The 10 m incremental shuttle walk test is a highly reliable field exercise test for patients referred to cardiac rehabilitation: a retest reliability study

Lisa C. Hanson [a,*], Nicholas F. Taylor [b], Helen McBurney [c]

[a] *La Trobe Rural Health School, La Trobe University, Bendigo, Victoria, Australia*
[b] *School of Allied Health, La Trobe University, Bundoora, Victoria, Australia*
[c] *School of Primary Health Care, Monash University, Victoria, Australia*

Abstract

Objectives To determine the retest reliability of the 10 m incremental shuttle walk test (ISWT) in a mixed cardiac rehabilitation population.
Design Participants completed two 10 m ISWTs in a single session in a repeated measures study. Ten participants completed a third 10 m ISWT as part of a pilot study.
Setting Hospital physiotherapy department.
Participants 62 adults aged a mean of 68 years (*SD* 10) referred to a cardiac rehabilitation program.
Main outcome measures Retest reliability of the 10 m ISWT expressed as relative reliability and measurement error. Relative reliability was expressed in a ratio in the form of an intraclass correlation coefficient (*ICC*) and measurement error in the form of the standard error of measurement (*SEM*) and 95% confidence intervals for the group and individual.
Results There was a high level of relative reliability over the two walks with an *ICC* of .99. The $SEM_{agreement}$ was 17 m, and a change of at least 23 m for the group and 54 m for the individual would be required to be 95% confident of exceeding measurement error.
Conclusions The 10 m ISWT demonstrated good retest reliability and is sufficiently reliable to be applied in practice in this population without the use of a practice test.
© 2015 Chartered Society of Physiotherapy. Published by Elsevier Ltd. All rights reserved.

Introduction

The 10 m ISWT is an externally paced and incremental field exercise test that may provide clinicians with information on an individual's exercise capacity and limitations, change over time, and individual or group response to an intervention. The test was originally developed to assess the functional capacity of patients with chronic airways obstruction [1] but has since been shown to be well tolerated in cardiac populations [2].

Previous research supports the relative reliability of the 10 m ISWT in the cardiac rehabilitation population, with reliability coefficients between the first and second walk ranging from 0.80 [3] to 0.94 [2,4] to 0.98 [5]. Relative reliability is further improved when the test is repeated, with reliability coefficients of .99 between the second and third walk [4,6].

Less information is known about the measurement error of the 10 m ISWT in cardiac rehabilitation populations and the number of tests required to achieve scores that minimise measurement error. Measurement error can be estimated for an individual score or around a change score for either a group, such as a cardiac rehabilitation group or for an individual within a program. Previous research has demonstrated that for change scores within a group the minimum amount of change required to be interpreted as real change over and

* Correspondence: La Trobe Rural Health School, PO Box 199, Bendigo, Victoria 3552, Australia. Tel.: +61 3 5448 9102; fax: +61 3 5448 9199.
E-mail address: L.Hanson@latrobe.edu.au (L.C. Hanson).

above measurement error after the completion of one 10 m ISWT ranged from 36 m in a mixed cardiac rehabilitation group in a single session [2], to 44 m in a group who were attending a community based maintenance cardiac rehabilitation program and completed the testing over a minimum of eight weeks [3] to 56 m for a group of patients following coronary artery bypass surgery who completed the tests within one week [4]. For an individual, after one test an improvement in test score required to be interpreted as more than measurement error ranged from 53 m in individuals with heart failure in a single session [7] to 122 m [4] to 203 m [3]. Additionally, Fowler *et al.* [4] reported measurement error was minimised if a practice walk was included. They demonstrated if a second walk was completed within one week, an increase in walk distance of more than 5 m for groups and 21 m for individuals exceeded measurement error with 95% confidence, in patients following coronary artery bypass graft surgery [4].

There remains uncertainty about whether there is systematic error when the 10 m ISWT is repeated in a cardiac rehabilitation population. Three papers reported significant improvement in test scores for the 10 m ISWT between the first and second walk [2,4,8], whereas four papers reported no significant change in test scores [5,7,9,10]. Two papers reported using a practice walk but did not provide any further information in their data analysis [5,6]. It is possible that a practice walk may be required when using the 10 m ISWT in a general outpatient cardiac rehabilitation population but little information is available about the absolute reliability of the test when assessed in a single session. The aim of the current study was to determine the relative reliability and measurement error of the 10 m ISWT in a mixed cardiac rehabilitation population.

Method

Design

A repeated measures design was used in the physiotherapy department at the two participating hospitals. All participants completed two 10 m ISWTs in a single session prior to commencing a cardiac rehabilitation program. The first 10 participants participated in a pilot study and completed a third 10 m ISWT in the same session. All walk tests were completed under the same conditions and by the same assessor.

Participants

Eligible participants were all adults with coronary artery disease referred to cardiac rehabilitation irrespective of severity or duration of the condition. Exclusion criteria included any medical condition where exercise would be contraindicated; unable to walk for any neurological or musculoskeletal reason; presentation to cardiac rehabilitation for risk factor reduction or with congenital heart disease; children or

pregnancy. Participants were excluded if they had previously completed a 10 m ISWT or cardiac rehabilitation or if limitations in English language production or comprehension skills precluded them from understanding the consent form.

University and Hospital Human Ethics Committees approved this research. All participants volunteered to participant in the study and provided written informed consent. No patient who met the inclusion criteria refused to participate in the study.

A sample size calculation was completed according to the method described by Walter *et al.* [11] and based on a priori set levels of optimal and minimal acceptable limits of reliability for clinical measurement. For two tests, a minimum of 46 people would be needed if a minimum *ICC* level of .8 (P_0) was accepted and the hypothesis that findings from this study would be consistent with the current literature at an *ICC* of .9 (P_1) [2,4,5], at a level of significance (α) of .05 and power of .8 ($\beta = 0.2$).

The baseline descriptive characteristics of the participants are summarised in Table 1. Of the 62 participants, 39 (63%) were referred following a revascularisation procedure and 16 (26%) were referred following medical management for coronary artery disease and seven (11%) following other cardiac interventions. The mean age of participants was 68 years (*SD* 10) years ranging from 46 to 91 years.

Procedure

The 10 m ISWT protocol was administered according to the description of Singh *et al.* [1]. Participants walked along an indoor flat 10 m course marked by two cones placed 0.5 m in from each end of the course (Fig. 1). A shuttle referred to one 10 m lap. Standardised prerecorded instructions for the test were played from a digital recording immediately prior to beginning the test. The test was externally paced, with

Table 1
Baseline demographic characteristics of the sample.

	Main study (*n* = 62)	Pilot study sample (*n* = 10)
Age, years	68 (10)[a]	67 (10)[a]
Gender		
Male:female, *n*	45:17	5:5
Intervention, *n* (%)		
Revascularisation procedure	39 (63)	8 (80)
Medical management	16 (26)	2 (20)
Other	7 (11)	0
Days post most recent cardiac event	29 (18)	28 (12)
Height, cm	170 (9)[a]	161 (11)[a]
Weight, kg	84 (15)[a]	83 (17)[a]
BMI, kg/m^2	29 (5)[a]	32 (5)[a]
Use of a gait aid, *n* (%)		
Single point stick	3 (5%)	2 (20%)

Note: BMI, body mass index.
[a] Mean (*SD*).