Journal of Frailty, Sarcopenia and Falls

Original Article

Six-minute walk test: A tool for assessing mobility in frail subjects

Jannis Papathanasiou[1,2], Yannis Dionyssiotis[3], Petya Kasnakova[4], Stefan Yanev[1], David Kanchev[1], Hristina Milanova[5], Troycho Troev[5]

[1]Department of Kinesiotherapy, Faculty of Public Health, Medical University of Sofia, Bulgaria; [2]Department of Medical Imaging, Allergology and Physiotherapy, Faculty of Dental Medicine, Medical University of Plovdiv, Bulgaria; [3]Physical Medicine & Rehabilitation Department, European Interbalkan Medical Center, Thessaloniki, Greece; [4]Department of Rehabilitation, Medical College, Medical University of Plovdiv, Bulgaria; [5]Department of Physical Medicine and Rehabilitation, Military Medical Academy, Sofia, Bulgaria

Abstract

Objective: Corridor tests (CT) are validated tools used to measure the effects of rehabilitation interventions in frail elderly subjects. Recently the six-minute walk test (6MWT) was introduced in the assessment of frail individuals. The purpose of this study was to investigate the use of the 6MWT as a tool for measurement the functional capacity and mobility in different frail populations with chronic heart failure (CHF). **Methods:** In this study 6MWT was applied in seventy-five (n=75) individuals randomized into two training groups for a 12th week period; group A (n=38) performed high-intensity aerobic interval training (HIAIT), while group B (n=37) fulfilled moderate intensive continuous training (MICT), for measuring the impact in the effectiveness in two different intensity cardiac rehabilitation (CR) interventions in patients with CHF. **Results:** The data indicate that the average six-minute walk distance (6MWD) in both groups (HIAIT and MICT) before the start of the CR programs was no statistically significant between them ($p>0.05$). A significant increase in the 6MWD in both CR groups was found after the final of 12-week of CR program ($p<0.001$). The increase obtained in HIAIT group was higher than the increase observed in MICT group (14.53% vs. 10.6%, respectively). **Conclusion:** The 6MWT is a safe tool for assessing the effectiveness of CR interventions on functional capacity and mobility in different frail populations with CHF.

Keywords: Cardiac rehabilitation, One-year survival, Safety, Six-minute walk test

Introduction

Corridor tests (CT) are also known as field tests (FT) appeared in the early 60's and are associated with Balke[1] and later modified to twelve-minute walk test by Kenneth Cooper[2]. Today CT are divided into two main groups, fixed distance FT and fixed time FT. Fixed distance FT are subdivided into short distance tests ranging from 2-15 meters designed primarily for individuals with severe neurological disorders[3-4]. Fixed distance (FT) as well as 100-meter walk test and 200-meter fast walk test were originally designed for individuals able to cover these distances in their own selected pace of walking and patients tolerating higher levels of aerobic limit beyond the aerobic threshold[5,6].

The 6MWT is widely used fixed time FT applied in various rehabilitation intervention, as an effective tool for analyzing functional capacity in patients with cardiovascular (CVD) and pulmonary diseases (PD)[7,8]. It has been shown that 6MWT serves as equivalent to functional capacity and is a powerful prognostic indicator of the severity of CVD and PD[9-12]. Functional capacity is referred the ability of an individual to perform aerobic work as defined by the maximal oxygen uptake (VO_{2max}), that is, the product of cardiac output and arteriovenous oxygen (a VO_2) difference at physical exhaustion[13]. Due to its easy implementation, low cost and better acceptance[14] by the patients is more often used than other FT[11].

The authors have no conflict of interest.

Corresponding author: *Jannis V. Papathanasiou, MD, MSc, PhD, Department of Kinesiotherapy, Faculty of Public Health, Medical University of Sofia, Bulgaria*

E-mail: *giannipap@yahoo.co.uk*

Edited by: *George Lyritis*

Accepted *29 November 2016*

Exclusion criteria	Inclusion criteria
Absolute contraindications:	• Detection of coronary artery disease (CAD) in patients • With chest pain (chest discomfort) syndromes or potential • Symptom equivalents • Evaluation of the anatomic and functional severity of CAD • Prediction of cardiovascular events and all-cause death • Evaluation of physical capacity and effort tolerance • Evaluation of exercise-related symptoms • Assessment of chronotropic competence, arrhythmias, and response to implanted device therapy • Assessment of the response to medical interventions
• Acute myocardial infarction within 2 days • Ongoing unstable angina • Uncontrolled cardiac arrhythmia with hemodynamic compromise • Active endocarditis • Symptomatic severe aortic stenosis • Decompensated heart failure • Acute pulmonary embolism, pulmonary infarction, or deep vein thrombosis • Acute myocarditis or pericarditis • Acute aortic dissection • Physical disability that precludes safe and adequate testing	
Relative contraindications:	**Additional:**
• Known obstructive left main coronary artery stenosis • Moderate to severe aortic stenosis with uncertain relation to symptoms • Tachyarrhythmias with uncontrolled ventricular rates • Acquired advanced or complete heart block • Hypertrophic obstructive cardiomyopathy with severe resting gradient • Recent stroke or transient ischemic attack • Mental impairment with limited ability to cooperate • Resting hypertension with systolic or diastolic blood pressures >200/110 mmHg • Uncorrected medical conditions, such as significant anemia, important electrolyte imbalance, and hyperthyroidism	• Development of the exercise plan or prescription • Response to medication • Evaluation of perioperative risk for non-cardiac surgery

Table 1. Inclusion and exclusion criteria for exercise training issued from NICE.

Numerous studies have been published about the validity of 6MWT in cancer patients, as well as in patients with traumatic brain injury, cerebral palsy and after total knee replacement[15-19].

The purpose of the present study was to investigate the use of the 6MWT as a tool for measurement of functional capacity and mobility in different frail populations with CHF.

Materials and methods

The study enrolled seventy-five (n=75) consecutive outpatients (mean age 64.28±6.25 years) with stable CHF in New York Heart Association classes II to IIIB in a 12-week CR program, identified by clinical and echocardiographic criteria (Left ventricular ejection fraction [LVEF] ≤40%). The present RCT was carried out at the Medical Center for Sports Medicine and Rehabilitation, Plovdiv-Bulgaria. The study was approved by the Bioethical Committee at the Medical University of Plovdiv in Bulgaria. All participants gave written informed consent. We applied the updated list of inclusion criteria issued from National Institute for Health and Care Excellence (NICE)[20] presented in Table 1. The causes of CHF were ischemic cardiomyopathy (58,7%), hypertensive heart failure (26,7%), and idiopathic dilated cardiomyopathy (14,7%). Included subjects were examined when they were clinically stable, without any changes in medication during the previous 4 weeks. Thirty-eight (n=38) of the included subjects were randomized to perform a group-based high intensity aerobic interval training (HIAIT) called m-Ullevaal for a 12 weeks period[21]. To increase the effectiveness of the rehabilitation process, HIAIT group was subdivided into six subgroups consisting of 5 to 8 individuals. The group-based HIAIT model consists of three high-intensity intervals where the subjects were encouraged to achieve 90% of the maximum heart rate (HRmax)[22]. The outpatients also performed simple aerobic dance movements involving upper and lower limbs to achieve postural control. During the two moderate intensity intervals of the m-Ullevaal, the subjects were encouraged to achieve (HR max: 70%). Strength exercises were included also in the high-intensity intervals[23,24]. Thirty-seven (n=37) subjects were randomized to perform moderate intensive continuous training (MICT) on electromagnetically braked cycle ergometers (Pure Bike R 4.1, Tunturi, Netherlands). During each MICT training session, the subjects were encouraged to achieve 70% of the HR max.

The 6MWT was used as a tool of measuring the effectiveness of two different CR interventions applied in CHF patients[25-26]. The 6MWT was performed in a 30-m marked corridor in Medical Center for Rehabilitation and Sports Medicine I - (Plovdiv- Bulgaria). Participants were instructed to walk continuously on a 30-m hospital corridor, covering as much ground as they could during six minutes[27]. 6MWT can

CR Groups	6MWD1* (m)	6MWD2* (m)	Change (%)
HIAIT	443.21 ± 42.86	506.34 ± 39.33	14.53 ± 4.65
MICT	436.54 ± 41.91	480.16 ± 43.93	10.06 ± 2.62

Table 2. The increase in 6MWD obtained between CR groups.

be administrated by all members of a rehabilitation team such as a PRM specialist, physiotherapist, occupational therapist as well a nurse optimal integrated into CR team. An extremely important issue is the safety of the 6MWT. Corridor length, encouraging phrases during the test, warning the remaining minutes and the position of the administrator (walking always behind the patient) are factors that can influence the 6MWT[11,14,15]. Older and obese individuals as well those who suffering from arthritis and other musculoskeletal disorders, or impaired cognitive abilities also cover shorter distance[6]. Conditions and diseases related with shorter 6 minutes' walk distance (6MWD) were presented in previous publication[8]. It's proven that 6MWT is an effective tool for measuring functional capacity of patients with CHF, and is closely associated with heart failure survival and QoL[8,10,12,13,21].

Statistical analysis of the data was performed using the SPSS version 20.0 (SPSS, Inc., Chicago, Illinois). All subjects' characteristics were quantitative variables and they were expressed as the mean ± standard deviation. The normality of their distribution was tested with Kolmogorov-Smirnov test. All tests were two tailed and statistical significance was considered for $p<0.05$.

Results

The average 6MWD1 in both CR groups (HIAIT and MICT) before the start of the CR programs was 443.21±42.86 and 436.54±41.91, respectively, and were no statistically significant. A significant increase ($p<0.001$) in the 6MWD2 in both CR groups (506.34±39.33 and 480.16±43.93, respectively), was observed after the end of the 12-week period CR program. The increase in 6MWD obtained in HIAIT group was significantly higher ($p<0.001$) compared to 6MWD in MICT group (63 m, 14.53±4.65% vs. 44 m, 10.06±2.62%, respectively) (Table 2).

Discussion

Both groups in our study increased 6MWD after a CR program. However, we found that HIAIT was superior than MICT according to 6MWD covered.

The primary measure obtained by 6MWT is the covered distance, while other physiological parameters as arterial blood pressure (at the start and end of the test), heart rate (HR), using HR monitors[14], oxygen saturation using pulse oximetry, and the perceived exertion on the Borg scale are measured simultaneously[28]. The 6MWT presents several interesting advantages for the evaluation of the exercise capacity in elderly people. Different authors have described reference equations and tables to predict the 6MWD in healthy elderly individuals. It's proven that the 6MWD decreased significantly with increasing age and with worsening health status[29]. Harada et. al., concluded that 6MWT is reliable and valid measure in relation to the performance and mobility in older adults[30]. More recently, the 6MWT has been used to characterize and monitor changes in walking capacity following stroke. The 6MWT is commonly used as a measure of walking endurance and is a significant predictor of community ambulation and integration in stroke survivors[31]. It's considered that 6MWD is a powerful prognostic indicator for survival of patients with CHF[11,12]. Current evidence-based analysis show that the average change in the 6MWT in patients with stable CHF included in programs of high intensity interval training is 40.9 m[21]. 6MWD provides useful prognostic information for patients with mild to moderate disease; however, maximal exercise testing may be more informative in those with severe heart failure who are referred for heart transplantation[11]. The 6MWD is independently related to mortality in patients who are on treatment, with those patients who achieve a threshold of 378 m having improved survival irrespective of their baseline 6WMD m[10]. The average 6MWD in subjects with CHF ranges from 310 m in those with a left ventricular ejection fraction (LVEF) of 20% up to 427 m in those with mild disease LVEF 53%[13].

The 6MWD was included in our study as the primary outcome measurement for functional capacity[21]. The significant increase in the 6MWD (14.53%) achieved by the HIAIT group of our study was greater[8] than the result achieved by the HIAIT group in the study of Freyssin et al., and Nilsson et al. (12% and 13%, respectively)[21,32]. Several studies have been published on the validity of the 6MWT as a significant measurement for functional capacity for patients with heart diseases, and it has been used in several high-quality studies to examine changes in physical function after exercise training protocols[15-18]. The mean increase in walking distance measured with the 6MWT in exercise intervention studies published in a Cochrane review was 40.9 m in stable patients with CHF[33]. Witham et al recently evaluated a cohort of 82 patients enrolled in a randomized controlled trial of exercise training in older patients with CHF[34].

Conclusion

In conclusion, results obtained so far encourage to continue studies in this direction in order to enlarge the sample and to perform more powerful statistical analysis. Indeed, another goal will be to use the results to individuate the best kind of treatment to subjects with CHF during CR.

References

1. Balke B. A simple field test for the assessment of physical fitness. Rep 63-6. Rep Civ Aeromed Res Inst US. 1963 Apr:1-8.
2. Cooper KH. A means of assessing maximal oxygen intake. Correlation between field and treadmill testing. JAMA 1968; 203(3):201-4.
3. Dalgas U, Severinsen K, Overgaard K. Relations between 6-minute walking distance and 10-meter walking speed in patients with multiple sclerosis and stroke. Arch Phys Med Rehabil 2012; 93:1167-72.
4. Dobkin BH. Short-distance walking speed and timed walking distance: redundant measures for clinical trials? Neurology 2006; 66(4):584-6.
5. Morice A, Smithies T. The 100-m walk: a simple and reproducible exercise test. Br J Dis Chest 1984; 78(4):392-4.
6. Gremeaux V, Iskandar M, Kervio G, Deley G, Pérénnou D, Casillas JM. Comparative analysis of oxygen uptake in elderly subjects performing two walk tests: the six-minute walk test and the 200-m fast walk test. Clin Rehabil 2008; 22(2):162-8.
7. Guyatt GH, Sullivan MJ, Thompson PJ, Fallen EL, Pugsley SO, Taylor DW, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. Can Med Assoc J 1985; 132(8):919-23.
8. Papathanasiou JV, Ilieva E, Marinov B. Six-minute walk test: an effective and necessary tool in modern cardiac rehabilitation. Hellenic J Cardiol 2013; 54(2):126-30.
9. Arena R, Myers J, Williams MA, Gulati M, Kligfield P, Balady GJ, Collins E, Fletcher G. Assessment of functional capacity in clinical and research settings: a scientific statement from the American Heart Association Committee on Exercise, Rehabilitation, and Prevention of the Council on Clinical Cardiology and the Council on Cardiovascular Nursing. Circulation 2007; 116(3):329-43.
10. Bittner V, Weiner DH, Yusuf S, Rogers WJ, McIntyre KM, Bangdiwala SI, et al. Prediction of mortality and morbidity with a 6-minute walk test in patients with left ventricular dysfunction. SOLVD Investigators. JAMA 2003; 270:1702-1707.
11. Zielińska D, Bellwon J, Rynkiewicz A, Elkady MA. Prognostic value of the six-minute walk test in heart failure patients undergoing cardiac surgery: a literature review. Rehabil Res Pract 2013; 2013:965494.
12. Rubim VS, Drumond Neto C, Romeo JL, Montera MW. Prognostic value of the Six-Minute Walk Test in heart failure. Arq Bras Cardiol 2006; 86(2):120-5.
13. Pollentier B, Irons SL, Benedetto CM, Dibenedetto AM, Loton D, Seyler RD, Tych M, Newton RA. Examination of the six-minute walk test to determine functional capacity in people with chronic heart failure: a systematic review. Cardiopulm Phys Ther J 2010; 21(1):13-21.
14. Zugck C, Krüger C, Dürr S, Gerber SH, Haunstetter A, Hornig K, Kübler W, Haass M. Is the 6-minute walk test a reliable substitute for peak oxygen uptake in patients with dilated cardiomyopathy? Eur Heart J 2000; 21(7):540-9.
15. Bellet RN, Adams L, Morris NR. The 6-minute walk test in outpatient cardiac rehabilitation: validity, reliability and responsiveness--a systematic review. Physiotherapy 2012; 98(4):277-86.
16. Schmidt K, Vogt L, Thiel C, Jäger E, Banzer W. Validity of the six-minute walk test in cancer patients. Int J Sports Med 2013; 34(7):631-6.
17. Mossberg KA, Fortini E. Responsiveness and validity of the six-minute walk test in individuals with traumatic brain inury. Phys Ther 2012; 92(5):726-33.
18. Nsenga Leunkeu A, Shephard RJ, Ahmaidi S. Six-minute walk test in children with cerebral palsy gross motor function classification system levels I and II: reproducibility, validity and training effects. Arch Phys Med Rehabil 2012; 93(12):2333-9.
19. Crosbie J, ET Yeo. The six-minute walk test is an excellent predictor of functional ambulation after total knee arthroplasty. BMC Musculoskelet Disord 2013; 14:145.
20. MI Secondary Prevention: Secondary Prevention in Primary and Secondary Care for Patients Following a Myocardial Infarction: Partial Update of NICE CG48 [Internet]. National Clinical Guideline Centre (UK). London: Royal College of Physicians (UK); 2013 Nov. National Institute for Health and Clinical Excellence: Guidance.
21. Nilsson BB, Westheim A, Risberg MA. Effects of a group-based high-intensity aerobic interval-training program in patients with chronic heart failure. Am J Cardiol 2008; 10:1361-1365.
22. MacGowan GA, Murali S.Ventilatory and heart rate responses to exercise: better predictors of heart failure mortality than peak exercise oxygen consumption. Circulation 2000; 102(24):E182.
23. Iellamo F, Caminiti G, Sposato B, et al. Effect of High-Intensity interval training versus moderate continuous training on 24-h blood pressure profile and insulin resistance in patients with chronic heart failure. Intern Emerg Med 2014; 9:547-552.
24. Koufaki P, Mercer TH, George KP, Nolan J. Low-volume high-intensity interval training vs continuous aerobic cycling in patients with chronic heart failure: a pragmatic randomized clinical trial of feasibility and effectiveness. J Rehabil Med 2014; 46:348-356.
25. Gayda M, Temfemo A, Choquet D, Ahmaïdi S. Cardiorespiratory requirements and reproducibility of the six-minute walk test in elderly patients with coronary artery disease. Arch Phys Med Rehabil 2004; 85(9):1538-43.
26. Rasekaba T, Lee AL, Naughton MT, Williams TJ, Holland AE. The six-minute walk test: a useful metric for the cardiopulmonary patient. Intern Med J 2009; 39(8):495-501.
27. ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med 2002; 166(1):111-7.
28. Aamot IL, Forbord SH, Karlsen T, Støylen A. Does rating of perceived exertion result in target exercise intensity during interval training in cardiac rehabilitation? A study of the Borg scale versus a heart rate monitor. J Sci Med Sport 2014; 17(5):541-5.
29. Bautmans I, Lambert M, Mets T. The six-minute walk test in community dwelling elderly: influence of health status. BMC Geriatr 2004; 4:6.
30. Harada ND, Chiu V, Stewart AL. Mobility-related function: assessment with a 6-minute walk test. Arch Phys Med Rehabil 1999; 80(7):837-41.
31. Ng SS, Tsang WW, Cheung TH, Chung JS, To FP, Yu PC. Walkway length, but not turning direction, determines the six-minute walk test distance in individuals with stroke. Arch Phys Med Rehabil 2011; 92(5):806-11.
32. Freyssin C, Verkindt C, Prieur F, Benaich P, Maunier S, Blanc P. Cardiac rehabilitation in chronic heart failure: effect of an 8-week, high-intensity interval training versus continuous training. Arch Phys Med Rehabil 2012; 93(8):1359-64.
33. Davies EJ, Moxham T, Rees K, Singh S, Coats AJ, Ebrahim S, Lough F, Taylor RS. Exercise based rehabilitation for heart failure. Cochrane Database Syst Rev 2010; (4):CD003331.
34. Witham MD, Argo IS, Johnston DW, Struthers AD, McMurdo ME. Long-term follow-up of very old heart failure patients enrolled in a trial of exercise training. Am J Geriatr Cardiol 2007; 16(4):243-8.