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Published in:
Journal of the American College of Cardiology

DOI:
10.1016/j.jchf.2017.02.005

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

JACC: HEART FAILURE
PUBLISHED BY ELSEVIER ON BEHALF OF THE AMERICAN
COLLEGE OF CARDIOLOGY FOUNDATION

VOL. 5, NO. 6, 2017
ISSN 2213-1779/$36.00
http://dx.doi.org/10.1016/j.jchf.2017.02.005

MINI-FOCUS ISSUE: CLINICAL ASSESSMENT OF HEART FAILURE

A New Clinically Applicable Measure of Functional Status in Patients With Heart Failure

The 60-Foot Walk Test

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CME/MOC Objective for This Article: After reading this article, the reader should be able to: 1) describe the appropriate methods for performing a 60-foot walk test in patients with chronic heart failure with reduced ejection fraction; 2) identify the association between the results of a 60-foot walk test and subsequent heart failure hospitalization or death; and 3) discuss the possible prognostic implications for patients that cannot perform a walk test and long-term outcomes.

CME/MOC Editor Disclosure: Editor-in-Chief Christopher M. O'Connor, MD, FACC, has received consultant fees/honoraria from AbbVie, Inc., Actelion Pharmaceuticals Ltd., Bayer, Bristol Myers Squibb, Cardiorentis, Merco & Co., Inc., ResMed, and Roche Diagnostics; and ownership interest in Biscardia, LLC. Executive Editor Mona Fiuzat, PharmD, FACC, has received research support from ResMed, Gilead, Critical Diagnostics, Otsuka, and Roche Diagnostics. Tariq Ahmad, MD, MPH, has received a travel scholarship from Thoratec. Robert Mentz, MD, has received a travel scholarship from Thoratec; research grants from Gilead; research support from ResMed, Otsuka, Bristol-Myers Squibb, AstraZeneca, Novartis, and GlaxoSmithKline; and travel related to investigator meetings from ResMed, Bristol-Myers Squibb, AstraZeneca, Novartis, and GlaxoSmith-Kline. Adam DeVore, MD, has received research support from the American Heart Association, Novartis Pharmaceuticals, Thoratec, and Amgen. Abhinav Sharma, MD, has received support from Bayer-Canadian Cardiovascular Society, Alberta Innovates Health Solution, Roche Diagnostics, and Takeda. Mitchell Psotka, MD, PhD, has reported that he has no relationships relevant to the contents of this paper to disclose.

Author Disclosures: Supported by National Heart, Lung, Blood Institute grant 1R01 HL085730 (Dr. Krantz, PI). The opinions and assertions expressed herein are those of the authors and do not necessarily express the views of Uniformed Services University of the Health Sciences or the U.S. Department of Defense. All authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Medium of Participation: Print (article only); online (article and quiz).

CME/MOC Term of Approval

Issue date: June 2017
Expiration date: May 31, 2018

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Manuscript received June 24, 2016; revised manuscript received January 30, 2017, accepted February 2, 2017.

JACC: HEART FAILURE VOL. 5, NO. 6, 2017
JUNE 2017:411–20

A New Clinically Applicable Measure of Functional Status in Patients With Heart Failure

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ABSTRACT

OBJECTIVES This study reports the development and predictive value of the 60-foot walk test (60ftWT), a brief functional status measure for patients with heart failure (HF). The goal was to develop a test suitable for clinical settings and appropriate for patients with walking impairments.

BACKGROUND The 6-min walk test (6MWT) has considerable predictive value, but requires a long walking course and has limited utility in patients with mobility-related comorbidities. A shorter, more clinically practical test is therefore needed.

METHODS A total of 144 patients (age 57.4 ± 11.4 years; 111 males) with symptomatic HF received baseline assessments using the 60ftWT, 6MWT, and self-reported symptom and health status. Patients were tested 3 months later to determine stability of assessments. HF hospitalizations or death from any cause were recorded for 3.5 years following baseline.

RESULTS Median 60ftWT completion time was 26 s (interquartile range: 22 to 31 s). Longer 60ftWT time was associated with shorter 6MWT distance ($r = -0.75$; $p < 0.001$), and with higher symptom severity at baseline ($r = -0.40$; $p < 0.001$). Longer 60ftWT times also predicted increases in 6MWT and symptoms from baseline to 3 months ($p < 0.01$). Both WTs predicted long-term clinical outcomes, with patients taking longer than 31 s to complete the 60ftWT at greatest risk for HF hospitalization or death (hazard ratio: 2.13; 95% confidence interval: 1.18 to 3.84; $p = 0.01$).

CONCLUSIONS The 60ftWT is an easily administered functional status measure that predicts adverse events, symptoms, and health status. It has the potential for considerable clinical utility to help identify patients at risk for future events and to calibrate treatments designed to improve functional status and quality of life. (J Am Coll Cardiol HF 2017;5:411–20) Published by Elsevier on behalf of the American College of Cardiology Foundation.

Treatment strategies and medical management of heart failure (HF) often rely on assessment of symptoms and on impairments in functional status. Current methods for assessment of functional status and the effects of symptoms on daily activity include peak oxygen consumption during cardiopulmonary exercise testing and the 6-min walk test (6MWT). The 6MWT has been validated against clinical outcomes and accepted as a safe and inexpensive alternative to cardiopulmonary exercise testing for inpatient risk stratification (1,2).

The 6MWT has the advantage of being self-paced and easily administered. However, its clinical use is limited because it is time consuming and requires a long continuous hallway course, which may not be available in clinical settings. Furthermore, many patients with HF present with multiple comorbidities and physical disabilities other than HF that prohibit them from walking significant distances (e.g., gout, foot ulcers, claudication, arthritis) (3–5).

Alternative methods for functional status assessment have been developed, but do not specifically address limitations of the 6MWT. For instance, a 15-foot walk test has previously been used in elderly populations as a measure of frailty, as well as a 2-min walk test in stroke patients, and in patients with chronic obstructive pulmonary disease (6–8). However, these methods have not been systematically validated against HF-related clinical outcomes. Therefore, to enhance the clinical applicability of functional status assessment in HF, we developed a

short and efficient walk test (WT) that can be administered in typical clinical settings, a 60-foot walk test (60ftWT) consisting of 4 laps of 15 feet. Associations of the 60ftWT with HF symptoms and clinical outcomes were tested and compared with the 6MWT.

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METHODS

PATIENT POPULATION. A total of 144 patients with HF (mean age, 57.4 ± 11.4 years; age range, 23 to 87 years; 111 [77.1%] men) were enrolled in the BETRHEART (Behavioral Triggers of HF) study (9–11). BETRHEART is a prospective observational cohort study designed to examine biobehavioral triggers of symptom exacerbations among patients with HF. The study design is presented in **Figure 1**. The present study represents a planned secondary analysis of this larger study. Patients were recruited from outpatient clinics at University of Maryland Medical Center and Baltimore VA Medical Center, with all assessments performed at University of Maryland Medical Center. Time between baseline and the most recent prior hospitalization varied across patients with 76% (n = 110) hospitalized >1 month from baseline, 22% (n = 31) hospitalized within 1 month of baseline, and 2% (n = 2) never previously hospitalized. Inclusion criteria included diagnosis of symptomatic HF for at least 3 months, New York Heart Association (NYHA) functional class II to IV, and a left ventricular ejection fraction (LVEF) ≤40% measured within the last year. Exclusion criteria were clinically significant valve disorder as primary diagnosis, myocarditis in past 6 months, thyroid dysfunction as primary etiological factor, current or past 6-month alcohol abuse, left ventricular assist device, prior heart transplantation, active cancer treatment, living in a nursing home, and cognitive impairments (≤12 on the Mini-Mental State Examination-Brief Version) (12). This study was approved by the institutional review boards at University of Maryland Medical Center and the Uniformed Services University of the Health Sciences, and all patients provided written informed consent before participation.

PROCEDURES. As part of the larger BETRHEART study, 144 participants received baseline assessments of functional status and symptoms, and 126 of these completed a second 3 month assessment. During each assessment, patients completed psychological and behavioral questionnaires, followed by blood collection, measurement of blood pressure, the 60ftWT, a 5-min rest period, and the 6MWT. Study staff members completed all assessments and procedures were standardized to minimize measurement variability. For each WT, patients were allowed to use any walking aids they typically used when ambulating (i.e., canes). No patients in the study were prescribed oxygen.

Between baseline and 3-month assessments, 18 participants were withdrawn from the study either because they no longer met eligibility criteria (i.e., received a left ventricular assist device, began abusing alcohol, were determined to have cognitive impairments [n = 3]), were lost to follow-up (n = 12), or died (n = 3). Individuals who withdrew were more symptomatic (chi-square [2] = 9.4; p = 0.009), primarily NYHA class III and IV, and had a lower body mass index (27.1 ± 5.5 vs. 31.4 ± 7.6) (t[142] = 2.3; p = 0.02). There were no differences in baseline WT performance among participants that withdrew and those that did not.

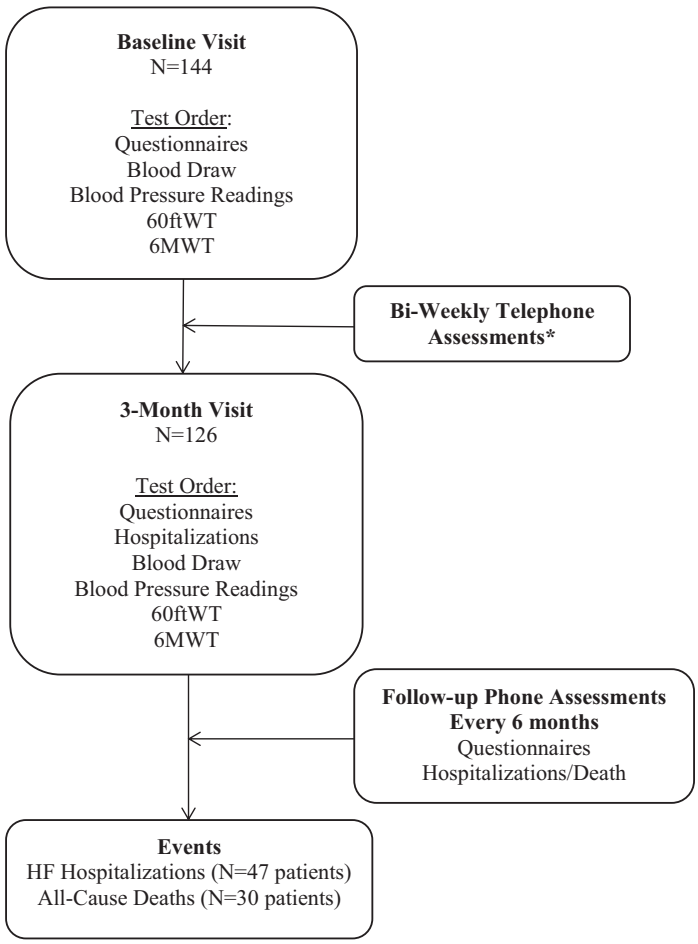
60ftWT PROCEDURE. A 15-foot distance was marked in a flat hospital corridor. The following instructions were provided to patients: "For this task we ask that you walk 4 laps of 15 feet. Your goal is to complete the task in as short a time as possible. However, to do so please walk at a comfortable pace, do not run. When completing this task, walk in a straight line and make sure that both feet are behind the hall marker before turning. Your turns should be small, staying as close as possible to the marker." Inclusion of the statement "comfortable pace" was added to ensure patient safety and reduce the likelihood of adverse events (i.e., falls) as patients traversed the short distance and completed several turns in a relatively short period of time. Following the instructions, a staff member demonstrated 1 proper lap, including a turn, to patients before the test began. Time taken to complete each of the 15-foot laps was recorded in seconds, as was total time used (duration) to complete the 4 laps. Lap time was measured when both of the patient's feet had crossed the marker, before they began their turn to complete the next lap. No encouragement was provided to patients during this task.

6MWT PROCEDURE. A 60-foot distance was marked in a flat hospital corridor and patients were instructed to complete laps at their own pace and to walk as far as possible for 6 min. Space constraints dictated the use of a 60-foot course for this study. However, all other American Thoracic Society guidelines for 6MWT administration (13) were followed, including standardized pre-test instructions and encouragement,

ABBREVIATIONS AND ACRONYMS

60ftWT = 60-foot walk test
6MWT = 6-min walk test
CI = confidence interval
HF = heart failure
HR = hazard ratio
KCCQ = Kansas City Cardiomyopathy Questionnaire
LVEF = left ventricular ejection fraction
NYHA = New York Heart Association classification
WT = walk test

FIGURE 1 The BETRHEART Study Design



Data from baseline and 3-month follow-up are presented in this article. *As part of the larger BETRHEART (Behavioral Triggers of HF) study, bi-weekly telephone assessments (11) were performed and additional clinic testing visits were conducted in a subset of patients. Data from these additional assessments were not included in the present manuscript. HF = heart failure; 6MWT = 6-min walk test; 6OftWT = 60-foot walk test.

with the latter provided every 1 min. If patients developed symptoms, they were advised to take a break and, if symptoms did not resolve, to terminate the test early (13). Total distance walked during the 6-min period was recorded, along with patient-reported symptoms, including those leading to early termination.

SYMPTOM ASSESSMENTS. Functional status based on symptoms was clinically assessed by a research nurse using NYHA functional classification criteria (14). Self-reported HF symptoms were measured by the Kansas City Cardiomyopathy Questionnaire (KCCQ), a disease-specific instrument comprised of 23 items designed to quantify physical limitations, symptoms, and HF-related quality of life (15). There are 9 subscales that comprise an overall summary score ranging from 0 to 100, with higher scores indicating better functioning and fewer symptoms. The KCCQ has been validated in both stable and decompensated patients with HF and has high sensitivity compared with other HF symptom assessment questionnaires (15). Results are reported for KCCQ Overall Summary, Clinical Summary, and Physical Limitation scales.

LONG-TERM CLINICAL OUTCOMES: HOSPITALIZATIONS AND DEATHS. All-cause mortality and inpatient HF hospitalizations were recorded for up to 1,200 days (3.5 years) after baseline. Information was collected via patient reports and subsequently verified by medical record review. For purposes of this study, HF hospitalizations were defined as a hospitalization for fluid overload or pump failure from information obtained in patient discharge summaries. In cases where the cause for hospitalization was unclear, HF hospitalizations were adjudicated by the study cardiologist (S.S.G.). Deaths were verified using the Social Security Death Index. The primary study endpoint was HF hospitalization or death from any cause.

STATISTICAL ANALYSIS. Regression and correlation analyses and analysis of variance were conducted to compare associations between each of the WTs and between NYHA functional class and the 2 WTs. Paired sample Student *t* tests and correlations were used to compare baseline performance on each WT with performance at 3 months and associations between changes in WT performance with changes in KCCQ scores. Hierarchical regressions, adjusted for comorbidities related to walking, height, weight, sex, smoking status, and age, were used to determine the degree to which the WTs were associated with KCCQ scores. Multivariate Cox proportional hazards regression models, adjusted for age, sex, race, smoking status, LVEF, and HF etiology, were used to examine associations between each WT at baseline and long-term outcomes of HF hospitalizations or all-cause death. The predictive value of the 2 tests for HF-related mortality was additionally examined by evaluating the area under the curve based on receiver operating characteristic curve analyses. Multivariate Cox proportional hazards regression models were also conducted to compare outcomes of patients performing the worst on each WT with outcomes for the rest of the sample, adjusted for age, sex, and LVEF. Because of the small sample size, for each analysis covariates were limited to demographic variables, indices of disease severity, and risk factors chosen

because of their possible association with study outcomes. All statistical analyses were conducted using SPSS version 22.0 (IBM Corp., Armonk, New York), and 2-tailed p values and 95% confidence intervals (CIs) are presented.

RESULTS

Clinical and demographic characteristics and comorbidities (including those affecting walking pace or distance) are summarized in Table 1. Most patients were African-American men (51.0%) with severely depressed left ventricular function (mean LVEF, 23.0 ± 7.4%). The sample included patients with ischemic (n = 67) and nonischemic (n = 77) HF etiology. Table 1 also provides reasons for not attempting each of the WTs.

60ftWT AND 6MWT PERFORMANCE. All patients attempting the 60ftWT were able to complete this assessment and walk the entire 60-foot distance. The median 60ftWT total completion time was 26 s (interquartile range: 22 to 31 s; range: 13 to 82 s). Median 6MWT total distance was 331 m (interquartile range: 269 to 370 m; range: 146 to 509 m). 60ftWT time was negatively correlated with total distance on the 6MWT at baseline (n = 130; $R^2 = 0.56$; r = −0.75; p < 0.001) (Figure 2, left). At baseline and 3-month assessments, 8 patients used a cane to complete the WTs. There was no difference in performance on either WT between patients using versus not using a cane to complete the WTs (all p > 0.05).

We examined if the presence of comorbidities affecting walking determined whether patients attempted the 2 WTs. Subject to limitations caused by the small sample size, those who did not attempt either WT (n = 7) had more comorbidities (0.86 ± 0.38) compared with those attempting only the 60ftWT (n = 7; 0.71 ± 0.49) and those attempting both WTs (n = 130; 0.46 ± 0.50) ($F[2,141] = 2.85$; p = 0.06).

CLINICAL CORRELATES OF THE 60ftWT AND 6MWT. HF severity. NYHA functional class was related to both WTs. Class II patients averaged a faster 60ftWT total completion time (26 ± 6 s vs. 30 ± 11 s) ($F[2,133] = 5.5$; p = 0.005), and greater 6MWT distance (354 ± 66 m vs. 287 ± 73 m) ($F[2,128] = 16.4$; p < 0.001) compared with class III patients. Neither WT was significantly correlated with LVEF (60ftWT: n = 137, $R^2 = 0.02$, $r = -0.14$, p = 0.12; 6MWT: n = 130, $R^2 = 0.01$, $r = 0.10$, p = 0.30).

Self-report health status. Adjusting for variables that could affect WT performance (presence of comorbidities related to walking, height, weight, sex, smoking status, and age), both WTs were associated with all 3 KCCQ subscales (Table 2).

TABLE 1 Baseline Participant Demographic and Clinical Characteristics

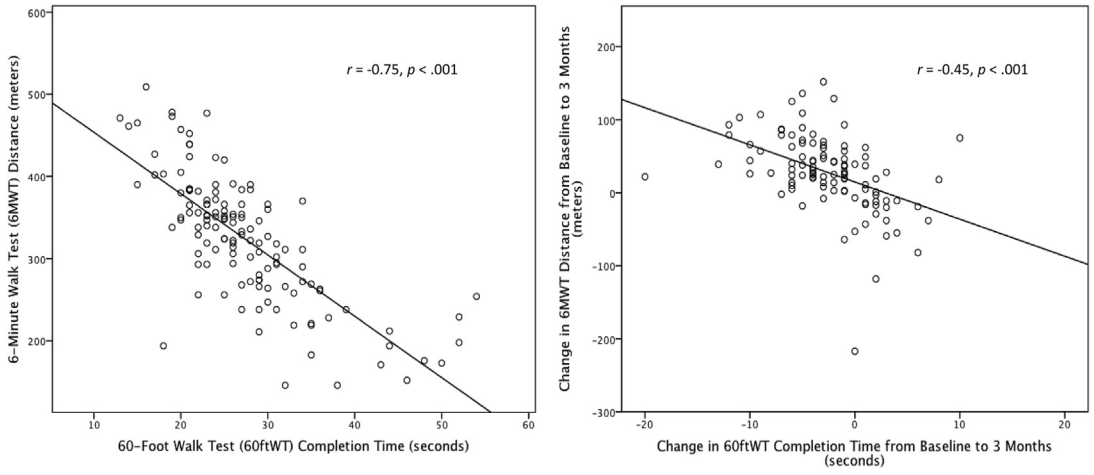
	60ftWT and 6MWT (n = 130)	Only 60ftWT* (n = 7)	Neither WT Attempted (n = 7)
Age, yrs	56.8 ± 11.3	65.4 ± 15.2	61.7 ± 7.8
Women	28 (22)	1 (14)	4 (57)
African American†	93 (72)	2 (29)	6 (86)
BMI, kg/m^2	30.7 ± 7.4	35.7 ± 7.7	28.9 ± 7.9
Coronary artery disease	60 (46)	5 (71)	2 (29)
Systolic blood pressure, mm Hg	122 ± 20	126 ± 18	112 ± 15
Diastolic blood pressure, mm Hg	76 ± 13	73 ± 9	75 ± 13
Heart rate, beats/min	70 ± 14	75 ± 5	76 ± 10
NYHA functional class			
II	73 (56)	4 (57)	3 (43)
III	55 (42)	3 (43)	3 (43)
IV	2 (2)	0 (0)	1 (14)
Ejection fraction, %	23 ± 7	23 ± 12	25 ± 8
B-type natriuretic peptide, pg/ml	456 ± 621	656 ± 1,041	576 ± 743
Serum creatinine, mg/dl	1.4 ± 0.7	1.1 ± 0.3	1.7 ± 0.6
Current smoker	38 (29)	0 (0)	2 (29)
Diabetes mellitus	56 (43)	6 (86)	3 (43)
Renal disease	30 (23)	1 (14)	3 (43)
Hyperlipidemia	75 (58)	5 (71)	4 (57)
Hypertension	103 (79)	5 (71)	6 (86)
Atrial fibrillation	27 (21)	3 (43)	2 (29)
History of VT/VF cardiac arrest	14 (11)	1 (14)	1 (14)
Comorbidities affecting walking			
Gout/leg ulcers	17 (13)	3 (43)	2 (29)
Musculoskeletal abnormalities	21 (16)	2 (29)	2 (29)
Nerve disorders affecting locomotion	5 (4)	0 (0)	0 (0)
Medications			
Beta-blocker	121 (93)	7 (100)	7 (100)
ACE inhibitor	101 (78)	5 (71)	6 (86)
Angiotensin-II receptor blocker	20 (15)	1 (14)	1 (14)
Calcium-channel blocker	17 (13)	2 (29)	0 (0)
Diuretic	108 (83)	7 (100)	6 (86)
Reasons for not attempting WT			
Extreme fatigue	–	3 (43)	1 (14)
Musculoskeletal pain	–	2 (29)	4 (57)
Time constraints	–	2 (29)	2 (29)
WT			
60ftWT total completion time, s	26 (22-30)	40 (29-45)	–
6MWT total distance, m	331 (269-370)	–	–
Events, number of patients			
HF hospitalization	42 (32)	2 (29)	3 (43)
Death (all-cause)	12 (9)	3 (43)	2 (29)

Values are mean ± SD, n (%), or median (interquartile range). Percentages represent the proportion of patients within each subgroup (i.e., column). *There were no patients who were able to complete the 6MWT, but not the 60ftWT. †Includes 1 Native American participant.

ACE = angiotensin-converting enzyme; BMI = body mass index; HF = heart failure; NYHA = New York Heart Association; 6MWT = 6-min-walk test; 60ftWT = 60-foot-walk test; VF = ventricular fibrillation; VT = ventricular tachycardia; WT = walk test.

Changes in 60ftWT over time. Between baseline and 3 months, 60ftWT total completion time decreased (improved) by an average of 2 ± 5 s ($t[115] = 5.27$; p < 0.001). Distance on the 6MWT increased by 28 ± 52 m ($t[105] = -5.50$; p < 0.001), and the change in 60ftWT completion time was correlated with the

FIGURE 2 Associations Between the 60ftWT and 6MWT



(Left) Associations between 6MWT distance and 60ftWT completion time (duration). **(Right)** Associations between the change in 6MWT distance and the change in 60ftWT completion time (duration) from baseline to 3-month assessments. 6MWT = 6-min walk test; 60ftWT = 60-foot walk test.

change in 6MWT distance (n = 104; R^2 = 0.020; $r = -0.45$; p < 0.001) (Figure 2, right). 60ftWT change was also correlated with change in the expected direction for KCCQ Physical Limitation (n = 97; R^2 = 0.05; $r = -0.22$; p = 0.03) and Clinical Summary (n = 99; R^2 = 0.05; $r = -0.23$; p = 0.02) scores. Several factors likely contributed to the improvement in WT performance, including practice effects and medical optimization between assessments.

Predictive value of the 60ftWT for HF hospitalizations or death. Adverse events were defined as death from any cause or HF-related hospitalization recorded for up to 3.5 years post-baseline. During this time, 64 patients (44.4%) had an event, including 47 with a HF hospitalization and 17 deaths from any cause (Table 1). Including all subjects (n = 137) completing the 60ftWT, covariate-adjusted multivariate Cox proportional hazards regression, adjusted for age, sex, race, smoking, LVEF, and etiology, indicated that the 60ftWT was predictive of adverse events (hazard ratio [HR]: 1.04; 95% CI: 1.02 to 1.07; p = 0.001). For every 1 second longer 60ftWT time, risk of an event was 4% greater. In subjects completing the 6MWT (n = 130), 6MWT performance was also predictive of event-free survival (HR: 0.992; 95% CI: 0.987 to 0.996; p < 0.001). For every 1 additional meter walked during the 6MWT, risk of HF hospitalization or death was 0.8% lower. Receiver operating characteristic curve results supported the predictive value of both WTs (60ftWT: area under the curve: 0.62; 95% CI: 0.52 to 0.71; p < 0.001; 6MWT: area under the curve: 0.69; 95% CI: 0.59 to 0.78; p < 0.001) for risk of HF hospitalization or death.

60ftWT time and 6MWT distance were each divided into best, medium, and worst performance based on tertiles in the distribution of scores. For the 60ftWT, best performance was <22 s, medium performance was 26 s, and worst performance was >31 s. For the 6MWT best performance was >370 m, medium was 331 m, and worst performance was <269 m. For each WT, we compared the patient group with the worst third of performance (60ftWT >31 s; 6MWT <269 m) with the remainder of the patients (60ftWT ≤31 s; 6MWT ≥269 m). Given the small size of these sample subgroups, covariates were limited to age, sex, and LVEF to ensure adequate power. Using

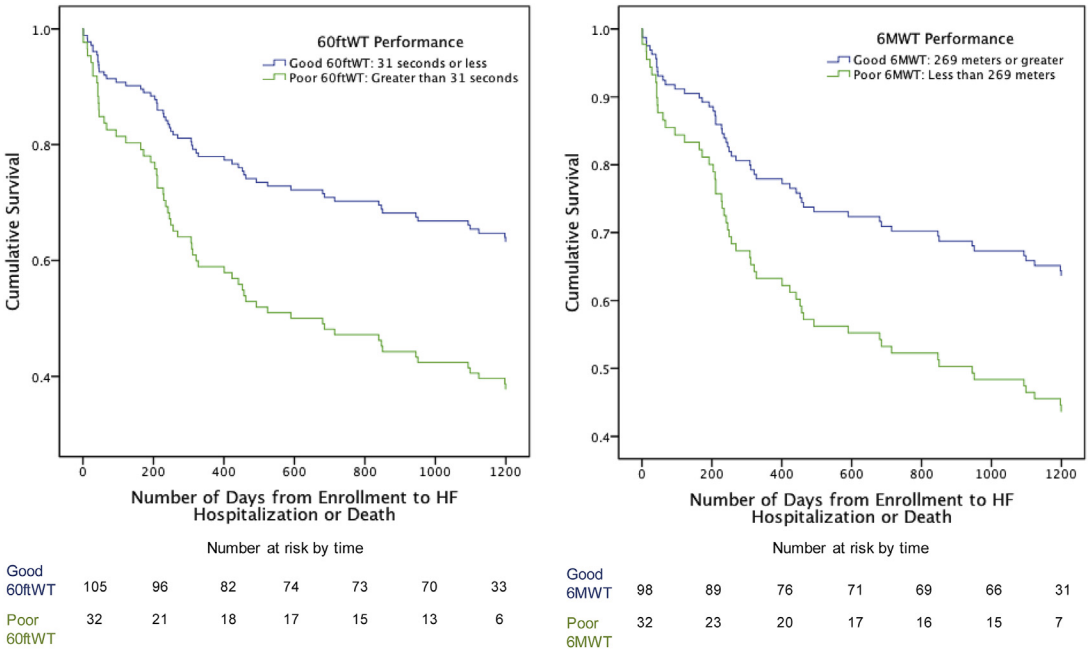
TABLE 2 Associations Between WT Performance and Heart Failure-Related Impairments Assessed Using 3 KCCQ Scales*

WT Measure	KCCQ Scale†		
	Physical Limitation	Clinical Summary	Overall Summary
6MWT distance walked	0.38‡	0.41‡	0.31§
60ftWT completion time	−0.49‡	−0.44‡	−0.40‡

*Data represent standardized regression coefficients adjusted for covariates. †Higher KCCQ scores indicate lesser impairment. Therefore, results indicate that lesser self-reported impairment is associated with longer 6MWT distance walked and shorter time to complete the 60ftWT. ‡p < 0.001. §p < 0.01.

KCCQ = Kansas City Cardiomyopathy Questionnaire; 6MWT = 6-min walk test; 60ftWT = 60-foot walk test; WT = walk test.

FIGURE 3 Walk Test Performance and Event-Free Survival



(Left) Cox proportional hazards regression survival curves for associations between 60ftWT completion time and event-free (HF hospitalization or all-cause death) survival. Those with the worst 60ftWT performance times (>31 s) are compared with the completion times of the remaining patients (≤31 s). **(Right)** Cox proportional hazards regression survival curves for associations between 6MWT distance walked and event-free (HF hospitalization or all-cause death) survival. Those with the worst 6MWT performance (<269 m) are compared with the performance of the remaining patients (distance walked ≥269 m). HF = heart failure; 6MWT = 6-min walk test; 60ftWT = 60-foot walk test.

this categorization, the 60ftWT was predictive of a higher event rate with patients performing the worst on the test (>31 s total completion time) having more than twice the risk of a HF hospitalization or all-cause death compared with the remainder of patients (HR: 2.13; 95% CI: 1.18 to 3.84; p = 0.01 (Figure 3, left). For the 6MWT, there was a trend for a similar higher event rate among patients in the worst tertile of the test (<269 m total distance) compared with the remainder of the patients who walked 269 m or more (HR: 1.94; 95% CI: 1.06 to 3.53; p = 0.03; overall model chi-square [4] = 8.24, p = 0.08) (Figure 3, right).

Fourteen (10%) patients in this sample did not complete the 6MWT and 7 (5%) did not complete the 60ftWT. Compared with those who completed the 6MWT, those who refused this test were more likely to have a HF hospitalization or death (chi-square [1] = 4.33; p = 0.04), suggesting that those not attempting the 6MWT had the most severe disease. To determine whether excluding these patients influenced the predictive value of the 6MWT, analyses were repeated including those patients who did not attempt the 6MWT in the worst performing group (<269 m total distance), rather than excluding them from analyses. Using this updated categorization and adjusting for age, sex, and LVEF, the 6MWT now predicted a higher event rate with patients performing the worst (either did not attempt WT or walked <269 m), demonstrating almost twice the risk of HF hospitalization or death compared with the remaining patients (HR: 1.92; 95% CI: 1.13 to 3.26; p = 0.02). Participants who refused the 60ftWT (n = 7) were no more likely to have a HF hospitalization or die compared with those attempting the WT (chi-square [1] = 2.05; p = 0.15), suggesting that disease severity was unrelated, or less strongly related, to test completion. With the inclusion of patients not attempting the 60ftWT in the worst performing group (>31 s total completion time), the test's predictive relationship remained the same (HR: 2.14; 95% CI: 1.22 to 3.73; p = 0.007).

DISCUSSION

This study reports the development of a new brief and easily administered measure of functional

status, the 60ftWT, which addresses several limitations of previously existing functional status measures. Among symptomatic patients with HF, total completion time on the 60ftWT is negatively correlated with the total distance completed during the 6MWT, is inversely associated with severity of HF symptoms, and is predictive of subsequent HF hospitalizations or all-cause death. Thus, the 60ftWT provides a shorter and more feasible alternative to the 6MWT that is less likely to be affected by comorbidities or other disabilities, and that seems suitable for office practice.

The goal of any measure of functional status is to provide an accurate representation of daily limitations posed by a patient's disease, and eliminate any bias associated with self-report measures. The 60ftWT is easy to administer, clinically relevant, and seems to satisfy these criteria. It predicts HF hospitalization or all-cause death, even in this relatively small sample, with an increase of 1 s on 60ftWT total completion time translating into a 4% increased risk for a HF-related hospitalization or all-cause death. Further supporting its validity as a measure of functional status in HF is its association with NYHA functional class, and self-reported symptoms and health status, and high correlation with the 6MWT. The 6MWT also requires a longer measured course and may not be appropriate for assessments in clinical practice settings.

Although we did not specifically assess the effect of comorbidities on the ability to perform each WT, preliminary findings suggest that the 60ftWT is a feasible alternative to the 6MWT that is less affected by comorbidities affecting walking. This has the potential to be a particularly salient benefit of the 60ftWT because patients with HF often present with comorbid conditions that impair daily activities and make it difficult to complete longer and more demanding functional status assessments. About half of the patients in our sample presented with comorbid conditions that could affect walking ability, including gout, musculoskeletal abnormalities, peripheral vascular disease, and diabetic neuropathy, among others. However, all patients who attempted the 60ftWT were able to walk the entire distance. Five percent of the sample did not attempt either WT and an additional 5% were only willing to attempt the 60ftWT.

Patients who refused to attempt 1 or both WTs cited a variety of refusal reasons, including fatigue and musculoskeletal pain traced to comorbidities, or time constraints preventing them from attempting 1 or both of the WTs. It is unclear whether this represented an excuse to avoid having to attempt a task that they may have viewed as challenging given their current symptomatic state. Those patients refusing the 6MWT were more likely to have a HF hospitalization or die compared with those not attempting this test. However, this difference in subsequent clinical events was not found when comparing patients who refused the 60ftWT and those who attempted this WT. Thus, although HF severity may prevent some patients from attempting the 6MWT, it does not seem to have the same effect on willingness to attempt the 60ftWT.

STUDY LIMITATIONS. The present study sample included only symptomatic patients with systolic HF. Therefore, the applicability of the 60ftWT to other HF populations requiring functional status assessment or to other chronic illness populations (e.g., chronic obstructive pulmonary disease) needs further investigation. Additionally, the sample was primarily male and African American and younger than typical HF samples. This is likely caused by a large percentage of patients with nonischemic HF. Thus, the test should be further evaluated among females, older adults, and individuals from other racial and ethnic backgrounds. Based on the assumption that the 60ftWT would produce less of a tiring effect among patients, the 60ftWT was always completed first, followed by a 5-min rest period and then the 6MWT. Despite the time for patients to rest between tests, giving the tests in this order may have increased the refusal rate or early stopping rate in the 6MWT. Recent guidelines also recommend that 2 6MWTs be performed, separated by a 30-min rest period, to control for potential learning effects (16). Future studies should attempt to counterbalance the order in which these WTs are performed, and to include multiple administrations to assess short-term repeatability. In this regard, it is possible that there were practice effects on 1 or both of these tests that may have affected the results.

In examining the predictive value of the WTs, the cutoff of <269 m chosen for the 6MWT was slightly <300 m, a value used in prior studies to identify those patients at highest risk for poor HF-related outcomes, and thus may explain why this relationship did not reach statistical significance (17,18). In addition, the relatively small sample and lack of a validation cohort in this study requires that the 60ftWT be validated against clinical endpoints in larger and more diverse samples. Furthermore, although not a primary aim of this study, we present findings suggesting that the 60ftWT is less affected by comorbidities. Future studies should aim to determine the impact of comorbidities on the ability to complete this task. Lastly, multiple comparisons were conducted as part of this study, thus introducing the possibility of type 1 error.

CONCLUSIONS

Assessment of functional status is an essential component of determining appropriate treatment strategies to manage symptoms and prevent adverse events. An easily administered measure of objective functional status that is predictive of adverse events, symptoms, and health status, and which can be given in a clinical practice setting has the potential for considerable clinical utility. In comparison with the more established 6MWT, preliminary findings suggest the 60ftWT is more accessible for patients with comorbidities that may impede walking longer distances. The utility of the 60ftWT is further increased by the fact that it can be implemented in any setting with an area of 15 feet and requires little time on the part of the patient and the clinician. The 60ftWT will also be useful in other conditions where repeated functional testing is performed, such as peripheral artery disease, chronic obstructive pulmonary disease, and pulmonary hypertension. By making functional status assessment more accessible to a wider array of providers and patients, the 60ftWT may help to identify patients at risk of future events and calibrate medical interventions designed to reduce patient symptoms, increase quality of life, and decrease likelihood of clinical events.

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PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: Treatment strategies and medical management of HF often rely on assessment of symptoms and on impairments in functional status. The 6MWT, a validated method for assessing functional status, has the advantage of being self-paced and easily administered. However, its clinical utility may be limited because it is time consuming, not suitable for patients with comorbidities that interfere with walking, and requires a long continuous hallway course. The authors report the development of the 60ftWT, an easily administered measure of objective functional status. The 60ftWT is predictive of adverse events, symptoms, and health status in patients with HF. This assessment can be given in a clinical practice setting and provides a measure of functional status useful for calibrating medical interventions and helping to identify patients at risk of future events. Results from the present study suggest that specific performance times (>31 s) on the 60ftWT are predictive of increased risk for clinical events among patients with HF.

TRANSLATIONAL OUTLOOK: The development of the 60ftWT provides an easily administered and accessible method for assessing functional status among patients with HF. The 60ftWT provides clinicians with an efficient measure that can be used to monitor symptom fluctuations and to identify those patients at greatest risk for future HF hospitalization or all-cause death. Early identification of these patients using the 60ftWT may allow for effective calibration of medical interventions that may reduce the need for hospitalization and lessen HF morbidity and mortality.

REFERENCES

1. Alahdab MT, Mansour IN, Napan S, Stamos TD. Six minute walk test predicts long-term all-cause mortality and heart failure rehospitalization in African-American patients hospitalized with acute decompensated heart failure. J Card Fail 2009;15:130–5.

2. Guyatt GH, Sullivan MJ, Thompson PJ, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. Can Med Assoc J 1985;132:919–23.

3. Xu L, Qian H, Gu J, Shi J, Gu X, Tang Z. Heart failure in hospitalized patients with diabetic foot ulcers: clinical characteristics and their relationship with prognosis. J Diabetes 2013;5:429–38.

4. Spieker LE, Ruschitzka FT, Lüscher TF, Noll G. The management of hyperuricemia and gout in patients with heart failure. Eur J Heart Fail 2002;4:403–10.

5. Inglis SC, Hermis A, Shehab S, Newton PJ, Lal S, Davidson PM. Peripheral arterial disease and chronic heart failure: a dangerous mix. Heart Fail Rev 2013;18:457–64.

6. Hirsch CH, Fried LP, Harris T, Fitzpatrick A, Enright P, Schulz R. Correlates of performance-based measures of muscle function in the elderly: the Cardiovascular Health Study. J Gerontol A Biol Sci Med Sci 1997;52:M192–200.

7. Kosak M, Smith T. Comparison of the 2-, 6-, and 12-minute walk tests in patients with stroke. J Rehabil Res Dev 2005;42:103–7.

8. Leung ASY, Chan KK, Sykes K, Chan KS. Reliability, validity, and responsiveness of a 2-minute walk test to assess exercise capacity of COPD patients. Chest 2006;130:119–25.

9. Gottlieb SS, Harris KM, Todd J, et al. Prognostic significance of active and modified forms of endothelin 1 in patients with heart failure with reduced ejection fraction. Clin Biochem 2015;48:292–6.

10. Wawrzyniak AW, Dilsizian V, Krantz DS, et al. High concordance between mental stress-induced and adenosine-induced myocardial ischemia assessed using SPECT in heart failure patients: hemodynamic and biomarker correlates. J Nucl Med 2015;56:1527–33.

11. Endrighi R, Waters AJ, Gottlieb SS, et al. Psychological stress and short-term hospitalisations or death in patients with heart failure. Heart 2016;102:1820–5.

12. Folstein MF, Folstein SE. Mini-Mental State Examination. 2nd edition. Lutz, FL: Psychological Assessment Resources, Inc., 2010.

13. 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;166:111–7.

14. The Criteria Committee of the New York Heart Association. Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Great Vessels. 9th edition. Boston, MA: Little, Brown; 1994.

15. Green CP, Porter CB, Bresnahan DR, Spertus JA. Development and evaluation of the Kansas City Cardiomyopathy Questionnaire: a new health status measure for heart failure. J Am Coll Cardiol 2000;35:1245–55.

16. Holland AE, Dowman L, Fiore J, Brazzale D, Hill C, McDonald CF. Cardiorespiratory responses to the 6-minute walk test in interstitial lung disease: not always a submaximal test. BMC Pulm Med 2014;14:136–43.

17. Roul G, Germain P, Bareiss P. Does the 6-minute walk test predict the prognosis in patients with NYHA class II or III chronic heart failure? Am Heart J 1998;136:449–57.

18. Cahalin LP, Mathier MA, Semigran MJ, Dec GW, DiSalvo TG. The six-minute walk test predicts peak oxygen uptake and survival in patients with advanced heart failure. Chest 1996;110:325–32.

KEY WORDS assessment, congestive heart failure, functional status, walk test

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