Efficacy Of Six-Minute Walk Test On Cardiac Rehabilitation Program

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Abstract: Sub-maximal laboratory test is considered as a gold standard prognostic tool which entails high significant score, particularly amongst cardiorespiratory population. However, the high cost, need for sophisticated equipment, expert personnel and physical abilities of subjects make this test inconvenient and impractical. Therefore, this paper attempts to quantify the effectiveness of the six minute walk test as an alternative screening tool amongst phase II cardiac rehabilitation population. This paper reviews with in-depth analysis, the current literature on important parameters in sub maximal tests. This review concludes that the 6MWT is the most suitable sub maximal fitness test amongst phase II and III cardiac rehabilitation patients. This knowledge should enable clinicians and researchers to make informed decision for inclusion of the 6MWT in program prescription.

Key words: Cardiac rehabilitation, Sub-maximal tests, 6MWT, phase II, Cardiorespiratory.

INTRODUCTION

Exercise rehabilitation is a method that has been particularly effective for treating individuals with physical functional impairment. Exercise rehabilitation has been shown to improve pain-free treadmill walking distance by 44 to 300% and absolute walking distance by 25 to 442% (Regensteiner et al., 1997). Cardiac rehabilitation, also known as cardiac rehab, is a modified program of exercise and education designed to help the heart patient to recover after a heart attack, or from other forms of heart disease or after heart surgery. Cardiac rehabilitation is known to be very significant and important as a secondary prevention strategy for cardiac patients from morbidity and mortality (Leon et al., 2005). The American Heart Association (AHA) and American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) have stated that the Cardiac Rehabilitation (CR) is a coordinated, multifaceted intervention designed with physical activity, psychological and social functioning, in addition to stabilizing, slowing or even reversing the progression of atherosclerotic processes (AHA/ AACVPR, 2005).

Thus, a comprehensive plan entails proper exercise programs established into four phases for ensuring efficacy and safety of the CR program. The four phases were designed into gradual stages which begins with phase one and finishes with phase four as illustrated in Table 1. The four phases involve monitored exercise, nutritional counseling, emotional support, and support and education about lifestyle changes to reduce risks of heart problems. The aims of cardiac rehabilitation are to help the heart patient regain strength, to prevent the condition from worsening and to reduce the risk of future heart problems. Cardiac rehabilitation is an option for people of all ages and with many forms of heart disease.

Commonly in the phase two program, the exercise scientist or physiologist will emphasize on the safety of the physical activity program designed to improve the functional capacity which limit the physiological and psychological effects of cardiac illness, reduce risk of sudden death and reinfarction, control cardiac symptoms, stabilize and reverse atherosclerotic processes of patients (Wenger et al., 1995). Thus, this phase II program refers to a medically supervised comprehensive outpatient program.

In phase two of CR, the patients are required to undergo a symptoms limited exercise tolerance or stress test prior to the program. The aim of doing this test is to establish the baseline of exercise capacity and maximum heart rate that are used as guidelines for an accurate exercise prescription. There were many types of symptom limited exercise tolerance or stress tests available with high reliability and validity for determining functional capacity. These includes Treadmill testing for jogging or walking or bicycle ergometer testing or...
field testing for clinical or non clinical use. However, use of the 6 minute walk test (6-MWT) is growing and becoming a prominent test amongst exercise scientists and physiologists in the phase two CR setting (Nomori et al., 2003).

Table 1: Cardiac Rehabilitation Phases

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
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<tr>
<td>Phase I Inpatient</td>
<td>Inpatient rehabilitation, usually lasting for the duration of hospitalization for an acute coronary event or surgery. It emphasizes a gradual, progressive approach to exercise and an education program that helps the patient understand the disease process, the rehabilitation process, and initial preventive efforts to slow the progression of disease. Sub-maximal exercise testing before hospital discharge is done to provide important prognostic information and help restore patient confidence.</td>
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<tr>
<td>Phase II Outpatient Electrocardiographically monitored</td>
<td>Multifaceted outpatient rehabilitation, lasting from hospital discharge to 2–12 weeks later. Phase II CR emphasizes safe physical activity to improve conditioning with continued behavior modification aimed at smoking cessation, weight loss, healthy eating, and other factors to reduce disease risk.</td>
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<tr>
<td>Phase III Supervised</td>
<td>Supervised rehabilitation, lasting 6–12 months. Establishes a prescription for safe exercise that can be performed at home or in a community service facility, such as a senior center, and continues to emphasize risk-factor reduction.</td>
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<tr>
<td>Phase IV Maintenance/Follow-Up</td>
<td>This is usually an indefinite program. The goal is to encourage lifelong adherence to the healthy habits established during Phase III. Follow-up visits can occur at 6–12 month intervals. Blood pressure and pulse measurement, serum lipid levels, and even repeat maximal exercise tolerance tests can provide useful feedback to the patient and indicate areas that may require lifestyle changes to minimize coronary.</td>
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Consensus suggests that the 6-MWT is simple, safe, inexpensive, easy to administer, self paced in nature and applicable for clinical setting (Faqqiano et al., 1997; Gayda et al., 2004; Jehn et al., 2009; Lipkin et al., 1986; Lucal et al., 1999) when compared to Cardiopulmonary Exercise Testing (CPET) with the measurement of peak oxygen uptake (peak VO₂) which is the "gold standard" for assessing aerobic capacity (Ross et al., 2010). Nevertheless, the issue of the effectiveness and accuracy of 6-MWT for phase two Outpatient CR program is constantly questioned because several research show inconsistency in conclusion.

Thus, the objective of this article is to provide a systematic review on the efficacy of the 6MWT in cardiac phase II rehabilitation program. The primary objective is to establish and emphasize that the 6-MWT is a beneficial alternative tool for use in outpatient CR programs. There are many modalities assessment in measuring health and fitness level. One of the most common, prominent and widely used tests amongst fitness and health practitioners is the 6 minute walk test. The 6-MWT is a practical, less time consume and simple test which only requires a 100 ft hallway, a timer, RPE Borg scale and blood pressure measuring equipment to complete the assessment (Hamilton et al., 2000). Compared to other sub maximal tests such as ergometer bike, arm crank, step test and treadmill walk test which require a specific room, high technology and expensive equipment, and highly trained technicians, makes the 6-MWT as the best option for use especially in large epidemiological studies (Jehn et al., 2009). Hence, the 6-MWT is slowly growing in demand amongst clinical and applied exercise physiologists; and current practice entails that phase two cardiac rehabilitation patients need to undergo the 6-MWT prior to exercise rehabilitation. However, there is increasing debate and arguments about the efficacy of this test amongst clinical health practitioners. Hence, there was a need for an evidence based review on the effectiveness of 6-MWT amongst phase two and three cardiac patients.

RESULTS AND DISCUSSIONS

The nature of interventions, the design and outcomes of previous reports on various studies are summarized in Table 2. All previous reports were analysed based on benefits, Indications, predictions and restrictions, while the potential for application were viewed based on reliability, validity, effectiveness, expediency, efficiency, and ease of administration.

Benefits of 6-MWT:

The benefit of the 6-MWT is not just a measure of a fitness component, but as a provider of various indications or predictions of health and fitness level. According to the American Thoracic Society (ACT) (2002), the 6-MWT has the ability to quantify the multiple fitness level for pulmonary and cardiovascular system, systematic circulation, hemodynamic changes, peripheral circulation, and neuromuscular and muscle metabolism (ACT, 2002). Besides, the 6-MWT is also significant for measuring functionality status, such as walking, lifting, lying, stepping, and other functions that usually affect heart disease patients (ACT, 2002). Steel
(1996) found that the 6-MWT was the most relevant and practical tool, because the test was simple, safe, inexpensive and mimics daily physical activities (ACT, 2002). The reason for describing the 6-MWT as a good functional measure was because it is self-paced and submaximal in nature, and therefore patients will have the ability to undertake physically taxing activities encountered in everyday life in a fashion similar to activities in this test. Moreover, the gradual progression with time and intensity at each level brings about a natural process that helps patients to perform in a self-paced and safe manner. For example, Grace and Bonie (2003) found that the initial effect of one to three minutes paced walking helped the patient’s body to tolerate the intensity, activity and learning effect to farther the distance without harm (Cahalin et al., 1996).

The 6-MWT was also found suitable for all types of populations, including both clinical and non clinical groups. The clinical group has shown strong indications for evaluating all pulmonary problems, obesity, musculoskeletal diseases, renal failure, children, all ages, artery diseases and sub types of chronic diseases (ACT, 2002; Cahalin et al., 1996; Fitts & Guthrie, 1995; Gualeni et al., 1998; Guyatt et al., 1991; Guyatt, 1987). Likewise, in non clinical groups, the 6-MWT was found suitable for testing amongst healthy adolescence populations.

### Table 2: Summary of Previous Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Topic of research</th>
<th>Disease</th>
<th>No of Subject &amp; Age Group</th>
<th>Intervention / Design</th>
<th>Outcome measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulz et al. (2008)</td>
<td>Incremental shuttle and six minutes walking test in the assessment of functional capacity in chronic heart failure.</td>
<td>Chronic Heart Failure</td>
<td>63 (mean age = 51)</td>
<td>Evaluated test retest of incremental shuttle test and six minute walk test in functional capacity.</td>
<td>Both test showed similar repeatability and accuracy in estimating peak VO2 maximum.</td>
</tr>
<tr>
<td>Gayda, (2004)</td>
<td>Cardiorespiratory requirement and reproducibility of the six minute walk test in elderly patients with CAD (coronary artery disease)</td>
<td>Coronary Artery Disease</td>
<td>25</td>
<td>Subject performed SLET (symptom limited exercise test) and a 6MWT (six minute walk test) to test the reproducibility.</td>
<td>The 6MWT cardiorespiratory requirement values did not differ with SLET (symptom limited exercise test) values at ventilatory threshold and the 6MWT values are reproducible in elderly patient with CAD.</td>
</tr>
<tr>
<td>Curtis et al. (2004)</td>
<td>The association of a 6-minute walk performance and outcome in stable outpatients with heart failure.</td>
<td>Stable Heart Failure</td>
<td>541</td>
<td>Patients were stratified into 4 groups (200 m, 200-300 m, 3001-400 m, &gt;400 m). The test distance covered will indicate mortality rate.</td>
<td>The 6-minute walk test identifies patients who walk less than 200 m as being at markedly increased risk of death</td>
</tr>
<tr>
<td>Menz, (2002)</td>
<td>To determine the extent to which physiological, psychological and health related factors predict 6 minute walk distance in older people</td>
<td>515 (62-95 years old)</td>
<td>Cross sectional study: 6MWD (six minutes walk distance) and qualitative test of vision, strength, peripheral sensation, reaction time, balance and short mini mental state examination, geriatric depression scale, Positive and Negative Affect Schedule (PANAS), Medical Outcome Study 36 Item Short Form Health Survey.</td>
<td>All physiological, psychological and health scores were significantly associated with 6MWD (six minutes walk distance).</td>
<td></td>
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<tr>
<td>Iribarri et al. (2002)</td>
<td>Comparison of the distances covered during 3 and 6 min walking test.</td>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>45</td>
<td>Comparative study on distance covered during 3 min and 6 min walk test using Oxygen saturation, heart rate, modified Borg scale and distance covered.</td>
<td>Significant increase in distance over 3 min and 6 min in the first 5 walks, with greatest increase in first 3 walks because of learning effect.</td>
</tr>
<tr>
<td>Opasich et al. (2001)</td>
<td>Six-minute walking performance in patients with moderate-to-severe heart failure: Is it a useful indicator in clinical practice?</td>
<td>Moderate – severe Heart Failure</td>
<td>315 (mean age = 53)</td>
<td>All subjects underwent the functional evaluation and 6MWT</td>
<td>In moderate-to-severe chronic heart failure patients, the 6-min walk test is not related to cardiac function and only moderately related to exercise capacity.</td>
</tr>
<tr>
<td>Harada, (1999)</td>
<td>Mobility-related function in older</td>
<td>86 (Older adult age)</td>
<td>Observational studies with 6 minute walk, chair stand.</td>
<td>The 6MWT is reliable and valid in relation to the</td>
<td></td>
</tr>
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<td>Study</td>
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<tr>
<td>Lucas et al. (1999)</td>
<td>The 6-min walk and peak oxygen consumption in advanced heart failure: Aerobic capacity and survival.</td>
<td>Advanced Heart Failure</td>
<td>321</td>
<td>This study compared 6MW with aerobic capacity both at peak exercise and during low level cycling.</td>
<td>The 6MW distance is not a surrogate for peak VO2 in assessing aerobic capacity or prognosis for individuals with advanced heart failure.</td>
</tr>
<tr>
<td>Faggiano et al. (1997)</td>
<td>Assessment of oxygen uptake during the 6-minute walking test in patients with heart failure: preliminary experience with portable device.</td>
<td>Heart Failure</td>
<td>26 24 M 2F (mean age = 54)</td>
<td>Patient been examined with 6MWT and simultaneously measure VO2 using portable instrument( Cortex-Metamax Germany)</td>
<td>The 6MWT is a sub maximal exercise that equal or even higher than peak VO2 with almost maximal effort. This was confirmed by the fact that in most of the patients (19 [73%] of 26), the physical work during the 6-MWT was performed at a level above the anaerobic threshold.</td>
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<tr>
<td>Strijbos et al. (1996)</td>
<td>A comparison between an outpatient hospital-based pulmonary rehabilitation program and a home-care pulmonary program in patients with COPD (Chronic Obstructive Pulmonary Disease).</td>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>45</td>
<td>Compared the effect of Hospital based outpatient rehabilitation program and homecare rehabilitation program</td>
<td>The walk test under 4 min was not sensitive enough for evaluating differences in distance walked.</td>
</tr>
<tr>
<td>Lipkin et al. (1986)</td>
<td>Six minute walking test for assessing exercise capacity in chronic heart failure.</td>
<td>Chronic Heart Failure</td>
<td>26 (mean age = 58)</td>
<td>Exercise capacity was assessed by a maximal treadmill test and the distance recorded in six minutes.</td>
<td>There were significant differences in distance between normal subjects and heart failure subjects.</td>
</tr>
<tr>
<td>Guyatt et al. (1985)</td>
<td>The 6-minute walk: a new measure of exercise capacity in patients with chronic lung disease.</td>
<td>Chronic Heart Failure and chronic lung disease</td>
<td>37 (mean age = 64)</td>
<td>Comparative Study between 6MWT and cycle ergometer in both group.</td>
<td>Both group showed improvement in walking test score up to the third walk with high precision seen after first two walks.</td>
</tr>
<tr>
<td>Butland et al., (1982)</td>
<td>Two, six and 12 minute walking test in respiratory disease.</td>
<td>Respiratory Disease</td>
<td>10 (mean age = 61) 30 (mean age = 61) 13 (mean age = 51)</td>
<td>Pacing during 12 minute test. Comparison of two, six and 12 minute test</td>
<td>12 minute suitable only for healthy population. High correlation between two, six and 12 minute walk test All tests are sensible with reproducibility. Requires two practice walks for better learning effect.</td>
</tr>
</tbody>
</table>

According to studies in Hong Kong and Austria, the 6 MWT was a highly acceptable tool for use in all health and fitness measurements. Li et al (2005) evaluated the 6-MWT amongst secondary school students of ages 4 to 11 years old, and reported very positive results with respect to reliability and validity. Gieger (2007) reported the same results in studies that were similar to that conducted by Li et al. (2005). Thus, the 6-MWT was proven to be a holistic evaluation tool as was previously suggested by the American Thoracic Society (2002).

There are several walk tests and obviously the review of literature suggests that the 6 minute walk test was far superior. Presently, there are 4 types walk tests commonly practiced in rehabilitation programs: 2 minute walk test, 12 minute walk test, self paced walk test and the shuttle walk test. Solway et al. (2000) compared all
four tests and reported that the 6 minute walk test was the most suitable tool as it had the highest correlation with oxygen consumption.

The 6-MWT was also found easy to administer compared to other sub maximal tests because it only required very basic equipment and facilities (a timer, cons, 20-30 meter hallway, and blood pressure measuring equipment). There were suggestions to include additional assessment accessories for clinical groups such as ECG and glucose marker, but these are optional. There were arguments to choose the treadmill as an optional tool to the 6 minute walk test, but the treadmill itself does not allow for self pacing compared to the 6 minute walk test, and therefore, the treadmill cannot be a substitute test (ACT, 2002).

**Indication, Prediction and Restriction:**
American Thoracic Society (2002) reported that the 6-MWT had strong indications for the moderate to severe heart and lung disease patients. Although, symptoms of exertion appeared during exercise, such as dyspnea, shortness of breath and increase heart rate towards completion of the test, but it was still an effective tool to provide complimentary information in clinical assessment. The 6-MWT was also found to have high indications of maximal oxygen consumption and a strong correlation with METs values. Studies by Hamilton et al (2000), found 88% of peak values equal VO2max with METs in 6 minute walk tests (Geiger et al., 2007). Cahalin et al (1996) had also revealed a strong correlation between 6-MWT and cycle ergometer tests on distance scale, where the distance the subject carried during sub maximal cycle ergometer test was equivalent to the distance doing a 6-MWT (Cahalin et al., 1996).

The 6-MWT is a good predictor tool for pulmonary and cardiovascular patients; for predicting types of morbidities associated towards mortality. Bittner et al. (1993) found that the 6 minute walk test amongst congestive heart failure patients combined with endpoint of death were able to predict mortality and morbidity rates through the walking distance and time of completion of the test. Therefore, the distance recorded from the 6 minute walk test is not only useful for comparing health and fitness level, but can also be used as an additional predictor of morbidity and mortality rate.

Furthermore, cardiovascular non-physical assessments, such as NYHA, Rand Instrument, Baseline Dysnea Index, Oxygen cost Diagram and Specific Activity Scale questionnaires were all strongly correlated with the 6 minute walk test. Guyatt (1991) reported moderate to high correlations (r=.47 to .59) between the 6-minute walk and the four functional status questionnaires (Rand Instrument, Baseline Dyspnea Index, Oxygen Cost Diagram, and Specific Activity Scale) amongst 43 patients with chronic heart and lung disease (Guyatt, 1987).

**Conclusion:**
Based on current and past studies it is clear that the 6-MWT is a premier tool of measurement between clinical and non-clinical populations. There were other established sub maximal tests, but with respect to cost effectiveness, expediency, efficacy of data, and handy administration, the 6 MWT was the best tool for a cardiac rehabilitation program. In addition the 6-MWT was also found to be highly efficient, valid and reliable in phase two and three patients in cardiac rehabilitation programs. Hence, it can be concluded that the 6MWT is the most suitable as sub maximal fitness test amongst phase II and III cardiac rehabilitation patients, and that this knowledge will enable clinicians and researchers to make informed decision for inclusion of the 6MWT in program prescription.

**REFERENCES**


