

Systematic review

The 6-minute walk test in outpatient cardiac rehabilitation: validity, reliability and responsiveness—a systematic review

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Abstract

Background The 6-minute walk test (6MWT) is a common outcome measurement in cardiac rehabilitation. However, a search of the literature found no established guidelines for use of the 6MWT in cardiac rehabilitation.

Objectives Systematic review of the validity, reliability and responsiveness of the 6MWT in cardiac rehabilitation.

Data sources OvidMEDLINE, SPORTdiscus, EMBASE, CINAHL, Cochrane Reviews and Cochrane Clinical Trials between January 1948 and April 2011.

Eligibility criteria Studies using 6MWTs in subjects with coronary artery disease undergoing cardiac rehabilitation on an outpatient basis, published in English, were included.

Study appraisal and methods Quantitative and qualitative analyses were conducted, including quality assessment of methodology, meta-analysis and assessment against level of evidence criteria.

Results Fifteen articles met the inclusion criteria. One high-quality study was identified for reliability, six high-quality studies were identified for validity and 11 high-quality studies were identified for responsiveness. The meta-analysis found strong evidence that the 6MWT was responsive to change in clinical status following cardiac rehabilitation, with an estimated mean difference in 6-minute walk distance of 60.43 m (95% confidence interval 54.57 to 66.30 m; $P < 0.001$). Qualitative analysis indicated moderate evidence for repeatability of the 6MWT in patients undergoing cardiac rehabilitation, for a 2% to 8% learning effect between repeated 6MWTs, for a relationship between peak heart rate during the 6MWT and during cycle exercise at the ventilatory threshold, and for moderate-to-high correlation between the 6-minute walk distance and maximum metabolic equivalents achieved on symptom-limited exercise tests.

Limitations Few studies assessed similar aspects of validity for the 6MWT.

Conclusion Strong evidence suggests that the 6MWT is responsive to clinical change following cardiac rehabilitation. Intra- and intertester reliability of the 6MWT and its validity in patients undergoing cardiac rehabilitation requires further research.

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Keywords: Six-minute walk test; Cardiac rehabilitation; Reliability; Validity; Responsiveness

Background

Measurement of oxygen consumption during cardiopulmonary exercise testing is the gold standard for determining baseline functional capacity, training intensity and cardiovascular risk, and for evaluating training outcomes in patients undergoing cardiac rehabilitation [1]. However, the 6-minute

walk test (6MWT) is often recommended [2–4] to estimate functional exercise capacity in patients undergoing cardiac rehabilitation, rather than subjecting patients to an exercise stress test. The primary outcome of the 6MWT, the 6-minute walk distance (6MWD), is used to prescribe exercise training intensity [5] and as an outcome measure for cardiac rehabilitation [6].

Despite common usage of the 6MWT in cardiac rehabilitation, guidelines for use of the 6MWT in this population were not found in a search of PubMed and CINAHL. Instead, researchers use guidelines developed for pulmonary patients [6–14]. It is not known if the 6MWT is valid and

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reliable in patients undergoing cardiac rehabilitation, and what changes in 6MWD would be expected following cardiac rehabilitation. Repeated 6MWTs are recommended in pulmonary [15–18] and chronic heart failure populations [19,20], although a recent study suggested that repeated 6MWTs are unnecessary in patients with heart failure who walk less than 300 m in their initial 6MWT [21].

Therefore, a systematic review was conducted to examine the validity, reliability and responsiveness of the 6MWT in patients undergoing cardiac rehabilitation on an outpatient basis.

Data sources

The first author conducted searches of OvidMEDLINE (January 1948 to March 2011), CINAHL and SPORTdiscus (January 1997 to April 2011), EMBASE (January 1980 to April 2011), Cochrane Reviews (current) and Cochrane Clinical Trials (current) databases using the search terms in **Box A** (see supplementary online material). The ‘date of publication’ limitation varied between the databases due to availability of library access.

Eligibility criteria

Trials using 6MWTs in subjects with coronary artery disease undergoing cardiac rehabilitation on an outpatient basis were included. Clinical trials and observational studies that described repeated 6MWTs, that compared 6MWDs with established reference tests, and that examined 6MWDs before and after cardiac rehabilitation were included. Trials that were not available as full-text articles, not in the English language, and in populations other than patients undergoing cardiac rehabilitation on an outpatient basis were excluded.

Study appraisal and synthesis methods

The first author screened titles and abstracts of the identified articles for duplicates, and adherence to inclusion and exclusion criteria. The reference lists of the included articles were scanned for potentially relevant studies. The first author extracted and tabulated the data from the included articles under the categories of reliability, validity and responsiveness, and the third author confirmed this process.

In order to assess the quality of the extracted articles for reliability, validity and responsiveness, Brink and Louw’s 13 questions [22] were combined with additional criteria on responsiveness and reliability developed by Jerosch-Herold [23] and May *et al.* [24,25] capitalising on the strengths of each tool. Questions were adapted to ensure a yes/no response [23,24]. Studies scoring over 60% positive responses for methodological criteria relevant to the study type were considered to be high quality [24], while studies scoring less than 40% were considered to be low quality. In scoring the

quality of the two reliability studies, the criteria for intra- and intertester reliability were omitted as the methodological design of both reliability studies did not include these comparisons. The first and third authors, blinded to one another, assessed each article against these criteria, as shown in **Table 1**. Differences in opinion between the two assessors were resolved through discussion and consensus.

Qualitative analysis was based upon the established level of evidence criteria in **Box 1** [24,26], and quantitative

Box 1: Levels of evidence.

Strong	Consistent findings from three or more high-quality studies
Moderate	Consistent findings from at least one high-quality study and a number of low-quality studies
Limited	Consistent findings in one or more low-quality studies
Conflicting	Inconsistent findings irrespective of study quality
No evidence	No studies found

analysis was performed using Review Manager Version 5.1. (Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). The data were standardised by converting scores to mean differences and standard errors to enable meta-analysis of 6MWD responsiveness. Data from subject subgroups were included in the meta-analysis when whole-cohort figures were not available. To further explore responsiveness of the 6MWD in patients undergoing cardiac rehabilitation, percentage changes and effect sizes [27] for the subjects (and subgroups) of the studies were calculated based on the means and standard deviations (SD) of 6MWDs provided for the groups. It is recognised that the percentage change calculated is a grouped measure and may not accurately reflect the true percentage change for the cohorts. Further, the data were examined for evidence of the ability of the 6MWD to discriminate between subjects based upon physiological factors.

Results

The search yielded 175 acceptable articles. **Fig. 1** outlines the flow of article selection for analysis and the reasons for exclusions. The size of study cohorts varied, with large subject numbers in retrospective studies [6,28–30] and smaller numbers in prospective trials [7,11,31,32]. One article described a prospective study and made comparisons retrospectively with data from patient files [10].

Table 1 shows the quality appraisal of the included articles. Some studies were assessed under more than one category (i.e. reliability, validity or responsiveness), and the methodological quality of these studies varied depending upon assessment against the appraisal criteria required for each study type. One high-quality study was identified for reliability, six high-quality studies were identified for validity, and 11 high-quality studies were identified for responsiveness.

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