional subgroups. Thus, in our view, grouping patients by 6MWD (greater or less than 439 m) significantly differentiates them with respect to their functional capacity.

Conclusions

The findings of our study and those reported by other investigators indicate that the 6MWT is an effective means of assessing functional capacity and prognosis, and is well tolerated by patients with cardiovascular and pulmonary diseases. This test is an objective, independent and powerful prognostic indicator and is able to predict peak oxygen uptake in patients with advanced chronic heart failure. It measures functional capacity, and is not a complement to or substitute for peak oxygen uptake. The 6MWT has also proved it can predict mortality in patients with symptomatic heart failure.

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