Validity of Pedometers for Measuring Exercise Adherence in Heart Failure Patients

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ABSTRACT

Background: Measuring adherence to exercise is important to clinicians and researchers because inadequate adherence can adversely affect the effectiveness of an exercise program and cloud the relationship between exercise and clinical outcomes. Hence, assessment strategies for adherence to exercise, as with assessment strategies for other outcomes, must have demonstrated validity if they are to be employed with confidence. We conducted this study to determine the validity of pedometers as a measure of exercise adherence to a home-based walking program in heart failure patients.

Methods and Results: Exercise adherence was measured using pedometers in 38 patients (74% men) age 54.1 ± 11.7 years who participated in a 12-month home-based walking program. A comparison of functional status as measured by the 6-minute walk distance and peak oxygen uptake (VO_2 max) at 6 months into the exercise training program was made between 2 groups of participants who were thought to represent adherers and nonadherers: participants who demonstrated ≥10% change in pedometer scores (n = 20) and those who showed no change in pedometer scores (n = 18) from baseline to 6 months. Patients who showed improvements in their pedometer scores over 6 months had better functional status at 6 months (6-minute walk distance 1718 ± 46 versus 1012 ± 25 meters, F = 5.699, $P = .022$; VO_2 max 17 ± 0.7 versus 10 ± 0.5 units, F = 7.162, $P = .011$) when compared with patients whose pedometers reflected minimal change in distance walked (ie, ≤10%).

Conclusion: Pedometers are inexpensive and readily available to both clinicians and researchers. The results of this study suggest that they may be a valid indicator of exercise adherence in heart failure patients who participate in a home-based walking program.

Key Words: Pedometer, Adherence, Functional status, Six-minute walk test, Peak oxygen uptake.

The American College of Cardiology and American Heart Association Guidelines for Management of Chronic Heart Failure in the Adult emphasized the need to incorporate a regular exercise regimen into the heart failure (HF) regimen.[1] Preliminary research demonstrates the beneficial effects of exercise on functional capacity and quality of life,[2–5] but results are dependent on patient adherence to the recommended exercise regimen.[5] The assessment of that adherence is often problematic because most patients with HF exercise at home and not in the carefully supervised setting of an exercise facility or research laboratory.

Exercise adherence refers to the level of participation achieved after agreeing to participate in an exercise program.[6] Measuring adherence to exercise is important to both clinicians and researchers because inadequate adherence can have an adverse impact on the effectiveness of exercise as an intervention and confound the interpretation of exercise study results. Nonadherence increases physician and patient frustration and leads to incorrect diagnoses and unnecessary treatment.[7] Conversely, patient adherence with planned interventions are generally linked to more positive outcomes.[8] Therefore, adherence is a valuable goal of lifestyle interventions. The magnitude of the relationship between adherence and treatment outcomes, however, is poorly understood. Particularly related to exercise, very few researchers in the HF literature have mentioned adherence with protocols during exercise trials,[9–11] and the relationships between exercise adherence and outcomes is oftentimes only briefly mentioned or alluded to under study implications or limitations.

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All decisions regarding this manuscript were made by a Guest Editor.

Manuscript received May 18, 2004; revised manuscript received October 18, 2004; revised manuscript accepted October 18, 2004.

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Partially supported by a grant from the American Heart Association Western Division (NCR, 133-09 [K.D.]) and from the University of California School of Nursing Intramural Research Grant.

1071-9164/$ - see front matter

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doi:10.1016/j.cardfail.2004.10.005

Several instruments have been used to measure exercise adherence, including heart rate monitors and uniaxial or triaxial accelerometers (eg, the Actigraph). Such techniques are often inappropriate outside the controlled setting of an exercise laboratory because of the expense or complexity of the instrument. Researchers and clinicians continue to seek valid and inexpensive ways to measure exercise adherence.[12] Comprehensive methods of assessing exercise adherence have not been applied systematically in many studies and measurement methods that allow for more detailed assessment of exercise adherence are not clearly described in previous research.[8] The lack of data about adherence to exercise programs makes it difficult to interpret study results or determine which exercise interventions are most effective.

The current study was conducted to determine the validity of pedometers as a measure of exercise adherence as part of a prospective trial examining the benefits of a home-based walking program on clinical outcomes in advanced HF patients. We addressed the following questions: (1) Are pedometer scores correlated with self-reported measures of exercise adherence? and (2) Can pedometer scores predict functional outcomes? The overall goal of this study was to determine if pedometers offered a practical, cost-effective, and acceptable assessment strategy that could be used with confidence to measure exercise adherence to a home-based walking program among HF patients.

Methods

Subjects

The sample included 38 advanced HF patients participating in a 12-month supervised home-based walking program designed to measure clinical outcomes, including rehospitalization events. In the parent study, 175 patients were randomized to an experimental exercise group (n = 86) or a control group (n = 87). Inclusion criteria for the parent study and the substudy reported here were as follows: English-speaking, age between 18 and 80 years with advanced HF defined as left ventricular systolic dysfunction with a left ventricular ejection fraction ≤40% (documented by echocardiogram or radionuclide ventriculography within the previous six months), and New York Heart Association class II-IV. Exclusion criteria for participation in the study included myocardial infarction or recurrent angina within the previous 3 months, orthopedic impediments to exercise, severe obstructive pulmonary disease with a forced expiratory volume in 1 second <1 L as measured by spirometry, stenotic valvular disease as measured by echocardiogram, history of uncontrolled ventricular tachyarrhythmias (documented by electrophysiology study or 24-hour Holter monitor) or history of sudden cardiac death, without implantable cardioverter-defibrillator, or cognitive impairment.

Procedures

Institutional Review Board approval for protection of human subjects was received before initiation of the study. Patients fulfilling the recruitment criteria were randomized to the exercise group or control group after collection of baseline samples and measurements. Patients assigned to the exercise group were asked to perform a graduated, low-level exercise protocol consisting of light aerobic exercise and resistive training. Aerobic training consisted of an individually tailored walking program of 45 minutes' duration, designed to achieve 60% of maximal heart rate. After 6 weeks of optimization of the aerobic portion of the protocol, a light resistive training component was added to the exercise regimen, and the aerobic portion was maintained until the end of the 12-month program. Patients in the control group maintained their usual level of daily activities, with no additional exercise component. All patients were monitored by monthly home visits and interviewed about their level of physical activity. Pedometers were given to all patients in the experimental group, and these patients were also asked to complete daily activity diaries for the first 6 months of the trial. Only the 38 patients (44% of the exercise participants) who were assigned to the experimental group and had complete pedometer and daily exercise diary data for the 6-month follow-up were used for this analysis. Sociodemographic data (eg. age, gender, race, marital status, education, employment status) and health history were obtained from patient self-reports and medical records. In examining the baseline characteristics of participants who had complete data (44%) and participants who had missing pedometer and exercise diary data from the cohort randomized to the intervention in the larger study (56%), we found that there were no significant differences between these 2 groups of participants on sociodemographic and clinical factors.

Pedometers

Patients were instructed to put the hip-borne pedometer (Sportline Pedometer Model 330, Sportline Inc, Yonkers, New York) on each morning and reset the device to 0. Patients then wore the pedometers over the course of the entire day. Pedometers have been validated previously in patients with HF,[13–15] and are designed to be worn on a belt to display an output proportional to the number of movements of a spring-loaded pendulum displaced by vertical acceleration of the hip during walking. This then produces a cumulative count proportional to the number of footsteps taken or distance traveled in miles. Patients were asked to write the total number of minutes walked and distance traveled on a log sheet before going to bed each night. Daily scores (total distance traveled in miles) were recorded and used to compute the monthly averages.

In a recent study comparing 13 models of pedometers in generally healthy adults, the pedometer model that was used in the current study was 1 of the 5 models that yielded mean values that were not significantly different from the criterion, as opposed to 5 models that underestimated steps and 3 that overestimated the steps when compared with the criterion. Based on their findings, the authors concluded that using 1 of the 5 models that did not significantly differ from the criterion for research purposes would provide both a statistical and practical tool for measuring distance traveled.[16]

Exercise Diaries

Participants were also asked to complete an exercise diary each week to provide a self-report assessment of exercise using a standardized form. They were asked to log the start and stop times of their walking regimens on a daily basis and submit the diaries to the research nurse during monthly visits. Data from the daily exercise diaries were used to compute the average monthly duration of exercise in hours per month. Survey-based measures have shown some reliability and validity[17,18] and have been used in previous exercise studies to encourage self-monitoring behaviors

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