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## Six-minute walk distance predicts 30-day readmission after acute heart failure hospitalization

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## ABSTRACT

**Objectives:** To determine the relationship between 6-min walk test distance (6MWD) and 30-day readmission in hospitalized heart failure (HF) patients.

**Background:** 6MWD is known to predict hospitalizations in outpatients with HF, but its ability to predict recidivism in hospitalized HF patients is relatively unknown.

**Methods:** Seventy-one hospitalized HF patients with NYHA Class II/III (mean age  $52.6 \pm 12.3$  years, 42.3% female, 73.2% African American) performed 6MWD prior to discharge. Logistic regression was used to determine relationships between 6MWD and 30-day readmission.

**Results:** 30-day readmission occurred in 14 (19.7%) patients. Average 6MWD was  $756.4 \pm 403.2$  feet. Higher 6MWD significantly decreased risk of 30-day readmission, even after adjusting for sociodemographic and clinical characteristics (OR = .84, 95% CI [.71, .99]). For each additional 100 feet walked, odds of a 30-day readmission decreased by 16%.

**Conclusions:** 6MWD predicted 30-day readmission in this study, warranting further investigation to understand how the 6MWD may predict readmissions and guide treatment in hospitalized HF patients.

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## Introduction

In outpatients with heart failure (HF), prognosis has improved significantly over the past two decades due to improved medical therapies, but for hospitalized patients with HF that accrue nearly 6.5 million hospital days per year, prognosis remains grim.<sup>1</sup> Approximately 25% of hospitalized HF patients will experience death or readmission within 30 days of discharge.<sup>1</sup> Significant efforts have been targeted at the reduction of readmissions in hospitalized HF patients since the onset of Medicare's 30-day financial penalties, but these efforts have been largely unsuccessful. In 2000, 30-day readmission rates per 10,000 persons were 35.5, reduced marginally to 32.5 in 2010.<sup>2</sup> Many clinical,

psychological, social, and health system factors have been previously tested as predictors of 30-day readmission in hospitalized HF patients, but the ability to identify patients at high-risk for early readmissions remains elusive.<sup>3</sup> In order to develop more effective interventions to reduce early readmissions, alternative means of identifying high-risk patients are needed. Assessment of functional capacity prior to discharge may assist in identifying patients at risk for readmission.

Functional capacity refers to the ability of an individual to perform activities of daily living, and reflects the ability of the cardiac, pulmonary, and skeletal systems to sustain aerobic metabolism.<sup>4</sup> Reduced functional capacity is a known predictor of mortality and long-term morbidity in HF patients,<sup>5,6</sup> but its relationship to short-term outcomes is not well understood. During acute exacerbations of HF, patients demonstrate reduced functional capacity related to their clinical congestion (i.e.: fluid volume overload that is observed through signs of jugular vein distention, rales, and edema).<sup>7</sup> Lingering clinical congestion at discharge in hospitalized HF patients may put them at higher risk for early HF-related readmissions.<sup>8</sup> Indeed, clinical congestion rather than reduced cardiac output is the most common cause of hospitalization in patients with HF.<sup>7</sup> Dyspnea on exertion is a hallmark sign of this clinical congestion, but the practice of pre-discharge assessment of

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clinical congestion typically includes observation of dyspnea at rest only, along with various laboratory and radiographic findings.<sup>7</sup> Dyspnea on exertion may best be observed through the assessment of functional capacity using the low-tech six-minute walk test (6MWT) in hospitalized HF patients which can quickly identify lingering congestion, not observed in a patient at rest. Limited evidence suggests that pre-discharge assessment of functional capacity using the 6MWT in hospitalized HF patients may also predict limitations in day-to-day activities, and is a predictor of late readmissions<sup>9,10</sup> and 30-day all-cause readmissions.<sup>11</sup> The use of the 6MWT to predict 30-day HF-related readmissions is not well understood, and thus the purpose of this analysis was to determine if the distance walked during a 6MWT (6MWD) in hospitalized HF patients was predictive of 30-day HF-related readmission.

## Methods

### *Design and sample*

A secondary analysis of participants from an on-going HF trial investigating fluid restriction was conducted to determine the relationship between 30-day readmission and in-hospital 6MWD. Included participants were aged 18–85 years, had New York Heart Association (NYHA) classification II–III, were hospitalized for HF exacerbation with planned discharge to a home setting, had the ability to read, write, and speak English, were on standardized HF medications (beta blocker, ACE-inhibitor, and diuretics unless contraindicated), and ambulatory. Participants were excluded for serum sodium less than 134mEq/L at discharge, serum creatinine greater than 2.0 mg/dl, hemoglobin less than 8.5 g/dl, uncontrolled hypothyroidism, and musculoskeletal or other disorders inhibiting ability to complete a walking test. Additional inclusion criteria for the secondary analysis included at least 30-day participation in the HF trial, and completion of a baseline 6MWT in the hospital prior to discharge. All participants were recruited during an acute HF hospitalization from a large, university hospital system in the Southeast between 2011 and 2014. As a secondary analysis, this sample from the parent study was by convenience and availability of data, and was not powered for this outcome.

### *Variables and measurement*

#### *Sociodemographic and clinical characteristics*

Age, gender, race, marital status, and education levels were determined by self-report and medical chart review. The patient's usual NYHA classification status prior to hospitalization was assigned by their primary cardiologist and obtained through medical record review. Left ventricular ejection fraction (LVEF) and brain-natriuretic peptide (BNP) during hospitalization were collected via medical chart review. Comorbidities and length of HF diagnosis (<5 years versus ≥5 years) were assessed by self-report. The Charlson Comorbidity Index (CCI), a well-validated<sup>12</sup> weighted score based upon the risk of dying from a possible list of 19 comorbidities, was reviewed with participants and calculated.<sup>13</sup> Length of hospital stay (LOS) was calculated for the index hospitalization, as longer LOS has been associated with readmissions in hospitalized HF patients.<sup>14</sup>

Congestion at rest was measured at the same time as the 6MWT and determined by assigning a value of 1 to the presence of orthopnea, jugular venous distention, peripheral edema, increase in weight, and/or the need to adjust diuretic dose and summing these values for a Total Congestion Score (0–5) in accordance with prior literature.<sup>15</sup> The CS has been evaluated in clinical trials as a guide for treatment of HF,<sup>16</sup> previously demonstrated to predict two-year survival,<sup>15</sup> and guided the clinical assessment of HF

patients randomized to treatment based upon pulmonary artery catheter (PAC) values or clinical assessment.<sup>17,18</sup> The internal consistency reliability was calculated using the split-half computations for dichotomous data revealing Spearman Brown co-efficient of .722 and Guttman Split-Half Coefficient of .713 in this sample.

Patient reported symptoms were assessed using the Heart Failure Symptom Survey (HFSS) for the frequency, severity, and interference with physical activity and enjoyment of life for 12 physical symptoms (e.g. shortness of breath at rest, irregular heart beat) and two psychological symptoms (depression and cognitive impairment) experienced by persons with HF in the previous 7 days.<sup>19,20</sup> Patient ratings on a scale of 0 (no symptom/interference) to 10 (very frequent or severe/great deal of interference) were then summed along the four subscales with higher results indicating worse symptom experience and interference. As has been reported in other studies,<sup>18,20,21</sup> this instrument was found to have high internal consistency across the four symptom dimensions with Cronbach alpha coefficients of .90, .91, .91 and .92 in this sample.

### *Clinical event*

The primary outcome was 30-day readmission for HF-related causes assessed by medical chart review.

### *Six-minute walk distance*

The 6MWT is a valid and reliable measure of functional status in patients with HF.<sup>5</sup> All participants performed a 6MWT in accordance with the American Thoracic Society guidelines.<sup>22</sup> Participants walked as far as possible along a hospital corridor for six minutes under the supervision of trained research nurses with the total distance walked quantified. Tests were conducted in the hospital near the day of discharge, though this was not standardized, as it was not a primary aim of the clinical trial. Total distance walked was the primary predictor. Interruptions (stopping for any reason during the test) and associated self-reported symptoms of dyspnea during the test were also documented. If a patient stopped walking during their 6MWT, this interruption was noted, but timing continued and no adjustments were made for less distance walked because of the interruption.

### *Statistical approach*

Descriptive statistics were analyzed for study variables overall and by those with or without a 30-day readmission. Differences between groups were determined using Fisher's exact or Wilcoxon Mann–Whitney tests where appropriate. Univariate and multivariate, forward stepwise logistic regression was used to test the relationship between 30-day readmission and 6MWD. All sociodemographic (age, gender, race) and clinical (LVEF, BNP, CCI, LOS of index hospitalization, and Congestion Score) variables with a correlation *p*-value less than .20 were entered into the regression model. BNP was transformed by taking the natural log, but the non-transformed descriptive is included in Table 1. Missing data were assessed with the plan to exclude variables with >10% missing data in multivariate analysis due to the limited number of events.<sup>23</sup> Only the HFSS met this criterion (*n* = 49). All data were analyzed using SPSS version 23 setting the level of statistical significance (alpha) at .05 to control the Type I error rate.

## Results

### *Sample characteristics*

Data from 71 eligible participants was included in this analysis to determine if 6MWD predicted 30-day HF readmission. Sample characteristics are shown in Table 1 including their relationship

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