

The Six-minute Walk Test (6MWT) for the Evaluation of Pulmonary Diseases

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ARTICLE INFO

Article type:

Review Article

Article history:

Received: 27 Feb 2015

Revised: 20 March 2015

Accepted: 4 April 2015

Keywords:

Exercise

Pulmonary Disease

Six-Minute Walk Test

ABSTRACT

The six-minute walk test (6MWT) is a well-tolerated test which reflects daily activities and can be easily used in clinical practice. The 6MWT provides information about functional capacity, response to therapy and prognosis across a range of chronic cardiopulmonary conditions.

Moreover, the 6MWT is sensitive to the common therapies used for chronic obstructive pulmonary disease, such as pulmonary rehabilitation with supplemental oxygen, long-term use of inhaled corticosteroids and lung volume reduction surgery.

Several studies have investigated the role of 6MWT in the evaluation of pulmonary disease and cardiac disorders. This article aimed to review the significance of 6MWT in pulmonary disease.

► Please cite this paper as:

Ghofraniha L, Dalir Sani Z, Vakilian F, Khajedalooyi M, Javid Arabshahi Z. The Six-minute Walk Test (6MWT) for the Evaluation of Pulmonary Diseases. *J Cardiothorac Med.* 2015; 3(2): 284-287.

Introduction

Walking is a daily activity which can be performed by all individuals (1). In the early 1960s, Balke tried to evaluate the exercise capacity of healthy individuals by a 12-minute walk test within a specific period of time. The test was adjusted for the assessment of disability in patients with chronic bronchitis (2); however, since the 12-minute walk was observed to be difficult for patients with respiratory diseases, a 6-minute walk test (6MWT) was alternatively proposed (3).

The six-minute walk test (6MWT)

In 1986, Lipkin first introduced 6MWT as a simple, practical method to evaluate functional capacity (4). 6MWT is regarded as a well-tolerated test, which is more reflective of daily activities compared to other walk tests (5). Furthermore, the 6MWT is an easily administered test, which only requires a 30-meter corridor with a flat surface, and

does not need any special equipment or trained technicians to be performed (6).

The test mainly measures that the distance a person can walk on a hard, flat surface within 6 minutes, simultaneously evaluating the responses of all the systems and mechanisms involved in the exercise, including the respiratory and cardiovascular system, systemic circulation, peripheral circulation, neuromuscular system, and muscle metabolism (6).

In addition, the 6MWT measures the submaximal level of functional capacity. Since a large number of patients may not be able to reach their maximal exercise capacity during this test, they are allowed to opt for their own exercise intensity and stop to rest at any point during the 6MWT (6).

According to recent studies, the distance walked in 6 minutes is considered a proper predictor for mortality in different patients (4).

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Furthermore, it could be applied for other diseases, such as fibromyalgia, cerebrovascular accidents, severe obesity, Alzheimer's disease, rheumatologic diseases, and pulmonary vascular disease in order to assess the patient's response to treatment and predict the prognosis (7).

Indications and limitations

In one study the main indication for the 6MWT is to measure the response to therapeutic interventions in patients with moderate to severe cardiac and pulmonary disease (6). Other indications of the test are described in Table 1. In addition, the 6MWT is considered a strong predictor for morbidity and mortality in these patients (6).

Table 1. Indications for 6MWT

Pre-treatment and post-treatment comparisons

Lung transplantation
Lung resection
Lung volume reduction surgery
Pulmonary rehabilitation
Chronic obstructive pulmonary disease (COPD)
Pulmonary hypertension
Heart failure

Functional status

COPD
Cystic fibrosis
Heart failure
Peripheral vascular disease
Fibromyalgia
Aged patients

Predictor for morbidity and mortality

Heart failure
COPD
Primary pulmonary hypertension

Definite contraindications for this test include unstable angina and myocardial infarction within the previous months (6), while the relative contraindications are as follows: 1) resting heart rate ≥ 120 beats per minute; 2) a systolic blood pressure ≥ 180 mmHg and 3) a diastolic blood pressure ≥ 100 mmHg (6).

Stable angina (exertional angina) is not considered an absolute contraindication for 6MWT; however, this test needs to be performed on patients with the symptoms after receiving anti-angina medications. Therefore, nitrate medicines should be made available for these patients since they may also be at a higher risk of arrhythmias and cardiovascular collapse during 6MWT.

Interpretation of the 6MWT

In most cases, 6MWT needs to be performed twice, before and after the intervention, and the matter in question is whether the patient has experienced a clinically significant improvement in his/her condition. However, an efficient method to describe the changes in distance is not yet available, either as an absolute value or a percentage.

6MWT in Pulmonary Disease

Chronic obstructive pulmonary disease (COPD)

The average distance in patients with moderate to severe COPD is 283-388 meters, with a range of 160-600 meters (8, 9), and a distance less than or equal to 350 meters is associated with an increased risk of hospitalization and/or mortality (8, 9).

6MWT has been shown to be a strong predictor for mortality in COPD patients. According to a study, 6MWT reduced by 19% (an average of 16 meters per year) during a 5-year period in patients with stage 3 COPD (FEV1 30-50%), while it reduced by 26% in patients with stage 4 COPD (FEV1 <30%).

On the other hand, no significant correlations are found between 6MWT and airflow obstruction, exertional dyspnea, and quality of life, and several studies have indicated that 6MWT might decrease over time.

In patients with advanced COPD, for whom lung volume reduction surgery (LVRS) is considered an option, 6MWT of less than 200 meters before surgery is associated with adverse outcomes.

A significant improvement ($P < 0.05$) in 6MWT has been observed after the acute administration of oxygen, long-term treatment with inhaled corticosteroids, pulmonary rehabilitation and LVRS (8). In addition, the use of supplemental oxygen (4 liters per minute), while conducting the test on patients with COPD or interstitial lung disease (ILD), was found to increase the mean walked distance by approximately 95 meters in 6 minutes (6).

In another study, COPD patients who received treatment with inhaled corticosteroids experienced a rise of 33 meters in 6MWT (10).

Moreover, exercise and strength training of the diaphragm in these patients resulted in a mean increase of 50 meters in 6MWT (11).

In patients with severe COPD who underwent LVRS, a mean increase of 55 meters was also observed in the 6MWT (12).

Heart failure

The mean 6MWT in patients with heart failure ranges from 310 meters (left ventricular ejection fraction (LVEF) $\leq 20\%$) to 427 meters in patients with a mild condition (LVEF $\geq 53\%$).

The 6MWD has an inverse relationship with New York Heart Association (NYHA) functional class and a weak inverse correlation with quality of life (13-14).

Several authors have considered 6MWT of less than 300 meters to be a strong predictor for increased mortality. In addition, the 6MWT provides a clinically useful prognostic factor for patients with mild to moderate conditions,

whereas maximal exercise testing in patients with severe heart failure is highly indicative of the need for cardiac transplant. Accordingly, treatment with beta-blockers may not enhance 6MWT despite improvements in LVEF and NYHA classification. Furthermore, treatment with angiotensin II receptor blockers and angiotensin-converting enzyme inhibitors may not improve 6MWT.

In the current study, the distance reduced to 41 meters after drug discontinuation in patients with LVEF <35%, who were treated by digoxin (8). On the other hand, the average increase in 6MWT was 170 meters in patients with severe heart disease undergoing cardiac rehabilitation programs (6).

Pulmonary hypertension

The mean 6MWD of the patients with idiopathic pulmonary arterial hypertension receiving treatment (mean age: 37 years) and the control group (matched in terms of age) was 297 meters and 655 meters, respectively, which is indicative of a severe damage of functional walking capacity in a relatively young patient group (15).

On the other hand, shorter walking distances are significantly associated with lower NYHA classification (15).

Furthermore, there is an independent association between 6MWT and mortality rate in patients treated for pulmonary arterial hypertension. Accordingly, patients arriving at the distance of 387 meters may achieve an improved survival, regardless of the baseline 6MWT distance (16). Nevertheless, no associations were observed between distance and mortality in patients with untreated pulmonary hypertension (17).

For another thing, desaturation during 6MWT is regarded as a better predictive factor compared to the walk distance. With every one percent decrease in the arterial oxygen saturation during the test, there is a 26% increased risk of mortality.

The 6MWT is widely used in order to evaluate the patients' response to specific treatments in pulmonary hypertension. In this regard, a clinically significant improvement in distance (76-44 meters) has been observed after treatment with Bosentan, which is the new pulmonary vasodilator. Similar improvements have been reported following treatments with sildenafil or iloprost inhalation (8).

Interstitial lung disease (ILD)

The mean 6MWT distance in patients with moderate to severe interstitial lung disease (ILD) has been reported to be 415 meters (range: 96-

681 meters), with an expected Diffusing Capacity of the Lungs for Carbon Monoxide (DLCO) of 49% (18).

In addition, shorter walking distances are significantly correlated with clinical markers such as DLCO, reduced forced vital capacity (FVC), elevated pulmonary arterial pressures and decreased quality of life.

On the other hand, oxygen desaturation during 6MWT is a significant prognostic marker in patients with idiopathic pulmonary fibrosis (IPF). Patients with oxygen desaturation greater than 88% during the test have a higher mortality rate compared to those without oxygen desaturation. In total, a 4-fold increased risk of mortality is probable in these patients during a 3-year follow-up (19).

In patients with severe IPF, who are on the waiting list for lung transplantation, 6MWT of less than 207 meters is associated with a 4-fold increased risk of mortality; however, other studies have not reported any such correlations between distance and mortality in patients who are not on the waiting list for lung transplantation (20). In individuals with IPF, bosentan has not been found to affect 6MWT after 12 months, despite the improvement in the patients' quality of life as well as the reduced disease progression.

On the other hand, a small but significant difference in the 6MWT has been observed following pulmonary rehabilitation in a group of 57 ILD patients, 30 of whom had IPF as well.

Limitations of 6MWT

One of the major limitations of 6MWT is lack of adequate information on the mechanism and cause of disability during exercise; therefore, it may not be useful in the medical diagnosis of diseases.

On the other hand, cardiopulmonary exercise testing provides comprehensive information on the correlation between the systems, organs and exercise intolerance (8).

Short distances are non-specific and non-diagnostic. Additional tests which might be practical in this regard are as follows: 1) pulmonary function tests; 2) cardiac function tests; 3) ankle-brachial index; 4) muscular strength tests; 5) nutritional status; 6) orthopedic assessment and 7) cognitive function test (6).

Given the fact that the only absolute contraindications for the 6MWT include unstable angina or myocardial infarction during the previous months, cardiopulmonary exercise testing is recommended for the patients who report significant exercise-related symptoms (e.g., syncope).

Although the 6MWT is regarded as a sensitive marker of change for functional walking ability in patients with moderate to severe diseases, its advantages for patients with better exercise tolerance still remain unknown (3).

Conclusion

The 6MWT is a simple, applicable test with a significant value in the prediction of pulmonary disease. However, further medical and surgical treatment interventions are required in order to determine the precise role of this test in disease diagnosis.

Conflict of Interests

The authors declare no conflict of interest.

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