Title

Simple Measures of Function and Symptoms in Hospitalized Heart Failure Patients Predict Short-Term Cardiac Event-Free Survival

Author

Zaharias, Evanthia

Publication Date

2012

Peer reviewed|Thesis/dissertation

Simple Measures of Function and Symptoms in Hospitalized Heart Failure Patients Predict Short-Term Cardiac Event-Free Survival

by

Evanthia Zaharias

THESIS

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF SCIENCE

in

Nursing

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA, SAN FRANCISCO

[redacted]

Dedication and Acknowledgements

This thesis is dedicated to my grandfather Dr. F.S. Sperry (1915-2005), a general physician who began his practice in rural Iowa after serving as a flight surgeon and high altitude physiology instructor during World War II. He had great technical skills as well as an ability to relate to anyone, and he always said that he never met a patient he didn't like. His deep appreciation of both the intellectual and human sides of medicine continues to inspire my endeavors as a nurse in the health care field.

My grandfather also suffered from heart failure in the last years of his life. He referred to it as the "Three S's" syndrome, characterized as it is by sleeplessness, shortness of breath, and swelling.

I am very grateful to my thesis committee members Janine Cataldo, Lynda Mackin, and Jill Howie-Esquivel (chair) for their expert guidance and support during the preparation of this work.

Special thanks to Jill Howie-Esquivel for allowing me the opportunity to work on the heart failure mobility study, for her ongoing encouragement, for her willingness to serve as my thesis advisor, and for generously sharing her wisdom with me on the professional analysis and write-up of nursing research.

The author also thanks P. Baiyor for her valuable assistance on calculations that facilitated data processing for this study.

Abstract

As the final stage of many types of heart disease, heart failure (HF) is a prevalent chronic condition and a costly public health issue. Patients with this highly symptomatic syndrome experience shortness of breath, fatigue, edema, and orthopnea. Mortality in HF is high and functional status is low. This study aimed to examine function and symptoms in hospitalized HF patients and determine whether function and/or symptoms predicted cardiac event-free survival within 90 days after discharge. Cardiac events were defined as cardiac rehospitalization, heart transplantation, or death. A convenience sample of 32 inpatients with primary or secondary HF diagnoses were enrolled. Symptoms were assessed with yes/no questions at two points in time during hospitalization and function was determined with tools including NYHA Classification and the Katz Index of Activities of Daily Living (ADLs), as well as by the direct performance measure of Short Physical Performance Battery (SPPB). Survival was analyzed via univariate Cox proportional-hazards regression with time to first post-discharge cardiac event as the outcome variable. Mean age was 58.2 ±13.6 years. Patient ADL function was nearly independent (5.6±1.1) while mean SPPB showed moderate functional limitation (6.4±3.1). All patients reported at least one symptom at the study outset. Within 90 days, 40.6% patients had a cardiac event. Results showed that each increase in NYHA Classification assessed 1.0 days (median) before discharge was associated with a 3.4-fold higher risk of cardiac events (95% CI 1.4-8.5). Patients reporting shortness of breath 1.0 days (median) before discharge had a 4.0-fold greater risk of cardiac events (95% CI 1.2-13.2). Risk of cardiac events was 9.7 times higher among patients reporting fatigue at this time (95% CI 1.2-75.1) and 12.8 times higher among those reporting orthopnea (95% CI 1.7-99.7). This study demonstrates that quick, simple assessments of function and symptoms that can easily be done at the bedside by physicians or nurses may be a meaningful way to predict short-term cardiac outcomes in hospitalized HF patients.

Table of Contents

List of Tables

Page

List of Figures

Page

Introduction

Heart failure (HF) is a complex syndrome resulting from structural or functional disorders of the heart that impair ventricular ability to fill with or eject blood (Hunt et al., 2009). As the final stage of many types of heart disease, HF is a prevalent chronic condition and a major public health issue (Bui, Horwich & Fonarow, 2011). The costs of HF are large: it has been called the "most costly cardiovascular disorder" in the U.S. (Thomas & Rich, 2007, p. 1). The total healthcare expenditure for HF in the U.S. in 2010 was 39.2 billion dollars (CDC, 2010), and hospitalizations were the top contributor to these costs (Bui et al., 2011). HF is the main reason for 6.5 million hospital days annually (Hunt et al., 2009), and the most common condition for hospital admission in people age 65 and over (Bui et al., 2011). The hospital burden of HF is expected to increase with the rapid aging of the U.S. population: 72 million adults are projected to be over age 65 by 2030 (He et al., 2005). Costs will further increase since HF is part of a key quality-related provision in the Affordable Care Act of 2010. This provision decreases hospital reimbursements for 30-day readmission rates not meeting targets for multiple chronic conditions that include HF (Bielaszka-DuVernay, 2011).

Despite current medical treatment, the prognosis for HF is poor, with a 5-year mortality rate of 45-60% (Bui et al., 2011). In addition to high mortality, disability levels in HF patients are also consistently high. A recent analysis in a national community-based sample of patients who reported having HF between 2003-2008 found that 11% had disability in activities of daily living (ADLs) and 57% had mobility disability, and these rates were constant among HF patients in study cohorts back to 1988 (Wong, Chaudhry, Desai, & Krumholz, 2011).

Conceptual Framework

A predominant conceptual model for investigating how health conditions such as HF affect disability is the International Classification of Functioning, Disability and Health ([ICF]; Dale et al., 2012). This biopsychosocial model was published in 2001 by the World Health Organization (WHO) and focuses on health and functioning instead of disability. The ICF was developed as a flexible framework to allow adaptation to a wide range of clinical issues (WHO, 2002) such as HF. The ICF defines human functioning on three levels (Table 1), and disability is defined as dysfunction at one or more of these levels.

Table 1

Function and Symptoms Understood Using ICF Nomenclature

ICF Terms				**Non-ICF Terms**
Level of Function	**Name of Function**	**Definition of Function**	**Problem with Function (Disability)**	**Measurement of Function**
Body	Body Function & Structure	No significant deviation or loss	Impairment	Symptoms
Whole Person	Activity	Execution of a task or action by an individual	Limitation	Physical function
Person in Society	Participation	Involvement in life situations (e.g. family, community, work)	Restriction	Global function

Note: Adapted from WHO, 2002

In the ICF (Figure 1) disability is influenced by dynamic interactions between health conditions, the three levels of function, and environmental and personal contextualfactors (WHO, 2002).

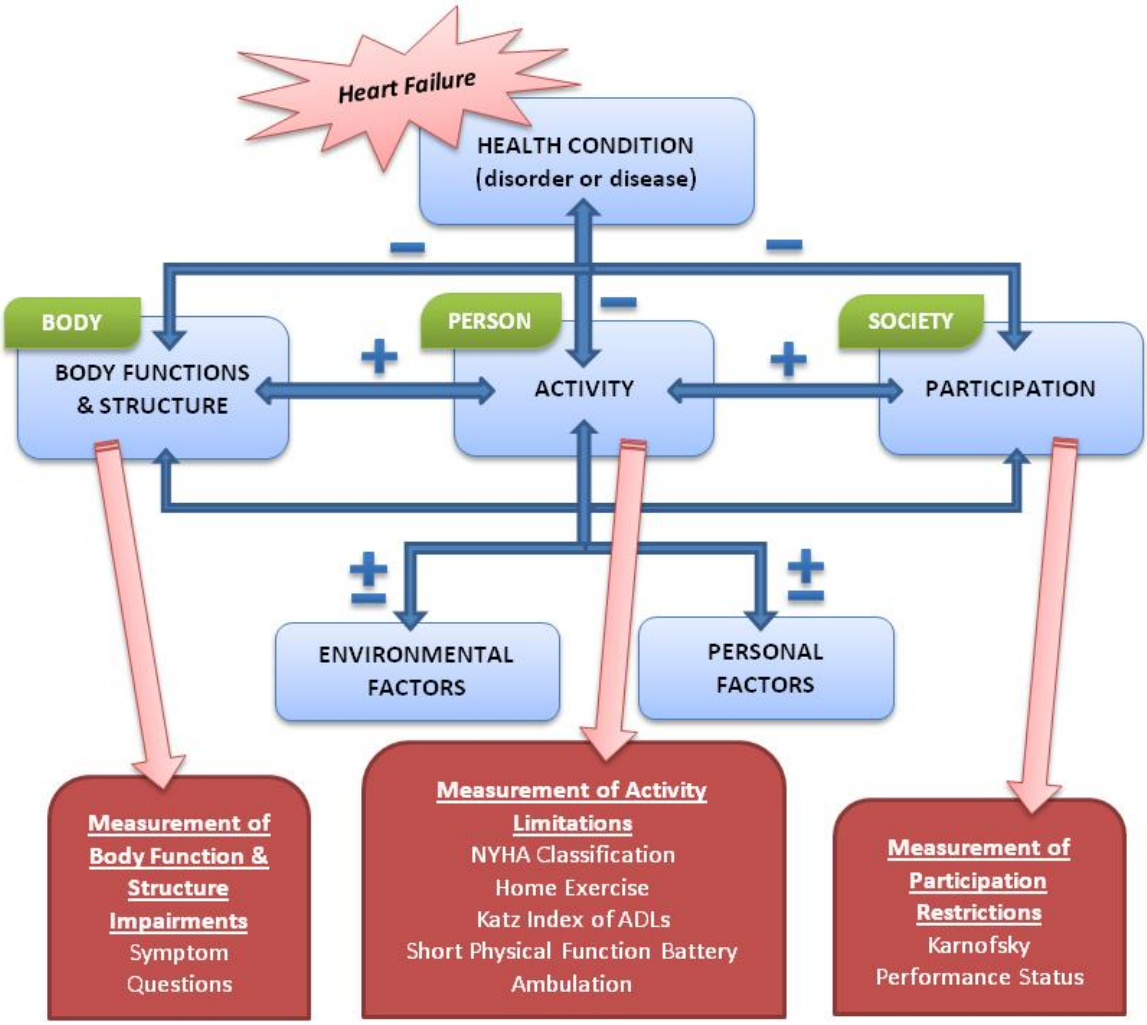

Figure 1. *Modified from the International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2002). Signs added to illustrate relationships between concepts. Plus sign indicates a positive relationship; minus sign indicates a negative relationship. Levels of function and measurements of each level of function in this study are shown. ADLs = Activities of Daily Living. NYHA= New York Heart Association.*

The ICF is valuable because it is flexible enough to account for diagnoses such as HF where length of hospital stay, level of required care, and functional outcomes are not predictable (WHO, 2002). In the ICF, the interplay between disease, function, and contextual factors may lead to a negative outcome, i.e. the cessation of activity and participation with impairment of body function. This negative outcome for patients is another way to conceptualize progressive morbidity and mortality.

This pilot study characterized the three ICF levels of function in hospitalized HF patients, with a focus on activity limitations, and investigated whether these measures predict cardiac events after discharge.

Function in Heart Failure Using the ICF

The pathophysiology of HF as a health condition leads to impairments of body functions and structure, such as cardiac remodeling, venous congestion, and impaired oxygen exchange. While most impairments are due to cardiac dysfunction, non-cardiac factors also play a role. Heart failure can lead to abnormal vasodilatory function, abnormal distribution of blood flow (Myers et al., 2006), changes in neurohormonal and reflex autonomic activity (Hunt et al., 2009), decreased aerobic capacity, and skeletal muscle myopathy (Gary et al., 2011). Early on, HF is compensated, but ongoing impairments are experienced by patients as symptoms. Symptoms, then, are a measure of bodily impairments as defined by the ICF and represent functioning at the body level.

In the ICF, "activity" is defined as "the execution of a task or action by an individual" (WHO, 2002, p. 10); in addition, physical function is defined as the sensory-motor skills needed to accomplish activities of daily living (Guccione & Scalzitti, 2007). Physical function can be seen as underlying the concept of activity in the ICF. Activities of daily living (ADLs) include self-care (e.g. bathing, dressing, and feeding) as well as physical mobility (e.g. turning in bed, transferring in and out of bed, and walking). Thus, measurement of ADLs and mobility (physical function) are also a measure of activity limitation in the ICF, and represent functioning at the whole person level.

The syndrome of HF is characterized by decreased activity, a common means of adaptation and protection during illness (Kaspar, 2003), but the hazards of prolonged

bedrest and immobility are well known and affect every body system. This cyclic relationship is illustrated in the ICF (Figure 1): body impairments from HF lead to activity limitation, which then cause additional body impairments. Complications from bed rest include muscle atrophy, orthostatic hypotension, decreased lung volumes and atelectasis, increased cardiac workload, constipation, pressure ulcers, and mood changes (Corcoran, 1991), all of which further decrease physical function and limit activity.

Hospitalization puts HF patients at higher risk for decreased activity. Daily activities are limited to some degree in all hospitalized patients due to the nature of the hospital environment (Kaspar, 2003), and illness like HF can further limit activity. As activity limitations with HF become more severe, the individual's ability to participate in home, work, and community life is increasingly restricted. Measures of global function, then, are measures of participation restriction in the ICF and represent functioning at the level of the person in society.

Review of Literature

Heart failure function and outcomes

In patients with HF, various measures of function have been shown to predict outcomes including rehospitalization and survival, and decreased mobility in hospitalized patients is associated with adverse outcomes like functional decline (Brown, Friedkin, & Inouye, 2004; Zisberg et al., 2011), new institutionalization, and death (Brown et al., 2004).

The most common system for quantifying the degree of functional limitation experienced by HF patients (Hunt et al., 2009) is the New York Heart Association (NYHA) Classification (American Heart Association, 2011, [Appendix A]). Originally

developed in 1928 (Severo, Gaio, Lourenço, Alvelos, Bettencourt, & Azevedo, 2011), the NYHA Classification describes functional status that ranges from Class I for patients who have no symptoms even with exertion to Class IV for patients who are symptomatic at rest (LeBlond, DeGowin, & Brown, 2009). Since it indicates what level of physical activity provokes HF symptoms, NYHA Classification can be viewed as a combined assessment of physical function and symptoms. Classification by NYHA is inherently subjective since it depends on a healthcare provider's interpretation of various levels of physical activity (e.g. what is meant by "ordinary" activity), and whether limitations should be called "slight" or "marked" (Severo et al., 2011). This subjectivity has caused some to question the validity of NYHA Classification (Raphael et al., 2007). However, studies show that NYHA Classification is a valid measure.

The NYHA Classification has been shown to predict mortality in multiple studies. In a study of function in 157 older hospitalized HF patients in Italy, Chiarantini et al (2010) found that increasing pre-admission NYHA class was associated with greater mortality over a median follow-up period of 444 days ($p=0.22$). Another study in outpatients at primary care practices in Belgium (n=556) found that more patients with a higher NYHA Classification at the time of HF diagnosis died within 6 months than those with a lower NYHA at diagnosis: 48% of patients who died in 6 months were NYHA Class IV, while only 21% of survivors were NYHA Class IV ([$p<0.001$], Devroey and Van Casteren, 2010).

Beyond the NYHA Classification, physical function can also be determined by directly measuring performance, by continuous ambulation monitoring, or by assessing ADLs, and a global determination of function can be made with instruments that measure

the impact of a health condition on the ability to work and care for oneself. Accelerometers have been used to measure patient ambulation in many studies across a wide range of ages and health conditions (Strath, Pfeiffer, & Whitt-Glover, 2012), but to our knowledge, no studies have used accelerometers to measure ambulation specifically in hospitalized HF patients.

Function in relation to ADLs is also associated with outcomes. One study examined multimorbidity and functional decline in a large cohort of Swedish older adults where 16-20% of the sample had HF. Baseline functional status as measured by the Katz Index of Independence in ADLs (Katz Index) was found to be the strongest predictor of mortality over a 3-year follow-up period, independent of number of co-morbidities (Marengoni, von Strauss, Rissuto, Winblad, & Fratiglioni, 2009). A direct performance measure such as the Short Physical Performance Battery (SPPB) was tested in older hospitalized Italian HF patients, and a strong association was found between survival over a median follow-up period of 444 days and a higher SPPB score at discharge (Chiarantini et al., 2010.) The Karnofsky Performance Status Scale (KPS) has rarely been reported as a measurement of global function in cardiac patients. One such study was designed to see if the KPS predicted outcomes in acute myocardial infarction (AMI) patients, and to compare its predictive value to that of two well-established predictors (Brezinski et al., 1991). Results showed that cumulative mortality was significantly higher in patients with higher pre-AMI KPS scores at 1 and 4-year follow up. The KPS was also found to be weakly but significantly correlated with left ventricular ejection fraction (LVEF) at the time of MI admission, and both LVEF and the KPS were equally predictive of mortality.

Heart failure symptoms and outcomes

Heart failure is a highly symptomatic syndrome in which patients commonly experience shortness of breath, fatigue, lower extremity edema, and orthopnea with varying severity over time (Hunt et al., 2009). These and other HF symptoms, both physical and psychological, create a high symptom burden and diminished health-related quality of life (Bekelman et al., 2007; Blinderman, Homel, Billings, Portenoy, & Tennstedt, 2008; Zambroski, Moser, Bhat, & Ziegler, 2005). The symptom burden in HF has been found to be similar to that of advanced cancer (Bekelman et al., 2009). Multiple investigators have examined the connection between outpatient HF symptoms and outcomes (Devroey & Van Casteren, 2010; Ekman, Cleland, Swedberg, Charlesworth, Metra, & Poole-Wilson, 2005; Ekman, Kjork, & Anderson, 2007; Lee et al., 2010; Moser et al., 2011). Few researchers have studied whether HF symptoms in an inpatient setting predict outcomes (Goldberg et al., 2010; Song, Moser, Rayens, & Lennie, 2010). Although it is known that the timing of assessment of potential risk factors (e.g. symptoms) during the illness trajectory may affect patient outcomes (Giamouzis et al., 2011), no studies known to the authors have studied whether the timing of HF symptom measurement during hospitalization (e.g. at admission or discharge) might predict outcomes such as rehospitalization or survival.

Predictors that help to identify hospitalized HF patients who are at higher risk of adverse cardiac outcomes allows for the development of more effective in-hospital care plans and more targeted interventions to prevent future cardiac events or less aggressive curative efforts if indicated, along with improved discharge coordination and follow-up care. This study is part of a parent study to characterize levels of ambulation in

hospitalized HF patients using accelerometers. The purpose of this study is to explore multiple measures of function as well as symptoms, and to examine related factors that might predict short-term cardiac event-free survival.

Aims

The specific aims of this study were to examine the: (1) function of HF patients at home and between two points in time during hospitalization; (2) symptoms of HF patients at two points in time during hospitalization, and; (3) to determine whether function and/or symptoms predict cardiac event-free survival up to 90 days after hospital discharge. Time points were the study start, which was up to 48 hours after hospital admission, and the study end, which was up to 7 days after hospital admission or the day of discharge if the hospital stay was less than 7 days. Function was measured by NYHA Classification, self-report of home exercise, the Katz Index of Independence in ADLs, the Short Physical Function Battery, the Karnofsky Performance Status Scale, and by time spent ambulating. Ambulation was defined as the average daily time spent lying, sitting, and standing or walking. Symptoms were measured by yes/no questions regarding shortness of breath, fatigue, orthopnea, and edema. Cardiac events were defined as rehospitalization attributed to a cardiac cause, heart transplantation, or death.

Methods

Study Design, Setting, and Sample

A convenience sample of 32 patients aged 30 and above was recruited for this prospective cohort study. The study was approved by the Committee on Human Research at the University of California, San Francisco. Inclusion criteria included a primary or secondary diagnosis of HF as determined by hospital records and/or medical team, ability

to ambulate with or without an assistive device during the month prior to hospitalization, having a doctors' activity order that allowed the patient to be out of bed, ability to speak English, and no isolation precautions. Exclusion criteria included dementia as measured by the MiniCog (Carolan Doerflinger, 2007) or indicated as severe in the medical record, delirium as measured by the Confusion Assessment Method ([CAM], Waszynski, 2007), and living in a skilled nursing facility prior to admission.

The study took place on two inpatient telemetry units at a large urban academic hospital. A Registered Nurse and graduate nursing student conducted all study procedures and data analysis in collaboration with the principal investigator. All patients admitted to the study units under either cardiology (includes HF service) or medical services within the prior 48 hours were pre-screened daily via chart review between April 2010 and February 2011. Once the patient consented, the Mini-Cog (Appendix E) and the CAM (Appendix F) were administered to screen for cognitive impairment and delirium, respectively, and the patient was enrolled if eligible.

The study procedure consisted of up to 5 hospital visits and one follow-up phone call after discharge (Table 2).

Table 2

Study Procedure

Study Start – Day 1	**Study Days 2-4**	**Study End - Day 5 (or day of discharge)**	**90 days after discharge**
Baseline Measures	Check-in Visits	Final Measures	Follow-up Call

Demographic: Age, gender, race, marital status Clinical: Vital Signs (VS), symptoms, Ejection Fraction (EF) Functional: home exercise (self report), NYHA Class at home and study start, Katz Index of ADLs, KPS, SPPB Ambulation: Place accelerometer monitors on ankle and thigh	Skin: Check skin condition under monitors Ambulation: Move accelerometer monitors to opposite ankle and thigh	Clinical: VS, symptoms, HRDES, EF confirmation, receipt of PT in hospital Functional: NYHA Class at study end Skin: Check skin condition under monitors Ambulation: Remove accelerometer monitors	Phone call to determine whether rehospitalization or emergency room visit occurred.

Note. NYHA= New York Heart Association, ADLs = Activities of Daily Living, KPS=Karnofsky Performance Status Scale, HRDES= High Risk Diagnosis for the Elderly Score, SPPB=Short Physical Function Battery

Data Collection

Demographic information was gleaned from medical records at enrollment and confirmed by patient interviews. Clinical information including co-morbidities (High Risk Diagnosis for the Elderly Score [HRDES]) was extracted from medical records when the patient was discharged (Desai, Bogardus, Williams, Vitagliano, & Inouye, 2002); (Appendix G). Vital signs, NYHA Classification and symptoms were determined by the study nurse at the beginning and end of the study; NYHA Class was also assessed at home prior to admission. Function was assessed at home (self-report of home exercise), at the beginning of the study (Katz Index, KPS, and SPPB), and during the study (ambulation). The Katz Index and the KPS were administered by questionnaire, while the SPPB was a direct performance measure. Ambulation was measured continuously during the study period via wireless accelerometer monitors.

Telephone follow-up occurred at 90 days following discharge to determine whether patients experienced hospitalizations or emergency department visits. In

addition, they were asked about which symptoms led them to seek care. Deaths were confirmed by public death records including internet-accessible obituaries and the Social Security Death Index (Ancestry.com, 2011).

Instruments

Function and symptom measures are described in Table 3 and related appendices.

Table 3

Reliability and Validity of Function and Symptom Measures

Instrument/Assessment	Type of Measure	Brief Description	Reliability	Validity
(1) NYHA Class	Physical Function and Symptoms	I: No symptoms/ limitations in ordinary physical activity. II: Mild symptoms & slight limitation in ordinary activity. III: Symptoms cause marked limitation even during <ordinary activity. IV: Severe limitations; symptoms at rest. **Appendix A**	Inter-rater reliability * 56% agreement (weighted κ=0.41) between 2 MDs (Goldman et al., 1981) * 54% agreement between 2 MDs (Raphael et al., 2007).	Concurrent validity * 41.7% agreement with Weber classifications of VO_2 max; moderate correlation suggests NYHA measures unique aspect of function (Bennett al., 2002) * NYHA associated with exercise test measures: inversely correlated with peak V_{O2} (-0.797, p<.001), correlated with VE/ V_{CO2} slope (0.580, p<.001); these measures shown to be predictors of hospitalization and mortality (Athanasopoulos et al., 2010) Predictive validity * NYHA Class at hospital discharge shown to predict both 30-day & 1-year readmissions according to a number of studies (Giamouzis et al., 2011) * Preadmission NYHA Class associated with greater mortality over a median follow-up period of 444 days (p=.022); (Chiarantini et al., 2010)
(2) Home Exercise	Physical Function	"Do you exercise at home?" Yes/No	NA	NA
(3) Katz Index of Independence in ADLs	Physical Function	Ability to perform six ADLs (bathing, dressing, toileting, transferring, continence, and feeding) independently **Appendix B**	Internal consistency * Cronbach's α in two studies: 0.87, 0.94 (Wallace & Shelkey, 2008)	Concurrent validity against Activity Index: 0.95 Construct validity (coefficient of scalability since Katz is a cumulative scale): 0.74-0.88 Predictive Validity: * Predicts functional outcomes in hospitalized patients, post-stroke patients, and older adults in short-term care (Wallace & Shelkey, 2008) * Baseline Katz strong predictor of mortality over 3-years in older Swedish adults, independent of number of co-morbidities (Marengoni et al., 2009)

(4) Short Physical Function Battery (SPPB)	Physical Function	Set of 3 tests (balance, gait speed, chair stands) to objectively measure lower extremity physical function **Appendix C**	Internal consistency * Spearman's ρ (gait speed vs. chair stands): 0.48; (gait speed vs. balance & chair stands vs. balance): 0.39 (all p<.001) * Cronbach's α: 0.76 (Guralnik et al., 1994) Test-retest reliability (intra-class correlation): 0.82 (Studenski et al., 2003)	Concurrent validity * 42% of variability in SPPB explained by self-report of disability (Guralnik et al., 1994) * Correlation with 400m walk test: r=0.74, p<.001 (Sayers et al, 2006). Predictive validity *Strong independent predictor of nursing home admission and mortality (Guralnik et al., 1994)
(5) Ambulation	Physical Function	Direct continuous ambulation measure via wireless accelerometers attached to lower extremity	Internal consistency * Median κ: 0.92, mean κ: 0.88 (Note: the κ statistic usually used for reliability is used more for validity here, κ is calculated to compare 20 sec increments of direct observation or monitors) (Brown et al., 2008)	Concurrent validity * Pearson coefficients correlating accelerometer data vs. behavioral observation by mean minutes in each position: Lying: 0.98, Sitting: 0.97, Standing or Walking: 0.91 (Brown et al., 2008)
(6) Karnofsky Performance Status Scale (KPS)	Global Function	Rating scale assessing impact of health condition on ability to work and care for oneself **Appendix D**	Internal consistency * Cronbach's α: 0.97 (Mor et al., 1984) Inter-rater reliability * Correlation coefficient: 0.85 (p=.01) (Liem et al., 2002)	Construct validity * KPS vs. ADL function (contingency coefficient): 0.49 *KPS vs. QOL measures (Kendall's tau): 0.35 Predictive validity: Lowest scores (10-20) associated with imminent death, scores (50+) with longer survival (Mor et al., 1984)
(7) Symptom Questions	Symptoms	Symptom - (SOB, fatigue, orthopnea, lower extremity edema)? - Yes/No	NA	NA

Note. ADLs: Activities of Daily Living; QOL: quality of life; Activity Index: instrument similar to Katz Index of ADLs; MD: physician; V_{O2} max: peak oxygen consumption, a direct measure of cardiovascular (CV) fitness, VE/V_{CO2}: minute ventilation/CO_2 production slope; NA: not applicable; Weber classifications: four levels of CV capacity based on V_{O2} max (Rostagano et al., 2000); SOB: shortness of breath.

Ambulation was measured in this study via Micro Care Timeliness Monitors, miniature recording 3-axis accelerometer monitors (AugmenTech, Pittsburgh, PA). Two accelerometer monitors were programmed and attached to the thigh and ankle of the patient for up to five days, or until discharge. Monitors were removed daily, skin condition was checked, and a new set of monitors was attached to the ankle and thigh on

the opposite leg. The HyperTerminal PE program (Hilgraeve Inc., Monroe, MI) was used to program monitors and download data. Gauze pads were used to cushion the monitors against the skin and Tegaderm (3M, St. Paul, MN) secured the monitors.

Statistical Analysis

Demographic and clinical data were analyzed using SPSS Statistics 19 software (IBM Corp., Armonk, NY). Descriptive statistics were used to summarize demographic and clinical data, including function and symptoms. Accelerometer monitor data was processed using Excel (Microsoft, Redmond, WA). Ambulation, defined as average daily time spent in each position (lying, sitting, and standing or walking), was calculated during the study period for each patient. Full analysis of the ambulation data is presented elsewhere. For this analysis, data on function and symptoms were used as independent variables for survival analysis. Survival analyses were completed using a univariate Cox proportional-hazards regression with time to first cardiac event after discharge as the outcome variable. An alpha of 0.05 was used. Hazard ratios and confidence intervals were calculated to identify predictors of cardiac events.

Results

Sample Characteristics

Thirty-two patients with a mean age of 58.2 ± 13.6 years participated in the study, and 78.1% were men (Table 4). More than half identified as white (59.4%), 31.3% as African-American, and 9.4% as Asian or Pacific Islander. Most had a history of hypertension (71.9%) and mean creatinine on admission was 1.9 ± 1.7 g/dL. Most patients had systolic HF: 70.9% had an EF of less than 40%. The co-morbidity score or mean HRDES was 3.3 ± 1.7, and the majority (53.1%) of patients fell into the

intermediate category, with a 31% chance of dying in the next year. Length of hospital stay ranged from 1–41 days, with a mean of 9.5 ± 9.9; median stay was 6.5 days. Two patients (6.3%) received an LVAD during the original study admission; these patients had the longest LOS at 41 days each. Within 90 days after discharge, a total of 3 patients (9.4%) died, 1 patient received a heart transplant, and 11 (34.4%) had a cardiac rehospitalization.

Table 4

Sociodemographic and Clinical Characteristics of Study Patients (N = 32)

Characteristic	**Value**
Age, years	
Mean ± SD	58.2 ± 13.6
Range	30 - 92
Sex, % (n)	
Male	78.1 (25)
Female	21.9 (7)
Race/Ethnicity % (n)	
Caucasian/White	59.4 (19)
African-American/Black	31.3 (10)
Asian/Pacific Islander	9.4 (3)
Marital Status, % (n)	
Married	28.1 (9)
Single	40.6 (13)
Other (widowed/divorced)	31.3 (10)
Smoking	
History of smoking, % (n)	75.0 (24)
Pack years, mean ± SD	21.0 ± 20.7
History of hypertension, % (n)	71.9 (23)
Creatinine on admission (g/dl), mean ± SD	1.9 ± 1.7
Etiology of Heart Failure, % (n)	
Ischemic	28.1 (9)
Idiopathic	65.6 (21)
Unknown/other	6.3 (2)
Ejection Fraction <40%, % (n)	71.9 (23)
ACEi/ARB use - study end, % (n)	62.5 (20)
Beta blocker use - study end, % (n)	78.1 (25)
High-Risk Diagnoses for the Elderly Scale	
Low (0)= 9.5% chance dying in 1 year	0 (0)
Intermediate (1-2)= 31% chance	53.1 (17)

High risk (3-5)= 46% chance	31.3 (10)
Very High Risk (≥6)= 74% chance	15.6 (5)
Length of hospital stay, Days	
Mean ± SD	9.5 ± 9.9
Median	6.5
Range	1 - 41
Physical Therapy - in hospital, % (n)	34.4 (11)
LVAD received during study admission, % (n)	6.3 (2)
Discharged with Physical Therapy, Occupational Therapy, or Home Health, % (n)	40.6 (13)
Cardiac Events – 90 days post-discharge, % (n)	
Cardiac readmission	34.4 (11)
Heart transplant	3.1 (1)
Mortality	9.4 (3)

Note. ACEi= angiotensin converting enzyme inhibitor; ARB=angiotensin receptor blocker; LVAD=left ventricular assistive device. Study end: median of 1.0 days before hospital discharge.

Functional Status

The proportion of patients in each NYHA Class differed across time points (Table 5). Close to half (46.9%) of patients reported having experienced symptoms at rest (NYHA Class IV) at home prior to admission. By the start of the study, a median of 1.0 days after admission, 18.8% reported symptoms at rest. Only one patient (3.1%) reported symptoms at rest at the study end, a median of 1.0 days prior to discharge.

Most patients (62.5%) reported exercising at home, and the mean Katz Index score was 5.6 ± 1.1 (possible 0-6) indicating near-independence in ADLs. The mean SPPB score at the study start was 6.4 ± 3.1, just above the category of moderate physical function limitation. The greatest number patients (38.7%) had results in the moderate category (score 4-6). Ambulation during the study showed that patients spent on average 59 ± 43 minutes daily standing or walking in the hospital, and an average of 16.8 ± 3.2 hours lying down.

The mean KPS score was 71.1 ± 9.0, with scores ranging from 50 – 90. Most patients (71.9%) fell into the middle KPS category of 50-79, indicating that they were unable to work but were able to live at home and care for most needs with varying amounts of assistance. No patients were unable to care for themselves and required the equivalent of hospital care (score <50), and 28.1% felt they were able to carry on normal activity without any special care (scores 80-100).

Table 5

Functional Status of Study Patients (n = 32 except where indicated)

Characteristic	**Value**		
NYHA Classification	At home	Study Start	Study End
Class I (no symptoms with activity)	6.3 (2)	6.3 (2)	15.6 (5)
Class II (symptoms with activity, slight limitations)	15.6 (5)	18.8 (6)	50.0 (16)
Class III (symptoms with activity, marked limitations)	31.3 (10)	56.3 (18)	31.3 (10)
Class IV (symptoms at rest)	46.9 (15)	18.8 (6)	3.1 (1)
Home exercise, patient-reported, % (n)		62.5 (20)	
Katz Index of Independence in ADLs, mean ± SD			
Score 6: independent *Score 4: moderate functional impairment* *Score 2: severe functional impairment* *Score 0: dependent*		5.6 ± 1.1	
Short Physical Function Battery - study start, mean ± SD (n = 31)		6.4 ± 3.1	
Score 10-12: Minimal limitations		22.6 (7)	
Score 7-9: Mild limitations		25.8 (8)	
Score 4-6: Moderate limitations		38.7 (12)	
Score 0-3: Severe limitations		12.9 (4)	
Ambulation, mean ± SD			
Average time spent in each position in hospital every 24 hours			
Standing or Walking		59 ± 43 minutes	
Sitting		5.5 ± 3.0 hours	
Lying		16.8 ± 3.2 hours	
Karnofsky Performance Status Scale			
Mean ± SD; Range		71.1 ± 9.0 (50 – 90)	
Score 80-100: Able to carry on normal activity and to work; no special care needed.		28.1 (9)	

Score 50-79: Unable to work; able to live at home and care for most needs; varying amount of assistance needed.	71.9 (23)
Score <50: Unable to care for self; requires equivalent of institutional or hospital care	0 (0)

Note. Study start was 1.0 days (median) after hospital admission; study end was 1.0 days (median) before discharge.

Symptoms

At the beginning of the study, the median number of symptoms reported was 4.0 out of the four HF symptoms assessed (shortness of breath, fatigue, orthopnea, and edema). The mean was 3.3 ± 1.0 symptoms, and all patients reported at least one symptom (Table 6). At the study end, the median number of symptoms reported decreased to 2.0, the mean was 2.1 ± 1.3 symptoms, and 10% of patients reported no symptoms (Figure 2). Fatigue was the most prevalent symptom (Figure 3) at both the study start (94%) and the study end (58%). Prevalence of SOB decreased the most between the study start and end, from 91% to 42%, and orthopnea decreased the least, from 63% to 61%.

Table 6

Number of Symptoms Reported at Beginning and End of Study

Statistic	**Study Start**	**Study End**
N	32	31
Range	1-4	0-4
mean ± SD	3.3 ± 1.0	2.2 ± 1.2
Median	4	2

Note. Study start was 1.0 days (median) after admission; study end was 1.0 days (median) before discharge.

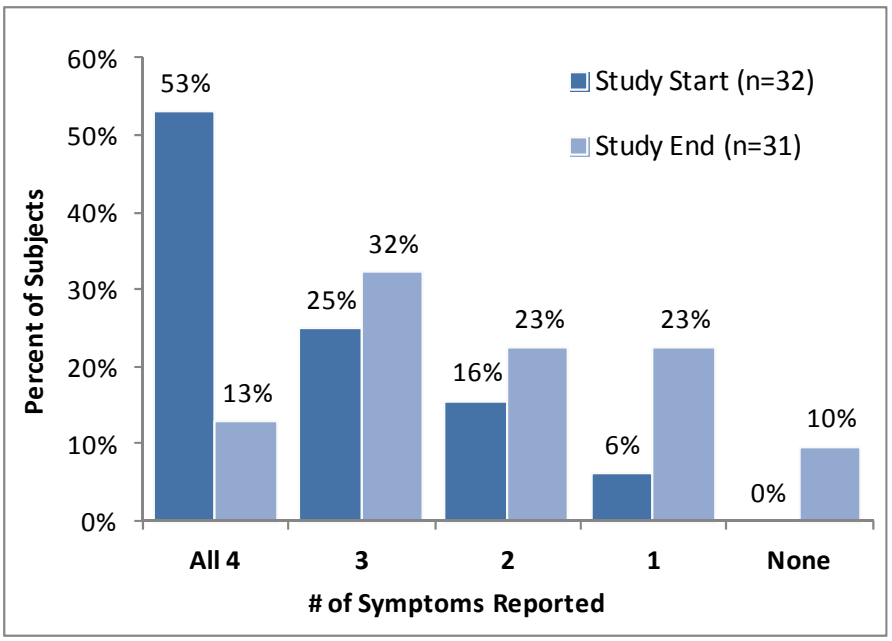

Figure 2: Percent of patients reporting different numbers of symptoms at study start and study end. Study start was 1.0 days (median) after admission; study end was 1.0 days (median) before discharge. Symptoms assessed were shortness of breath, fatigue, orthopnea, and edema.

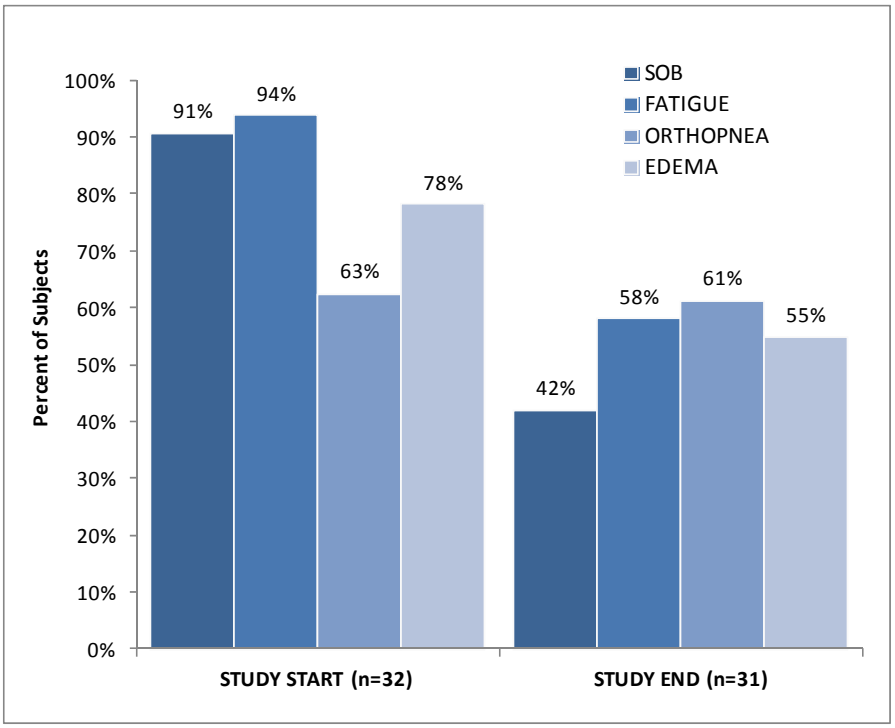

Figure 3: Percent of patients reporting individual symptoms common in HF at the beginning and end of the study. SOB= shortness of breath. Study start was 1.0 days (median) after admission; study end was 1.0 days (median) before discharge.

Prediction of Cardiac Event-Free Survival

Cardiac events occurred in 13 patients (40.6%) within 90 days after discharge. Most events (11 patients) were cardiac readmissions, including one patient readmitted for heart transplantation. One patient who died within 90 days had a prior cardiac readmission during the follow-up period, which was analyzed as the first cardiac event. The two additional deaths were analyzed as first cardiac events.

Of the demographic and clinical characteristics analyzed, two factors were found to be associated with cardiac event-free survival (Table 7). Results showed that patients were 4.2 times less likely to have a cardiac event if they had a history of hypertension (HR 0.238; 95% CI 0.08-0.71). Additionally, an increased LOS was associated with a higher risk of cardiac events. Results showed an 8.5% increase in risk with each additional day in the hospital (HR 1.085; 95% CI 1.03-1.15).

Among the physical function measures, each increase in NYHA Class at the study end was associated with a 3.4-fold higher risk of cardiac events within 90 days (HR 3.404; 95% CI 1.37-8.46). The sole measure of global function, KPS, was predictive of cardiac events at an alpha level of 0.1. For every increase in KPS category (e.g. from scores in the 60's to scores showing a higher level of function in the 70's), a 1.6-fold decrease in risk of cardiac events was seen (HR 0.620; 95% CI 0.36-1.06).

Three of the 4 symptoms reported at the study end (median of 1.0 days before discharge) were significant predictors of cardiac events. Patients reporting SOB at the study end had a 4.0-fold greater risk of cardiac events than those who did not report this symptom (HR 3.962; 95% CI 1.19-13.22). Risk of cardiac events was 9.7 times higher among patients reporting fatigue at the study end (HR 9.661; 95% CI 1.24-75.06), and

risk of cardiac events was 12.8 times higher among patients who reported orthopnea at study end (HR 12.807; 95% CI 1.65-99.73). No symptoms at study start predicted outcomes, and edema was the only symptom not associated with outcomes at study end.

Table 7

Cox Univariate Predictors of Cardiac Events within 90 Days Post-Discharge

Variable	Hazard Ratio (HR)	95% Confidence Interval (CI)	p value
Age	0.974	0.93-1.02	0.266
Gender	1.548	0.34-6.99	0.570
ACEi or ARB therapy at end of study	0.941	0.31-2.88	0.916
Beta blocker therapy at end of study	0.510	0.16-1.66	0.264
Ambulation - average daily time spent standing or walking in hospital	1.006	0.99-1.02	0.394
Ambulation - average daily time spent lying down in hospital	1.067	0.90-1.27	0.468
Creatinine	1.024	0.78-1.35	0.869
Home exercise, patient-reported	0.667	0.22-1.99	0.467
Physical therapy in hospital	1.375	0.45-4.21	0.576
Discharged with physical or occupational therapy, or home health	1.327	0.45-3.96	0.612
Ejection Fraction <40%	2.327	0.52-10.52	0.272
History of hypertension	**0.238**	**0.08-0.71**	**0.010**
History of smoking	1.109	0.31-4.03	0.875
Current smoking	1.484	0.70-3.15	0.304
Pack years	0.999	0.97-1.03	0.941
Karnofsky Performance Status Scale Category (KPS)	0.620	0.36 - 1.06	0.082
Katz Index of ADLs - study start	1.084	0.63-1.87	0.770
Length of stay	**1.085**	**1.03-1.15**	**0.007**
NYHA Class - home	1.607	0.79-3.25	0.188
NYHA Class - study start	1.28	0.63-2.59	0.493
NYHA Class - study end	**3.404**	**1.37-8.46**	**0.008**
Shortness of breath - study start	24.449	0.15-39302.29	0.396
Shortness of breath - study end	**3.962**	**1.19-13.22**	**0.025**
Fatigue - study start	22.814	0.00-169995.56	0.492
Fatigue - study end	**9.661**	**1.24-75.06**	**0.030**
Orthopnea - study start	2.462	0.68-8.96	0.172
Orthopnea - study end	**12.807**	**1.65-99.73**	**0.015**
Edema - study start	0.649	0.20-2.11	0.472
Edema - study end	0.660	0.21-2.05	0.471
Total number of symptoms – study start	1.500	0.748-3.007	0.254
Total number of symptoms – study end	**2.341**	**1.310-4.182**	**0.004**
SPPB Total Score - study start	1.042	0.89-1.23	0.618
SPPB Balance Score - study start	1.473	0.84-2.57	0.173

SPPB Gait Score - study start	1.153	0.77-1.72	0.488
SPPB Chair Stand Score - study start	0.869	0.57-1.33	0.515

Note. Study start was 1.0 days (median) after admission; study end was 1.0 days (median) before discharge. **Bold** indicates results with $p < 0.05$.

Discussion

In this study we found that higher NYHA Classification and presence of three symptoms (shortness of breath, fatigue, or orthopnea) at the study end (a median of 4.5 days after admission and 1.0 days before discharge) each predicted cardiac events in HF patients within 90 days after hospital discharge. These results are unique because they suggest that a quick, simple assessment of function and symptoms that can easily be made at the bedside by physicians or nurses before hospital discharge may be a meaningful way to predict short term cardiac outcomes in HF patients.

Function

NYHA Classification was found to be predictive of cardiac events at study end (median of 1.0 days before discharge). This is consistent with a recent review that examined risk factors for HF hospitalization. The authors noted that NYHA Classification at hospital discharge has been shown to predict both 30-day and 1-year readmissions according to a number of studies (Giamouzis et al., 2011). The NYHA Classification system has also been associated with predicting mortality. Results from an outpatient study by Devroey and Van Casteren (2010) showed that patients who died of HF within 6 months of their diagnosis had a higher NYHA Class at diagnosis than those who did not die: 48% of patients who died were Class IV, while only 21% of survivors were Class IV ($p<.001$). In another study of function in 157 older hospitalized HF patients, Chiarantini et al. (2010) found that increasing pre-admission NYHA Class was associated with greater mortality over a median follow-up period of 444 days ($p=.022$).

This is in contrast to results reported here, in which only pre-discharge, not pre-admission, NYHA Classification predicted outcomes.

The distribution of NYHA Class results from the 32 patients changed from home to the study start and to the study end. Thus, the NYHA Class reflects the dynamic clinical course of HF, from the overall severity of HF exacerbation in the study cohort prior to admission to the symptomatic relief obtained after initial treatment (study start) to further improvements after ongoing treatment (study end). It is common to find NYHA Classification in a patient's hospital admission notes, but our results suggest that particular attention should also be paid to assessing and documenting NYHA Classification close to hospital discharge for optimal discharge planning.

Chiarantini et al. (2010) found that SPPB was related to survival in their cohort study involving 157 HF patients with a mean age of 80 ± 0.5 at two Italian hospitals. A higher SPPB score at discharge conferred greater risk of mortality over a median follow-up period of 444 days (HR 1.52 [95% CI 1.06-2.16], p=.022). These results differ from our study, which found no significant relationship between cardiac events (including mortality) and the SPPB. However our study population was more than two decades younger on average. The follow-up period was also shorter, and the SPPB was assessed closer to admission, a different time point.

The relationship of KPS to outcomes in our study provided a trend toward significance, but was not significant at an alpha of .05 (p=.082). A higher KPS score, indicating higher function, conferred a 1.6-fold decrease in risk of cardiac events. The possible effect we saw is in agreement with literature using KPS in cardiac patients. One study found that KPS predicted outcomes in 849 acute myocardial infarction (AMI)

patients at 1 and 4 years after AMI, and was equal in predictive value to LVEF, a well-established predictor of post-AMI outcomes (Brezinski et al., 1991). The KPS may not have been significant in our study because of the small sample size or because it is not a measure specific to the HF population.

Symptoms

Among the three symptoms that predicted outcomes, orthopnea conferred the greatest risk for cardiac events, followed by fatigue and shortness of breath. Edema was not predictive at either of the time points measured. These results are similar to those found by investigators in the large European beta-blocker drug trial, COMET (Carvedilol or Metoprolol European Trial). Ekman et al. (2005) conducted a secondary analysis of this outpatient study to determine the importance of self-reported symptom severity as a predictor of outcomes in HF among 3,029 COMET subjects. Investigators reported the patient's NYHA Class, assessed edema, and asked patients to rate their breathlessness, fatigue, and angina on a 5-point scale, and to report orthopnea as a yes/no question. The same assessments were conducted at baseline and every 4 months for an average follow-up of 4.8 years. Univariate analysis showed that only breathlessness, orthopnea, and fatigue were each significantly related to the development of worsening HF and to reduced survival. Assuming that breathlessness is equivalent to shortness of breath, it is striking that these are the same three symptoms found to be significant in univariate analyses in the present study. Ekman et al. (2005) also found that angina was related to mortality and all-cause hospitalizations, but not to HF progression. When a multivariate Cox regression was done, fatigue was still a significant predictor of progression to worsening HF, while only breathlessness remained a significant predictor of mortality

and hospitalization. The COMET analysis (Ekman et al., 2005) differed from our study in that it was a larger, took place in an outpatient setting, and had a longer follow-up period.

Results of our study are congruent with the findings of Song, Moser, Rayens, & Lennie (2010), who completed a prospective cohort study to identify symptom clusters and determine their impact on cardiac-related death and rehospitalization in HF patients. Patients with HF exacerbation (n=421) were recruited at two large South Korean medical centers. The mean age was 62 ±14 (range 23-97) and 60.3% were male. Symptoms were assessed using the Memorial Symptom Assessment Scale-Heart Failure questionnaire, and administered 1-2 days prior to discharge. Monthly follow-up was conducted to monitor rehospitalizations and mortality up to 12 months after discharge. Two main physical symptom clusters emerged, termed "dyspneic" (shortness of breath, difficulty breathing when lying flat, and waking up breathless at night) and "weary" (lack of energy, lack of appetite, and difficulty sleeping). Key results from the study were that a higher level of distress from the weary symptom cluster was an independent predictor of cardiac rehospitalization-free survival (p=.011), and higher distress from the dyspneic symptom cluster was an independent predictor of cardiac death-free survival (p=.012). Both analyses controlled for multiple clinical variables like age, sex, HF etiology, BMI, EF, and comorbidities, making a strong argument that the symptom experience alone is related to negative outcomes. The "dyspneic" cluster (Song et al., 2010) includes two of the three symptoms that were significant in the present study, and they were also measured at a similar time close to discharge. This supports our results and suggests that these same symptoms might also predict longer term outcomes. Both the Song et al.

(2010) study and the Ekman et al. (2005) COMET analysis corroborate our finding that symptoms can predict outcomes in hospitalized HF patients.

Other Findings

Although it is known from previous studies (Harjola et al., 2010), increased length of stay was associated with increased risk of cardiac events after discharge in this study. Longer LOS may be a marker of severity of illness, comorbidities, or other factors.

History of hypertension (HTN) in this study was found to decrease risk of cardiac events. This could be explained by the greater likelihood of having HF with preserved EF (HFPEF) in patients with longstanding HTN, but having an EF over 40% (likely HFPEF) had no effect on outcomes in this study. It is known that lower systolic blood pressure increases risk of mortality of HF patients in both community and in-hospital settings (Fonarow, 2008), but this may be a separate phenomenon from history of HTN. In a large survey of hospitalized HF patients in Europe, both a higher admission blood pressure and history of HTN were associated with increased survival at 1 year but not at 3 months (Harajola et al., 2010), as was found in the present study.

Timing

Our results demonstrate that the timing of assessment is of paramount importance when predicting outcomes. It is known that when a risk factor is measured during the course of illness (e.g. at diagnosis, hospital admission, or discharge) may affect prediction of outcomes (Giamouzis et al., 2011). Hospitalization with acute HF is a time of high risk for patients, in which adverse outcomes are more likely (Fonarow, 2008). In this study, function at home prior to admission and function and symptoms at the study start were not related to outcomes, whereas both function (NYHA Classification) and

symptoms at the study end were found to predict outcomes. By the end of the study, patients had undergone medical therapy for 4.5 days (median time between admission and study end) and they were 1.0 days (median) from discharge. One possibility is that these patients were inadequately diuresed, leading to continued symptoms close to discharge. Another possibility is that a snapshot of function and symptoms at this time represents the patient's new clinical baseline. For patients who continue to be functionally impaired and have refractory symptoms after 4-5 days of treatment, it may indicate progression of disease that affects prognosis.

Strengths and Limitations

A strength of this pilot study is that it was conducted with a theoretically sound and evidence-based premise. Another strength is the result that simple, standard measures of function and symptoms predict short-term outcomes in hospitalized HF patients. An additional strength is that the study population was diverse in terms of both race/ethnicity and age: 40.7% were non-Caucasian/White, and patient ages ranged from the thirties to the nineties.

This pilot study has several limitations. The sample size was small, with 32 patients included. Another limitation is that a formal instrument was not used for assessing symptoms. Many well-characterized instruments exist for measuring multiple symptom dimensions, including prevalence, frequency and severity, which might provide more insight than yes/no questions alone. While the value of the present study results lies in the simplicity of the predictive assessments, this same feature may also be a limitation. Others have noted that many risk factors can exist in the same patient, so looking at

individual factors alone may not provide the most meaningful assessment of risk (Fonarow, 2008).

In addition, this study included fewer HF patients with shorter stays. Patients who were discharged within the 48-hour enrollment window were often not able to be approached for enrollment. The authors presume that the study patients may have been "sicker" or more complicated to manage than their shorter-stay counterparts and therefore may not represent the full range of typical hospitalized HF patients.

Larger studies that include more patients and use formal instruments to measure multiple aspects of symptoms are needed to better characterize the association between symptoms, NYHA Classification, and short-term cardiac outcomes in hospitalized HF patients. Despite these limitations, this small study provides evidence that assessments of basic HF symptoms and functional status before discharge can predict short term outcomes.

Clinical Implications

When measured before hospital discharge, NYHA Classification, the most common system for quantifying the degree of functional limitation experienced by HF patients (Hunt et al., 2009), and three of the most common symptoms of HF (orthopnea, fatigue, and shortness of breath) have important independent predictive value for determining risk of cardiac events within 90 days. These simple bedside assessments can be used by physicians or nurses to identify high-risk HF patients, to improve clinical decision-making in the hospital, and to provide insight for discharge planning.

Symptoms and NYHA Classification assessed after admission were not predictive of short-term outcomes in this study, underscoring the importance of the timing of

assessments used for prognostication. The increased risk of cardiac events in patients with symptoms and higher NYHA Classification close to discharge suggests that symptoms and NYHA Classification should be assessed at this time and that caution should be used when discharging patients who remain symptomatic after treatment (in this study, treatment duration was a median of 4.5 days). The various pressures to discharge patients quickly must be balanced with the goal of maximizing HF treatment and preventing negative outcomes like cardiac events, including rehospitalization.

References

American Heart Association. (2011). Classes of Heart Failure. Retrieved from: http://www.heart.org/HEARTORG/Conditions/HeartFailure/AboutHeartFailure/Classes-of-Heart-Failure_UCM_306328_Article.jsp

Athanasopoulos, L.V., Dritsas, A., Doll, H.A., & Cokkinos, D.V. (2010). Comparative value of NYHA functional class and quality-of-life questionnaire scores in assessing heart failure. *J Cardiopulm Rehabil Prev, 30*(2), 101-105

Ancestry.com. (2011). Social Security Death Index [database on-line]. Provo, UT, USA: Ancestry.com Operations Inc.

Bekelman, D.B., Havranek, E.P., Becker, D.M., Kutner, J.S., Peterson, P.N., Wittstein, I.S., Gottlieb, S.H., Yamashita, T.E., Fairclough, D.L., & Dy, S.M. (2007). Symptoms, depression, and quality of life in patients with heart failure. *J Card Fail. 13*(8), 643-648.

Bekelman, D.B., Rumsfeld, J.S., Havranek, E.P., Yamashita, T.E., Hutt, E., Gottlieb, S.H., Dy, S.M., & Kutner, J.S. (2009). Symptom burden, depression, and spiritual well-being: a comparison of heart failure and advanced cancer patients. *J Gen Intern Med, 24*(5), 592-598.

Bennett, J.A., Riegel, B., Bittner, V., & Nichols, J. (2002). Validity and reliability of the NYHA classes for measuring research outcomes in patients with cardiac disease. *Heart Lung, 31*(4), 262-270.

Bielaszka-DuVernay, C. (2011). Health policy brief: Improving quality and safety. *Health Affairs*. Retrieved from: http://www.healthaffairs.org/healthpolicybriefs/brief.php?brief_id=45

Blinderman, C.D., Homel, P., Billings, J.A., Portenoy, R.K., & Tennstedt, S.L. (2008). Symptom distress and quality of life in patients with advanced congestive heart failure. *J Pain Symptom Manage, 35*(6), 594-603.

Brezinski, D., Stone, P.H., Muller, J.E., Tofler, G.H., Davis, V., Parker, C., Hartley, L.H., & Braunwald, E. (1991). Prognostic significance of the Karnofsky Performance Status score in patients with acute myocardial infarction: comparison with the left ventricular ejection fraction and the exercise treadmill test performance. The MILIS Study Group. *Am Heart J, 121*(5), 1374-1381.

Brown, C.J., Friedkin, R.J., & Inouye, S.K. (2004). Prevalence and outcomes of low mobility in hospitalized older patients. *J Am Geriatr Soc, 52*(8), 1263-1270.

Brown, C.J., Roth, D.L., & Allman, R.M. (2008). Validation of use of wireless monitors to measure levels of mobility during hospitalization. *J Rehabil Res Dev., 45*(4), 551-558.

Bui, A.L., Horwich, T.B., Fonarow, G.C. (2011). Epidemiology and risk profile of heart failure. *Nat Rev Cardiol, 8*(1), 30-41.

Carolan Doerflinger, D.M. (2007). How to try this: the mini-cog. *Am J Nurs. 107*(12), 62-71.

Chiarantini, D., Volpato, S., Sioulis, F., Bartalucci, F., Del Bianco, L., Mangani, I., Pepe, G., Tarantini, F., Berni, A., Marchionni, N., & Di Bari, M. (2010). Lower extremity performance measures predict long-term prognosis in older patients hospitalized for heart failure. *J Card Fail, 16*(5), 390-395.

Corcoran, P.J. (1991). Use it or lose it--the hazards of bed rest and inactivity. *West J Med., 154*(5), 536-538.

Dale, C., Prieto-Merino, D., Kuper, H., Adamson, J., Bowling, A., Ebrahim, S., & Casas, J.P. (2012). Modelling the association of disability according to the WHO International Classification of Functioning, Disability and Health (ICF) with mortality in the British Women's Heart and Health Study. *J Epidemiol Community Health, 66*(2), 170-175.

Desai, M.M., Bogardus, S.T. Jr., Williams, C.S., Vitagliano, G., & Inouye, S.K. (2002). Development and validation of a risk-adjustment index for older patients: the high-risk diagnoses for the elderly scale. *J Am Geriatr Soc. 50*(3), 474-4781.

Devroey, D., & Van Casteren, V. (2010). Symptoms and clinical signs associated with hospital admission and mortality for heart failure. *Cent Eur J Public Health. 18*(4), 209-214.

Ekman, I., Cleland, J.G., Swedberg, K., Charlesworth, A., Metra, M., & Poole-Wilson, P.A. (2005).Symptoms in patients with heart failure are prognostic predictors: insights from COMET. *J Card Fail. 11*(4), 288-292. Erratum in: (2005). *J Card Fail. 11*(5), 404.

Ekman, I., Kjörk, E., & Andersson, B. (2007). Self-assessed symptoms in chronic heart failure--important information for clinical management. *Eur J Heart Fail. 9*(4), 424-428.

Fisher, S.R., Goodwin, J.S., Protas, E.J., Kuo, Y.F., Graham, J.E., Ottenbacher, K.J., & Ostir, G.V. (2011). Ambulatory activity of older adults hospitalized with acute medical illness. *J Am Geriatr Soc. 59*(1),91-95. Erratum in: (2011). *J Am Geriatr Soc, 59*(4), 777.

Fonarow, G.C. (2008). Epidemiology and risk stratifiation in acute heart failure. *Am Heart J, 155*, 200-207.

Friendlander, A.H., & Ettinger, R.L. (2009). Karnofsky performance status scale. *Spec Care Dentist, 29*(4), 147-148.

Gary, R.A., Cress, M.E., Higgins, M.K., Smith, A.L., & Dunbar, S.B. (2011). A combined aerobic and resistance exercise program improves physical functional performance in patients with heart failure: A pilot study. *J Cardiovasc Nurs*. doi: 10.1097/JCN.0b013e31822ad3c3

Giamouzis, G., Kalogeropoulos, A., Georgiopoulou, V., Laskar, S., Smith, A.L., Dunbar, S., Triposkiadis, F., & Butler, J. (2011). Hospitalization epidemic in patients with heart failure: risk factors, risk prediction, knowledge gaps, and future directions. *J Card Fail., 17*(1), 54-75.

Goldberg, R.J., Spencer, F.A., Szklo-Coxe, M., Tisminetzky, M., Yarzebski, J., Lessard, D., Gore, J.M., & Gaasch, W. (2010). Symptom presentation in patients hospitalized with acute heart failure. *Clin Cardiol, 33*(6), E73-80.

Goldman, L., Hashimoto, B., Cook, E.F., & Loscalzo, A. (1981). Comparative reproducibility and validity of systems for assessing cardiovascular functional class: Advantages of a new specific activity scale. *Circulation, 64*(6), 1227-1234.

Guccione, A.A., & Scalzitti, D.A. (2007). Examination of Functional Status and Activity Level. In O'Sullivan, S.B., & Schmitz, T.J. (Eds.), *Physical Rehabilitation*, (5th ed., pp. 373-400). Philadelphia, PA: F.A. Davis Company.

Guralnik, J.M., Simonsick, E.M., Ferrucci, L., Glynn, R.J., Berkman, L.F., Blazer, D.G., Scherr, P.A., & Wallace, R.B. (1994). A short physical performance battery

assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol, 49*(2), M85-94.

Harjola, V., Follath, F., Nieminen, M., Brutsaert, D., Dickstein, K., Drexler, H., & ... Tavazzi, L. (2010). Characteristics, outcomes, and predictors of mortality at 3 months and 1 year in patients hospitalized for acute heart failure. *European Journal Of Heart Failure*, *12*(3), 239-248. doi:10.1093/eurjhf/hfq002

He, W., Sengupta, M., Velkoff , V.A., & DeBarros, K.A. (2005). *U.S. Census Bureau Current Population Reports, 65+ in the United States: 2005*. Washington, DC: U.S. Government Printing Office. Retrieved from: http://www.census.gov/prod/2006pubs/p23-209.pdf

Hunt, S.A., Abraham, W.T., Chin, M.H., Feldman, A.M., Francis, G.S., Ganiats, T.G., … Yancy, C.W. (2009). Focused update incorporated into the ACC/AHA 2005 guidelines for the diagnosis and management of heart failure in adults: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines: developed in collaboration with the International Society for Heart and Lung Transplantation. *Circulation, 119*(14), e391-e479. doi: 10.1161/CIRCULATIONAHA.109.192065

Kaspar, C.E. (2003). Skeletal Muscle Atrophy. In Carrieri-Kohlman, V., Lindsey, A.M., & West, C.M. (Eds.), *Pathophysiological Phenomena in Nursing: Human Responses to Illness*, (3rd ed., pp. 389-411). St. Louis, MO: Saunders.

LeBlond, R.F., DeGowin, R.L., & Brown, D.D. (2009). Chapter 8. The Chest: Chest Wall, Pulmonary, and Cardiovascular Systems; The Breasts. In R.F. LeBlond,

R.L. DeGowin, D.D. Brown (Eds.)., *DeGowin's Diagnostic Examination*, 9e. Retrieved from http://www.accessmedicine.com/content.aspx?aID=3661355.

Lee, K.S., Song, E.K., Lennie, T.A., Frazier, S.K., Chung, M.L., Heo, S., Wu, J.R., Rayens, M.K., Riegel, B., & Moser, D.K. (2010). Symptom clusters in men and women with heart failure and their impact on cardiac event-free survival. *J Cardiovasc Nurs. 25*(4), 263-272.

Liem, B.J., Holland, J.M., Kang, M.Y., Hoffelt, S.C., & Marquez, C.M. (2002). Karnofsky Performance Status Assessment: Resident versus attending. *J Cancer Educ, 17*(3), 138-141.

Marengoni, A., von Strauss, E., Rizzuto, D., Winblad, B., & Fratiglioni L. (2009). The impact of chronic multimorbidity and disability on functional decline and survival in elderly persons. A community-based, longitudinal study. *J Intern Med, 265*(2), 288-295.

Mor,V., Laliberte, L., Morris, J.N., & Wiemann, M. (1984). The Karnofsky Performance Status Scale. An examination of its reliability and validity in a research setting. *Cancer, 53*(9), 2002-2007.

Moser, D.K., Frazier, S.K., Worrall-Carter, L., Biddle, M.J., Chung, M.L., Lee, K.S., & Lennie, T.A. (2011) Symptom variability, not severity, predicts rehospitalization and mortality in patients with heart failure. *Eur J Cardiovasc Nurs, 10*(2), 124-129.

Myers, J., Zaheer, N., Quaglietti, S., Madhavan, R., Froelicher, V., & Heidenreich, P. (2006). Association of functional and health status measures in heart failure. *J Card Fail, 12*(6), 439-445.

Raphael, C., Briscoe, C., Davies, J., Ian Whinnett, Z., Manisty, C., Sutton, R., Mayet, J., & Francis, D.P. (2007). Limitations of the New York Heart Association functional classification system and self-reported walking distances in chronic heart failure. *Heart, 93*(4), 476-482.

Rostagno,C., Galanti, G., Comeglio, M., Boddi, V., Olivo, G., & Gastone Neri Serneri,G. (2000). Comparison of different methods of functional evaluation in patients with chronic heart failure. *Eur J Heart Fail.2*(3), 273-280.

Sayers, S.P., Guralnik, J.M., Newman, A.B., Brach, J.S., & Fielding. R.A. (2006). Concordance and discordance between two measures of lower extremity function: 400 meter self-paced walk and SPPB. *Aging Clin Exp Res, 18*(2), 100-106.

Severo, M., Gaio, R., Lourenço, P., Alvelos, M., Bettencourt, P., & Azevedo, A. (2011). Indirect calibration between clinical observers - application to the New York Heart Association functional classification system. *BMC Res Notes, 4*, 276.

Song, E.K., Moser, D.K., Rayens, M.K., & Lennie, T.A. (2010). Symptom clusters predict event-free survival in patients with heart failure. *J Cardiovasc Nurs, 25*(4), 284-289.

Strath, S.J., Pfeiffer, K.A., Whitt-Glover, M.C. (2012). Accelerometer use with children, older adults, and adults with functional limitations. *Med Sci Sports Exerc, 44*(1 Suppl 1), S77-S85.

Studenski, S., Perera, S., Wallace, D., Chandler, J.M., Duncan, P.W., Rooney, E., Fox, M., & Guralnik, J.M. (2003). Physical performance measures in the clinical setting. *J Am Geriatr Soc, 51*(3), 314-322.

Thomas, S., & Rich, M.W. (2007). Epidemiology, pathophysiology, and prognosis of heart failure in the elderly. *Clin Geriatr Med, 23*(1), 1-10. doi:10.1016/j.cger.2006.08.001

Volpato, S., Cavalieri, M., Guerra, G., Sioulis, F., Ranzini, M., Maraldi, C., Fellin, R., & Guralnik, J.M. (2008). Performance-based functional assessment in older hospitalized patients: Feasibility and clinical correlates. *J Gerontol A Biol Sci Med Sci, 63*(12), 1393-1398.

Wallace, M., & Shelkey, M. (2008). Monitoring functional status in hospitalized older adults. *Am J Nurs, 108*(4), 64-71.

Waszynski CM. (2007). How to try this: detecting delirium. *Am J Nurs.107*(12), 50-59.

Wong, C.Y., Chaudhry, S.I., Desai, M.M., & Krumholz, H.M. (2011). Trends in comorbidity, disability, and polypharmacy in heart failure. *Am J Med. 124*(2), 136-143.

World Health Organization. (2002). Towards a Common Language for Functioning, Disability and Health ICF. Retrieved from the WHO website: http://www.who.int/entity/classifications/icf/training/icfbeginnersguide.pdf

Zambroski, C.H., Moser, D.K., Bhat, G., & Ziegler, C. (2005). Impact of symptom prevalence and symptom burden on quality of life in patients with heart failure. *Eur J Cardiovasc Nurs., 4*(3), 198-206.

Zisberg, A., Shadmi, E., Sinoff, G., Gur-Yaish, N., Srulovici, E., & Admi, H. (2011). Low mobility during hospitalization and functional decline in older adults. *J Am Geriatr Soc, 59*(2), 266-273.

Appendix A

New York Heart Association (NYHA) Classification

Class	Description
I	No symptoms and no limitation in ordinary physical activity.
II	Mild symptoms and slight limitation during ordinary activity. Comfortable at rest.
III	Marked limitation in activity due to symptoms, even during less-than-ordinary activity. Comfortable only at rest.
IV	Severe limitations. Experiences symptoms even while at rest.

Appendix B

Katz Index of Independence in Activities of Daily Living

Activities Points (1 or 0)	**Independence** (1 Point) *NO supervision, direction or personal assistance*	**Dependence** (0 Points) *WITH supervision, direction, personal assistance or total care*
BATHING Points:_____	(1 POINT) Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity	(0 POINTS) Need help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing
DRESSING Points:_____	(1 POINT) Get clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	(0 POINTS) Needs help with dressing self or needs to be completely dressed.
TOILETING Points: _____	(1 POINT) Goes to toilet, gets on and off, arranges clothes, cleans genital area without help.	(0 POINTS) Needs help transferring to the toilet, cleaning self or uses bedpan or commode.
TRANSFERRING Points: _____	(1 POINT) Moves in and out of bed or chair unassisted. Mechanical transfer aids are acceptable	(0 POINTS)Needs help in moving from bed to chair or requires a complete transfer.
CONTINENCE Points:_____	(1 POINT) Exercises complete self control over urination and defecation.	(0 POINTS) Is partially or totally incontinent of bowel or bladder
FEEDING Points: _____	(1 POINT) Gets food from plate into mouth without help. Preparation of food may be done by another person.	(0 POINTS) Needs partial or total help with feeding or requires parenteral feeding.
Total Points:	6 = Patient is independent, 0 = Patient is dependent	

Appendix C

Table C1

Short Physical Performance Battery – Balance Test

A. Side-by-side-stand
Held for 10 sec ❒ 1 point
Not held for 10 sec ❒ 0 points
Not attempted ❒ 0 points
If 0 points, end Balance Tests

Number of seconds held if
less than 10 sec: ___._ _sec

If participant did not attempt test or failed, circle why:
Tried but unable 1
Participant could not hold position unassisted 2
Not attempted, you felt unsafe 3
Not attempted, participant felt unsafe 4
Participant unable to understand instructions 5
Other (specify) _____ 6
Participant refused 7

B. Semi-Tandem Stand
Held for 10 sec ❒ 1 point
Not held for 10 sec ❒ 0 points
Not attempted ❒ 0 points *(circle reason above)*
If 0 points, end Balance Tests

Number of seconds held if less than 10 sec: ___._ _sec

C. Tandem Stand
Held for 10 sec ❒ 2 points
Held for 3 to 9.99 sec ❒ 1 point
Held for < than 3 sec ❒ 0 points
Not attempted ❒ 0 points (circle reason above)

Number of seconds held if less than 10 sec: ___._ _sec

D. Total Balance Tests score_____(sum points)

Comments: _____
_____
_____
_____
_____

Table C2

Short Physical Performance Battery – Gait Speed Test

Length of walk test course: Four meters ❒ Three meters ❒

A. Time for First Gait Speed Test (sec)

1. Time for 3 or 4 meters __ __.__ __sec
2. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not walk unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify) _____	6
Participant refused	7
Complete score sheet and go to chair stand test	

3. Aids for first walk.....None ❒ Cane ❒ Other ❒

Comments:_____

_____

_____

B. Time for Second Gait Speed Test (sec)

1. Time for 3 or 4 meters __ __.__ __ sec
2. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not walk unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify)	6
Participant refused	7

3. Aids for second walk..... None ❒ Cane ❒ Other ❒

What is the time for the faster of the two walks?
Record the shorter of the two times __ __.__ __ sec
[If only 1 walk done, record that time] __ __.__ __ sec

If the participant was unable to do the walk: ❒ **0 points**

For 4-Meter Walk:		**For 3-Meter Walk:**	
If time is more than 8.70 sec:	❒ **1 point**	If time is more than 6.52 sec:	❒ **1 point**
If time is 6.21 to 8.70 sec:	❒ **2 points**	If time is 4.66 to 6.52 sec:	❒ **2 points**
If time is 4.82 to 6.20 sec:	❒ **3 points**	If time is 3.62 to 4.65 sec:	❒ **3 points**
If time is less than 4.82 sec:	❒ **4 points**	If time is less than 3.62 sec:	❒ **4 points**

Table C3

Short Physical Performance Battery – Chair Stand Test

Single Chair Stand Test

		YES	NO	
A.	Safe to stand without help	❒	❒	
B.	Results:			
	Participant stood without using arms	❒		→ Go to Repeated Chair Stand Test
	Participant used arms to stand	❒		→ End test; score as 0 points
	Test not completed	❒		→ End test; score as 0 points
C.	If participant did not attempt test or failed, circle why:			
	Tried but unable	1		
	Participant could not stand unassisted	2		
	Not attempted, you felt unsafe	3		
	Not attempted, participant felt unsafe	4		
	Participant unable to understand instructions	5		
	Other (Specify) _____	6		
	Participant refused	7		

Repeated Chair Stand Test

		YES	NO
A.	Safe to stand five times	❒	❒
B.	If five stands done successfully, record time in seconds.		
	Time to complete five stands __ __.__ __ sec		
C.	If participant did not attempt test or failed, circle why:		
	Tried but unable	1	
	Participant could not stand unassisted	2	
	Not attempted, you felt unsafe	3	
	Not attempted, participant felt unsafe	4	
	Participant unable to understand instructions	5	
	Other (Specify)	6	
	Participant refused	7	

Scoring the Repeated Chair Test

Participant unable to complete 5 chair stands or completes stands in >60 sec:	❒ 0 points
If chair stand time is 16.70 sec or more:	❒ 1 points
If chair stand time is 13.70 to 16.69 sec:	❒ 2 points
If chair stand time is 11.20 to 13.69 sec:	❒ 3 points
If chair stand time is 11.19 sec or less:	❒ 4 points

Appendix D

Karnofsky Performance Status Scale

General Category	**Index**	**Specific Criteria**
Able to carry on normal activity and to work; no special care needed.	100	Normal no complaints; no evidence of disease.
	90	Able to carry on normal activity; minor signs or symptoms of disease.
	80	Normal activity with effort; some signs or symptoms of disease.
Unable to work; able to live at home and care for most personal needs; varying amount of assistance needed.	70	Cares for self; unable to carry on normal activity or to do active work.
	60	Requires occasional assistance, but is able to care for most of his personal needs.
	50	Requires considerable assistance and frequent medical care.
Unable to care for self; requires equivalent of institutional or hospital care; disease may be progressing rapidly.	40	Disabled; requires special care and assistance.
	30	Severely disabled; hospital admission is indicated although death not imminent.
	20	Very sick; hospital admission necessary; active supportive treatment necessary.
	10	Moribund; fatal processes progressing rapidly.
	0	Dead

Appendix E

MiniCog Screen

Mini Cog Test	**Result**
Word Recall Patient is told 3 words and asked what they are in 5 minutes	Recall score: _____ Recall score of 3:____Yes ____No
Clock Drawing *(draw circle for patient)* Patient Draws a Clock with Current Time	Clock Scoring: _____ Normal _____ Abnormal
Overall Scoring Patient is included in the study based on: (A) Word recall of 3 (yes) or (B) Word recall score of 1 or 2 with a normal clock	Pass: ____Yes ____No

Appendix F

Confusion Assessment Method (CAM) Diagnostic Algorithm

CAM Feature and Description	**Result**
Feature 1: Acute Onset or Fluctuating Course This feature is usually obtained from a family member or nurse and is shown by positive responses to the following questions: Is there evidence of an acute change in mental status from the patient's baseline? Did the (abnormal) behavior fluctuate during the day, that is, tend to come and go, or increase and decrease in severity?	
Feature 2: Inattention This feature is shown by a positive response to the following question: Did the patient have difficulty focusing attention, for example, being easily distractible, or having difficulty keeping track of what was being said?	
Feature 3: Disorganized thinking This feature is shown by a positive response to the following question: Was the patient's thinking disorganized or incoherent, such as rambling or irrelevant conversation, unclear or illogical flow of ideas, or unpredictable switching from subject to subject?	
Feature 4: Altered Level of consciousness This feature is shown by any answer other than "alert" to the following question: Overall, how would you rate this patient's level of consciousness? (alert [normal]), vigilant [hyperalert], lethargic [drowsy, easily aroused], stupor [difficult to arouse], or coma [unarousable])	
The diagnosis of delirium by CAM requires the presence of features **1 and 2 and either 3 or 4.**	**Score :** _____

Appendix G

High-Risk Diagnoses for the Elderly Score (HRDES)

Condition (present during hospital stay)	Weight	Patient information	Score
CHF/cardiomyopathy	2		
Pneumonia during admission	1		
COPD/Chronic lung disease	2		
Cancer (solid tumor, localized)	3		
Cancer (metastatic)	3		
Lymphoma/leukemia	6		
Major stroke (hemiplegia)	2		
Acute Renal failure	5		
Chronic Renal Failure	2		
		Total Score	
Score Interpretation Low (0) = 9.5% chance dying (in 1 year) High risk (3-5) = 46% chance dying Intermediate (1-2) = 31% chance dying Very High Risk (> 6) = 74% chance dying			

Publishing Agreement

It is the policy of the University to encourage the distribution of all theses, dissertations, and manuscripts. Copies of all UCSF theses, dissertations, and manuscripts will be routed to the library via the Graduate Division. The library will make all theses, dissertations, and manuscripts accessible to the public and will preserve these to the best of their abilities, in perpetuity.

Please sign the following statement:

I hereby grant permission to the Graduate Division of the University of California San Francisco to release copies of my thesis, dissertation, or manuscript to the Campus Library to provide access and preservation, in whole or in part, in perpetuity.

Cynthia Zaharis — June 12, 2012

Author Signature **Date**