Predictive Validity of NYHA and ACC/AHA Classifications of Physical and Cognitive Functioning in Heart Failure

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Abstract   In clinical and research settings, heart failure (HF) is typically assessed using the New York Heart Classification (NYHA class) criteria and/or the American College of Cardiology/ American Heart Association (ACC/ AHA) Stages of HF criteria to assess severity and functional capacity of HF patients. Recent evidence suggests that there may be inconsistencies between the two classification schemes relative to correlations between physical function and cognitive function in HF patients. As cognitive function has been identified as a significant risk factor for patient outcomes, these inconsistencies between classification systems may limit the generalizability of the use of each assessment for research purposes. Therefore, the predictive validity of these two classification schemas were examined for their association with physical ability measured by six-minute walk test (6MWT) and cognitive function screened using the Montreal Cognitive Assessment (MoCA) in a published study of 90 patients with HF. The results revealed both the NYHA class (RS = -0.232, 0.028) and ACC/AHA stages of HF (RS = -0.258, p=0.014) have good predictive validity for determining cognitive indicating the need to include assessment of cognitive impairment as an at-risk factor among HF patients. The NYHA class revealed an inverse association with functional status measured by 6MWT (RS = -.298, p= 0.004), with no association to ACC/AHA stage of HF that indicates structural damage to the heart (RS = -.178; p= .093). Results support the impact of on functional status and cognitive function that are two important sequellae for considerations in staging severity and for patients with HF.

Keywords   NYHA Class, Heart Failure Stages, Cognitive Impairment, Functional Impairment, Montreal Cognitive Assessment, Six-minute Walk Test

1. Introduction

Heart failure (HF) is a progressive disease requiring ongoing assessment of illness severity as individuals move through an unpredictable trajectory. In order to do this, clinicians require valid assessment schemes to determine HF severity to manage according to national clinical practice guidelines[1]. Clinicians typically assess HF severity using the New York Heart Association functional classification (NYHA class) or the American College of Cardiology/ American Heart Association (ACC/ AHA) stages of HF[2]. Determination of the NYHA class is based on patient symptoms (Table 1), while the specific ACC/ AHA stages of HF(Table 2) is based on the extent of damage to the heart[2].

Clinicians might use NYHA class or the ACC/AHA stage of HF exclusively and/or use both together to make clinical treatment decisions. Pathophysiologic impairments underlying HF and the impact of HF on functional status and cognitive function are two important sequellae for considerations in staging severity and caring for patients with HF[3]. However, there is conflicting evidence regarding whether the ACC/AHA stages of HF and NYHA classes are correlated to physical and cognitive function[4, 5]. This paper aims to examine the validity of these two classification schemas on their association with physical ability and cognitive function in a study of 90 patients with HF.

Each of these classification systems have strengths and limitations based on the underlying conceptual approach to staging and/or classifying. The NYHA class is an indicator of cardiac symptoms, cardiac status, and functional capacity[6]. In recent years, the NYHA classes have progressed from a clinical tool to assess HF severity, to an entry criterion and an efficacy outcome measure in clinical

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trials[7]. In contrast, the ACC/AHA stages of HF reflect disease progression, identify high-risk conditions and enable initiation of appropriate preventive measures before symptom manifestation[3]. The ACC/AHA stages of HF have not been utilized considerably in clinical trials, since the stages are progressive, and patients who improve are not recatogerized to a less severe stage[3]. The ACC/AHA stages of HF do not supplant the NYHA class assessment, but rather complement it by addressing the importance of the progressive nature of HF (Figure1)

Although most providers are experienced in assigning a NYHA class, the method of assignment is not standardized and the reproducibility and consistency of determining NYHA class have never been established[8]. There is evidence of uncertainty in the management of patients admitted in advanced stages of HF whose symptoms improve, oreven reverse,after treatment[9]. This change or improvement often creates a dilemma for clinicians in determining what NYHA class therapies from the guidelines to prescribe, resulting in undertreatment and readmissions [9].

In addition, an inter-rater variability showed only a 54% concordance between four cardiologists who assessed the same patients on the same day; indicating that assessment of NYHA class was not reproducible and reliable to predict self-reported walking distance or exercisetolerance of the patients with HF[5]. Inconsistencies in the use of NYHA class and ACC/AHA stages of HF were reported in a large retrospective study[10].These findings suggest poor understanding and inconsistent assessment of the NYHA class and ACC/AHA staging of HF, and place limitations on utilizing these measures for research and clinical practice [10,11]. Examining the validity and utility of both these measures may assist clinicians in appropriate assessment and management of persons with HF.
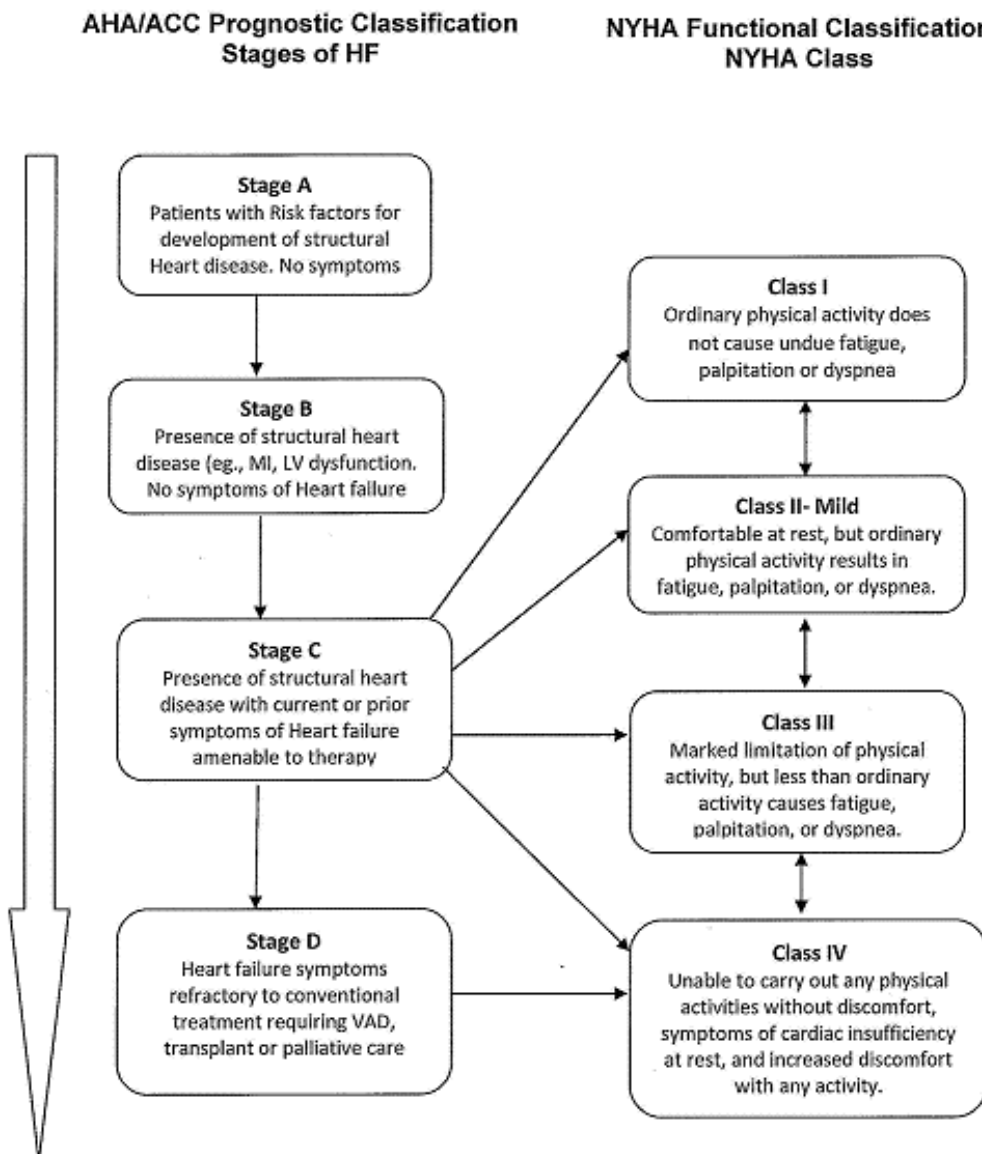

Figure 1. Comparison on the ACC/AHA stages of HF and NYHA Classification

The purpose of this secondary analysis is to examine the validity of the NYHA class and ACC/AHA stages of HF to determine HF severity among 90 individuals with HF. Predictive validity was determined by correlating the NYHA class and ACC/AHA stages of HF with selected related variables[12,13]. HF severity was defined as abnormalities in cardiac structure and function that are typical of the HF syndrome and associated with limitations in physical and mental performance[14]. The related variables selected to test the validity of NYHA class and ACC/AHF stages were: functional ability assessed by six-minute walk test (6MWT), and the Montreal Cognitive Assessment (MoCA) to screen for cognitive impairment[15-17]. We aimed to find a reasonable negative correlation of NYHA class and ACC/AHF stages with related measures of 6MWT and the MoCA score.

2. Review of Literature

Evidence from earlier studies indicated that the severity of HF assessed by NYHA class was associated with functional ability in HF[18,19]. However, there are concerns and inconsistencies in the reproducibility, and validity of the NYHA classification system, and "it is prudent to refrain from using the NYHA class as the sole outcome measure of changes in function in research studies" (p. 262)[11].The cardiopulmonary exercise testing (CPET) is the gold standard for measuring functional ability in persons with cardiac disease[20]. Nonetheless, the 6MWT is being used increasingly as an alternative to CPET due to its wide availability, security, and ease of implementation[21,22].The discriminative ability of the 6MWT was similar to that of treadmill exercise capacity for predicting cardiovascular events (C statistics for both 0.72; $P = .29$)[23].Distance walked in six-minute was significantly correlated with the peak VO_2 (p= .01) with a correlation coefficient of 0.78[24]. Although the 6MWT is considered a submaximal exercise, it best reflects the activities of daily living and is generally well tolerated by persons with HF[25]. Distance walked during the 6MWT was moderately inversely related (r = -0.43, p =.001) to NYHA class in a previous study with an interclass correlation coefficient of 0.88-91[15]. Yet, participants in NYHA class II had a significantly higher peak oxygen (VO_2) uptake (16.1 ± 4.6 vs. 13.0 ± 4.2 ml/kg/min) and a longer duration of exercise (11.0 ± 3.9 versus 8.0 ± 3.4 minutes) than participants in NYHA class III/IV[26]. The multicenter HF-ACTION study (N=2331) reported an improvement by one NYHA class among 30% of the exercise-training cohort (p= .03)[19]. The ACC/AHA stages of HF are based on structural damage to the heart and the assessment doesn't involve functional ability, hence there is scant evidence available that compared functional ability with stages of HF.

The 6 MWT was a better predictor of mortality in HF (HR= 2.38; 95% CI 2.02 to 57.6; p= .005); the mortality was 11.5% among participants in NYHA class II compared to 58.8% in NYHA class III(p= .001), indicating that worse NYHA class was associated with increased mortality[27]. Increased mortality was found among participants (n=188) who received cardiac resynchronization therapy (p= .001), of whom 74% were in NYHA class III[28]. In addition, another study found that the 6MWT (distance ≤200 meter) was the strongest predictor of mortality (HR=2.14; 95% CI 1.20 to 3.81; p= .01) and HF rehospitalization (HR= 1.62; 95% CI, 1.10 to 2.39; p = .02)[29]. NYHA class III/IV has been negatively associated with the 6MWT (t -2.86; p=.005) and the distance walked in six minutes progressively decreased with worsening HF[30]. The distance walked in 6MWT was also associated with mortality rate[31]. Collectively, these studies support that worse NYHA class is associated with poor functional ability measured by 6MWT and HF readmissions.

Similarly to the effect of HF on the decline in functional ability, cognitive impairment is increasingly recognized as a common adverse consequence of HF, which increases as heart function decreases[4]. Across studies, the point prevalence of cognitive impairment among patients with HF ranged from 25% to as high as 74%[32]. In a sample of 249 community-dwelling individuals with HF, those in NYHA class I/II performed significantly better on cognitive tests measuring memory, visuo-spatial ability, psychomotor speed, and executive function (p= <0.05 for all) compared to patients with NYHA class III to IV[17]. Similar linear associations with cognitive impairment have been reported on NYHA class[33] and ACC/AHA stage 'D' HF[34].In addition, distance walked in the 6MWT was strongly associated with cognitive scores measured by Mini Mental State Examination (MMSE) among 80 individuals with HF (R^2 = .53; p= .0001) after adjusting for demographic parameters[30]. A case control study reported that individuals with HF incur a 4-fold risk for cognitive impairment (odds ratio 4.47, CI 1.75 -11.43; p=.002) compared with matched community controls; but reported no association of cognitive impairment with NYHA class and physical functioning (p= .08)[35]. However, community-dwelling seniors with no prior history of cognitive impairment, but who had a history of HF, revealed an increased risk(HR 1.84 & 1.80) of developing mild cognitive impairment over a five-year period[36]. Similarly, in a cross-sectional study of (N=57), 53% of persons with HF NYHA class II–III scored below 24 on the MMSE indicating mild cognitive impairment[37]. Feola et al. (2006) reported otherwise, finding no association between MMSE score and NYHA class (r= .01; p=.37)[38]. A recent study of 70 % of participants with HF scored less than the cut of score on the MoCA (≤ 26) indicating mild cognitive impairment. In addition, the MoCA score was strongly associated with NYHA class; among those in NYHA Class III/IV, 91% were classified as cognitively impaired compared to 52% in NYHA Class I/II[16].

3. Aims and Hypothesis

Although NYHA class and ACC/AHA stages of HF are used exclusively or together to determine the algorithm for HF management, these measures are inconsistent in classifying HF severity and have not been examined thoroughly for validity. The purpose of this secondary analysis is to examine the predictive validity of the NYHA class and ACC/AHA stages of HF utilizing the related variables of physical and cognitive ability. In addition, we examined the concurrent validity of the two measures, the NYHA class and ACC/AHA stages of HF that measures the same construct, which is the severity of HF. In light of the evidence from the literature review, we hypothesized that: 1) The NYHA class and ACC/AHA stages of HF will be moderately, negatively correlated to physical ability measured by the 6MWT;

2) The NYHA class and ACC/AHA stages of HF will be moderately, negatively correlated to cognitive function measured by the MoCA; and 3) The NYHA class will be positively correlated with ACC/AHA stages of HF.

4. Methods and Variables

This is a secondary analysis of a cross-sectional correlation study that enrolled ninety community-dwelling adults with HF from outpatient cardiology offices[39]. Inclusion Criteria were the original study were: (1) clinical diagnosis of HF as defined by the ICD-9-CM; (2) community dwelling adults residing at home; (3) 50 years of age or older, because the incidence of HF among the US population increases sharply with age, affecting about 6% of people in their 60s and 10% of people in their 80s[40]. Persons were excluded if they were (1) on continuous oxygen; (2) listed for heart transplant with United Network for Organ Sharing as status 1A or 1B, (3) supported by ventricular assist device or home inotropic therapy; (4) enrolled in a palliative or hospice care program; (5) diagnosed with dementia or Alzheimer's disease; or (6) a clinical history of stroke.

4.1. Ethical Consideration

The study was approved by the Research Subject Review Board of the University. Participants were recruited over a four-month period in 2007 from cardiology offices affiliated with the University Hospital. Participants were identified with a code number.

4.2. The NYHA Classification

The NYHA functional classes on the study participants were determined by a cardiology nurse practitioner on the day of data collection based on the individuals' HF symptoms and 6MWT. NYHA class provides a simple way of classifying patients in one of four grading categories (I, II, III, &IV) with higher class indicating more severe HF symptoms[41]. Grading is based on the individual clinicians' judgment partly based on cardiac functional ability and objective cardiac assessment (Table 1, grading criteria).

Functional ability is an estimate of what the patient's heart will allow them to do physical activities. This ability is not influenced by the character or structural damage to the heart[41].

Table 1. NYHA Classification Grading Criteria

Functional Capacity	Objective Assessment
Class I. Patients with cardiac disease but without resulting limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or anginal pain.	**A.** No objective evidence of cardiovascular disease.
Class II. Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea, or anginal pain.	**B.** Objective evidence of minimal cardiovascular disease.
Class III. Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary activity causes fatigue, palpitation, dyspnea, or anginal pain.	**C.** Objective evidence of moderately severe cardiovascular disease.
Class IV. Patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of heart failure or the anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.	**D.** Objective evidence of severe cardiovascular disease.

Validity and reliability on determining NYHA class using CPET, which is the gold standard, and 6MWT (r = 0.51, p= .001 and r = −0.40, p = 0.005 respectively) was reported [24]. Therefore, NYHA class was assessed objectively based of patients' self-reported HF symptom experience and ability to walk at least a block.

4.3. The ACC/AHA stages of HF

Ultrasound techniques such as the 2D/3D echocardiogram, cardiac magnetic resonance, and cardiac angiogram permit a comprehensive assessment of morphology, function, and the extent of structural damage to the heart and have been the accepted norms in determining the ACC/AHA stages of HF[2, 42]. Therefore, the ACC/AHA stages of HF on the study participants were extracted from medical records based on an objective cardiac assessment within past 6 months (Table 2, grading criteria).

Table 2. ACC/AHA Heart Failure Stages Grading Criteria

HF Stage A	Patients at high risk for developing HF in the future but no functional or structural heart disorder
HF Stage B	A structural heart disorder but no symptoms at this stage
HF Stage C	Previous or current symptoms of heart failure in the context of an underlying structural heart problem, but managed with medical treatment
HF Stage D	Advanced disease requiring hospital-based support, a heart transplant or palliative care

4.4. Functional Ability

Functional ability in this study was measured using the 6MWT[21]. The reported correlation coefficient of 6MWT with peak VO2 was 0.68 (p < 0.001)[43]. The 6MWT was given according to the guidelines provided by the American Thoracic Society (ATS) Pulmonary Function Standards Committee[44,45]. Participants were told to walk at their own pace in a straight plane of the research unit corridor and the laps were counted and measured in meters walked in 6 minutes; each lap was 120 meters. The primary measurement was the total distance walked in meters over six minutes. Among healthy and sedentary subjects (122), age and BMI was a strong (r= 0.97) and significant (p= .001) predictor for distance walked in 6 minutes[46]. Therefore, predicted distance walked and the percent completed by the individual was compared in the manner described by Enright & Sherrill (1998); which was calculated using the formula based on age, gender, height, and weight of the participants (Table 3)[47].

Table 3.   Reference Equation for 6MWT for Predicted Distance in Meters/ Percent Completed

Men: 6MWT= (7.57 X height in cm) - (5.02 X age) - (1.76 X weight in kg) - 309 m. Alternate equation using BMI for men: 6MWT= 1,140 m - (5.61 X BMI) - (6.94 X age) When using either equation, subtract 153 m for the Lower limits of normal **Women:** 6MWT= (2.11 X height in cm)- (2.29 X weight in kg) - (5.78 X age) + 667m Alternate equation using BMI for women: 6MWT= 1,017 m - (6.24 X BMI) - (5.83 X age) When using either equation, subtract 139 m for the Lower limits of normal

This reference equation was recently compared on distance walked by healthy adults from seven counties and reported consistency among centers and provided reference percentile curves for use in clinical settings[48].

4.5. Cognitive Impairment

Participants were screened for cognitive impairment using the MoCA[49]. The MoCA is a one page; paper-and-pencil test that consists of 8 cognitive domains (i.e., visuo-spatial, naming animals, memory, attention, language, abstraction, delayed recall, and orientation) that test 13 items[49].The MoCA is administered by an interviewer and takes about 10-12 minutes to complete. The scoresrange from 0 to 30.A score above 26 is considered normal, score 22 to 26 suggests mild cognitive impairment, 17 to 21 suggests moderate cognitive impairment, and less than 17 suggests dementia[49]. The validity and reliability of the MoCA was originally tested on 94 participants with mild cognitive impairment, 93 with Alzheimer's disease, and 90 healthy elderly controls. The MMSE revealed a sensitivity of 78%, whereas the MoCA was 100% sensitive;MMSE had a specificity of 100% and the MoCA was 87%. Test-retest reliability had less than one point variation (r = 0.92, p < .001). The internal consistency of the MoCA on the standardized items was a Cronbach's alpha of 0.83. The

MoCA had been approved as a screening tool for mild cognitive impairment in the Canadian Guidelines for the Diagnosis and Management of Dementia[50]. The MoCA was identified as a sensitive cognitive screening tool among patients with HF[51,52]; high-risk populations with cardiovascular diseases[53]; and stroke[54]. To minimize the effects of education, one point is added to the score as a correction factor for subjects with less than high school education[49].

4.6. Control Variables

Demographic variables included were age, education, race, and socioeconomic status. These data were collected using a demographic and clinical questionnaire created for the study to examine as covariates[51]. Data on co-morbidities was assessed using the modified version of Cumulative Illness Rating Scale,which included 14 organ systems and considered the hematopoietic system separately from the vascular system with an intra-class correlation of 0.78[55].

5. Data Analysis

The aim of the secondary data analysis was to use the Spearman Rho correlation coefficients statistics to examine the predictive validity of both NYHA class and ACC/AHA stages of HF using the related variable of cognitive screening scores (MoCA score) and functional ability score (6MWT).

Table 4.   Demographic and Clinical Characteristics of the Sample

	Description	Percent %	Mean and SD	Range
Age in Years	Above 65 years	35	62.2 ± 9.2	50-89
Education in years	High School or less	65.6	13.83 ± 2.76	10-22
Marital Status	Married	68.9		
Race	White Others	77.8 22.2		
Living Arrangement	Alone Spouse/ SOS	21.1 78.9		
Family History of HF	Yes No	76.7 23.3		
Etiology of HF	Ischemic Non-ischemic	50 50		
NYHA Class	Class I Class II Class III Class IV	13.3 54.4 32.2 0		
HF Stage	Stage B Stage C Stage D	14.4 80 5.6		
EF %	EF ≤40%	76.7	30 ± 14	10- 60
6MWT Distance in meters	≤ 75% Predicted	29	482 ±58	107-648
MoCA			24.73	2.76

Table 5. Spearman's rho Correlation Matrix on Construct Validity

		NYHA Class	ACC/AHA Stages of HF	6MWT	MoCA total score
NYHA Class	CC				
ACC/AHA Stages of HF	CC	.019			
6MWT	CC	-.298**	-.178		
MoCA Score	CC	-.232*	-.258*	.331**	

* Correlation is significant at < 0.05 level (2-tailed)
** Correlation is significant at < 0.001 level (2-tailed)

Table 6. Cross tabulation of Pearson Chi-square Analysis of 6MWT and MoCA Score within NYHA Class and ACC/AHA Stages of Heart Failure

		NYHA class I	NYHA class II	NYHA Class III	HF Stage B	HF Stage C	HF Stage D	Total
6MWT	< 75% FS	11.1%	19.6%	50.0%	15.4%	31.9%	20.0%	28.9%
	Norm FS	8.9%	45.6%	16.7%	81.2%	54.4%	4.4%	71.1%
MoCA Score	≤26 CI	7.8%	52.9%	60.0%	30.8%	59.7%	100%	57.8%
	>26i Norm	2.2%	26.7%	13.3%	23.7%	76.3%	0.0%	42.2%

Abbreviations in Table: FS=Functional status;
Norm= Normal; CI= Cognative impairment

6. Results

Participants (N=90) were predominantly men (66%), Caucasian (79%), and aged 50-89, with mean age 62 ± 9 years. Ejection fraction refers to the percentage of blood that's pumped out of a filled ventricle with each heartbeat with 55 to 70% considered normal. Mean ejection fraction of the participants was 30% with SD ± 14, ranged from 10 to 60%; 77% of them having ejection fraction below 40% indicating systolic heart failure due to insufficient contraction. Ejection fraction above 40% is known as diastolic heart failure due to insufficient relaxation[39]. More than 50% of the participants were in NYHA class II and 32% were in class III, none in class IV. Almost 80% of the participants were in ACC/AHA stage 'C' HF, and 14% of patients in stage B were misclassified as NYHA class III.The mean MoCA score was 24.73 SD ± 2.76. The MoCA identified 54% of the participants with mild cognitive impairment. The mean distance walked in six-minute was 482 meters, SD ±58. Table 4 provides details on the demographic and clinical variables.

6.1. Test for Predictive Validity of NYHA Class and ACC/AHA stages of HF

As indicated in the correlation matrix (Table 5),predictive validity was examined by Spearman Rho correlation coefficients between NYHA class and ACC/AHA stages of HF with MoCA score and 6 MWT. Both the NYHA class (R_S= -0.232, p= 0.028) and ACC/AHA Stages of HF (R_S=-0.258, p=0.014) revealed significant inverse association with MoCA score. The NYHA class revealed a statistically significant inverse association with functional status measured by the 6MWT (R_S = -.298, p= 0.004). ACC/AHA stage of HF showed no association with the 6MWT (R_S = -.178; p= .093).

6.2. Concurrent Validity of NYHA Class and ACC/AHA Stages of HF

Spearman Rho correlation coefficients were calculated to examine association between NYHA Class and ACC/AHA stages of HF. Although both measure HF severity, the result indicated that they are not significantly related to each other (R_S = 0.02, p=0.86).

A cross tabulation with a Pearson Chi-square analysis (Table 6) showed that the 6MWT score ≤75% of predicted distance walked, which indicates poor functional status, was associated with NYHA class (X^2(2)10.03; p =.001) but not associated with ACC/AHA stages of HF (X^2(2)2.03; p = .09). A dichotomized MoCA score ≤26, indicating Mild Cognitive Impairment,was associated with both NYHA class (X^2(2)6.67; p = .001) and ACC/AHA stages of HF (X^2(2)7.65; p = .001).

7. Discussion

The predictive validity of NYHA class and ACC/AHA Stages of HF was supported by their relationship with the cognitive screening scores ofthe MoCA. Both measures showed inverse associations with the MoCA score indicating similar predictive validity on the cognitive measure. These findings of association between NYHA class and cognitive function are consistent with current literature[16,17]. Similar findings of association have been reported between stage 'D' ACC/AHA stages of HF and cognitive impairment in mental processing speed, verbal and visual memory function

deficits[34]. On the other hand, an older study showed that patients with previous myocardial infarction (MI) in NYHA class III/IV performed similar in memory function tests (p=>0.05 in all) compared to similar MI patients who had no HF[56]. The result of our study confirms the findings of more recent HF research on the association between NYHA class and ACC/AHA stages of HF and cognitive impairment, and provides validity data for both classification strategies.

Predictive validity of the NYHA class for functional ability was supported by its correlation with the 6MWT (p=0.007). Similar findings of association between NYHA class and functional ability have been reported in HF literature[26,57,58]. The rate of ischemic cerebrovascular events increased from 6.7% in patients with no HF to 9.2% in patients of NYHA functional class I, and 9.7% for patients with NYHA functional classes II and III, which was significantly associated with poor functional ability (P < .001)[59]. Major clinical intervention studies have used NYHA class as a measure of change in functional status over time including, OPTIMIZE-CHF[60]; CARE-HF[61]; COPERNICUS[62]; and COMPANION[63]. The work of these large intervention studies supports the association of NYHA class with functional status.

However, the predictive validity of ACC/AHA stages of HF was not supported for functional ability measured by the 6MWT confirming that the ACC/AHA stages of HF is based on extent of damage to the heart not functional ability. The NYHA class measures functional ability that fluctuates based on patients self-reported HF symptoms, whereas the ACC/AHA stages of HF progresses in one direction only and is not influenced by patients' symptoms[10]. There is also lack of evidence in the literature that supports association between ACC/AHA stages of HF and functional ability.

We found no significant association between NYHA class and ACC/AHA stages of HF to support the concurrent validity (p=0.86). Our findings support that the NYHA class measures functional ability that fluctuates based on HF symptoms, whereas the ACC/AHA stages of HF progresses in one direction only and is not influenced by patients' symptoms, hence are not similar in identifying severity of HF[10]. In our study, 14% of participants were classified as ACC/AHA stage 'B' HF (high risk, with no HF symptoms); the same were classified as NYHA class II/III (with HF symptoms). This inconsistency in the classification could also possible explain the non-association found in this study. The ACC/AHA Stage 'B' HF is defined by the ACC/AHA guidelines as patients with structural heart disease but no current or prior symptoms of HF to alert providers to plan treatment protocol to minimize remodeling of the heart. Once a patient experiences symptom of HF, they advance to stage C even if they later become asymptomatic[9]. Wang and colleagues (2003) found that more than half of all patients with impaired systolic function (34% to 92% of patients) had been characterized as asymptomatic stage 'B' HF[64]. This was also found in a cross sectional study (N= 424), where persons in the early asymptomatic HF stages 'B' showed significantly lower scores on physical and mental

function, suggesting inconsistency in the classification of HF symptom in persons with stage 'B' HF[65]. Thus, evidence supports our findings on the non-association between NYHA class and ACC/AHA stages of HF are potentially due to inconsistency in HF symptom classification.

8. Limitation

This is a secondary analysis of a published study that compared the NYHA class that was determined on the date of data collection based on participants reported HF symptoms by one cardiology nurse practitioner. Whereas, cardiologist clinical reports based on an objective assessment of echocardiogram within 6 months was used to determine ACC/AHA Stages of HF. Thus comparing a current functional class with a past 6 months data on structural damage may be a reason for the non-significance; hence the result should be viewed with caution.

9. Summary and Relevance to Clinical Practice

Results from this study indicate that both NYHA class and ACC/AHA stages of HF have good predictive validity for determining cognitive impairment screened using the MoCA indicating the need to include early assessment of at-risk for cognitive impairment among HF patients. This result supports the evidence both the ACC/AHA and Heart Failure Society of America (HFSA) guidelines that encourage providers to use both measures. The AHA and HFSA guidelines warrant providers to use ACC/AHA stages of HF to determine initiation of HF therapies based on evidence from clinical trials for high-risk patients with structural damage to heart who have no HF symptoms supporting the management goal of prevention of HF progression by remodeling of the structure of the heart[3, 6]. Results from our study indicate possibility of adding cognitive impairment as an at-risk factor in HF. Patients with HF are expected to perform regular maintenance tasks such as monitoring weight and responding to water retention related to weight gain, edema, dyspnea, and being adherent to multiple medications, following a sodium-restricted diet, as well as engaging in moderate physical activity[66]. Cognitive impairment may contribute to self-care deficit through problems with decision-making and executive function in complex situations such as early recognition and interpretation of HF symptoms, thus increasing patients' risk for non-compliance and increased readmission rates for decompensation[67].

The NYHA classes showed good predictive validity for functional status measured by 6MWT; while the ACC/AHA stage of HF that is based on structural damage to the heart showed no association to 6MWT suggesting NYHA class is a better predictor of functional ability than ACC/AHA stages of HF. This notion supports the 2010 HFSA guideline recommendation to use the 6MWT in addition to HF

symptoms in the assessment of NYHA class and provide step-by-step management strategies to determine progress after treatment implementation[3]. Similarly, the Canadian Cardiovascular Society's consensus model for the management of HF used only NYHA class as a basis for HF treatment determinations[68].

In summary, the ACC/AHA stages of HF complement NYHA class by addressing the importance of the progressive nature of HF. Findings from this study add to the evidence the need for assessing at-risk that includes physical and cognitive ability among patients with HF. Results support the impact of HF on functional status and cognitive function that are two important sequellae for considerations in staging severity and caring for patients with HF.

The guidelines warrant the providers to use both classifications schemes in order to have consistency n assessing at-risk and progress in the management of patients with HF. Appropriate use of both measures is vital in the management of HF.

What this Paper Adds

● Both the NYHA class and ACC/AHA stages of HF have good predictive validity for determining cognitive function. However, cognitive impairment is currently not an at-risk factor among HF patients that warrant screening.

● The NYHA classes showed good predictive validity for functional status measured by 6MWT and should be used by clinicians in determining NYHA functional class.

● Results support the impact of HF on functional status and cognitive function that are two important sequellae for considerations in staging severity and caring for patients with HF.

● The ACC/AHA stages of HF do not supplant the NYHA class assessment, but rather complement it by addressing the importance of the progressive nature of HF. Findings from this study add to the evidence the need for assessing at-risk factors that includes physical and cognitive ability among patients with HF.

REFERENCES

[1] Go, A. S., Mozaffarian, D., Roger, V. L., Benjamin, E. J., Berry, J. D., Borden, W. B., . . . Turner, M.B. American Heart Association Statistics Committee and Stroke Statistics Subcommittee. (2013). Executive summary: Heart disease and stroke statistics--2013 update: A report from the American heart association. *Circulation, 127*(1), 143-152. doi:10.1161/CIR.0b013e318282ab8f; 10.1161/CIR.0b013e318282ab8f

[2] Hunt, S. A., Abraham, W. T., Chin, M. H., Feldman, A. M., Francis, G. S., Ganiats, T. G., . . American Heart Association. (2009). 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. *Journal of the American College of Cardiology, 53*(15),

e1-e90. doi:10.1016/j.jacc.2008.11.013

[3] Lindenfeld, J., Albert, N. M., Boehmer, J. P., Collins, S. P., Ezekowitz, J. A., . . . Walsh, M. N. (2010). HFSA 2010 comprehensive heart failure practice guideline. *Journal of Cardiac Failure, 16*(6), e1-194. doi:10.1016/j.cardfail.2010.04.004

[4] Gaviria, M., Pliskin, N., & Kney, A. (2011). Cognitive impairment in patients with advanced heart failure and its implications on decision-making capacity. Congestive Heart Failure, 17(4),175-179.doi:10.1111/j.1751-7133.2011.00242.x

[5] Raphael, C., Briscoe, C., Davies, J., Ian Whinnett, Z., Manisty, C., Sutton, R., . . . Francis, D. P. (2007). Limitations of the New York heart association functional classification system and self-reported walking distances in chronic heart failure. *Heart (British Cardiac Society), 93*(4), 476-482. doi:10.1136/hrt.2006.089656

[6] Jessup, M., Abraham, W. T., Casey, D. E., Feldman, A. M., Francis, G. S., Ganiats, T. G., . . . Yancy, C. W. (2009). 2009 focused update: ACCF/AHA 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), 1977-2016. doi:10.1161/CIRCULATIONAHA.109.192064

[7] Miller-Davis, C., Marden, S., & Leidy, N.K. (2007). The New York Heart Association Classes and functional status: What are we really measuring? *Heart Lung, 35*(4), 217–224.

[8] Kubo, S.H., Schulman, S., Starling, R.C., Jessup, M., Wentworth, D., & Burkhoff, D. (2004). Development and validation of a patient questionnaire to determine New York Heart Association classification. *Journal of Cardiac Failure, 10*(3), 228–235.

[9] Goldberg, L.R., & Jessup, M. (2006). Stage B Heart Failure. Management of Asymptomatic Left Ventricular Systolic Dysfunction. *Circulation, 113,* 2851-2860.

[10] De Marco, T., Delgado, R.M III., & Agocha, A. (2004). Confusion at Large: Incorrect Assignment of Patients to the AHA/ACC Stages of Heart Failure in the ADVANCENT Registry. *Journal of Cardiac Failure, 10,* S96. Abstract 288.

[11] 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.

[12] Nunnally, J, C., & Bernstein, I.H. (1994). *Psychometric theory.* 3rd ed. New York: McGraw-Hill. Page 251.

[13] Streiner, D., & Norman, G. (2003) *Validity.* In: Streiner D, Norman G, editors. Health Measurement Scales. A Practical Guide to Their Development and Use.3rd edition. Oxford: Oxford University Press.

[14] Di Bari, M., Pozzi, C., Cavallini, M. C., Innocenti, F., Baldereschi, G., De Alfieri, W., . . . Marchionni, N. (2004). The diagnosis of heart failure in the community. Comparative validation of four sets of criteria in unselected older adults: The ICARe dicomano study. *Journal of the American College of Cardiology, 44*(8), 1601-1608. doi:10.1016/j.jacc.2004.07.022

[15] Demers, C., McKelvie, R.S., Negassa, A., & Yusuf, S. (2001)

[16] Reliability, validity, and responsiveness on the six-minute walk test in patients with heart failure. *American Heart Journal, 142*(4), 698-603.

[17] Harkness, K., Demers, C., Heckman, G. A., & McKelvie, R. S. (2011). Screening for cognitive deficits using the Montreal cognitive assessment tool in outpatients >/=65 years of age with heart failure. *The American Journal of Cardiology,* doi:10.1016/j.amjcard.2010.12.021

[18] Pressler, S. J., Subramanian, U., Kareken, D., Perkins, S. M., Gradus-Pizlo, I., Sauve, M. J., . . . Shaw, R. M. (2010). Cognitive deficits in chronic heart failure. *Nursing Research, 59*(2), 127-139. doi:10.1097/NNR.0b013e3181d1a747

[19] Kervio, G., Ville, N.S., Leclercq, C., Daubert, J.C., & Carre. F. (2004). Cardio- respiratory adaptations during the six-minute walk test in chronic heart failure patients. *European Journal of Cardiovascular Preventive Rehabilitation, 11*(2), 171-177.

[20] O'Connor, C.M., Whellan, D.J., Lee, K. L., Keteyian, S. J., Cooper, L.S., Ellis, S.J., … Pina, I.L. HF-Action Investigator (2009). Efficacy and Safety of Exercise Training in Patients With Chronic Heart Failure. HF-ACTION Randomized Controlled Trial. *JAMA, 301*(14), 1439-1450. doi:10.1001/jama.2009.454; 10.1001/jama.2009.454

[21] Mann, D. L. (2007). *Pathophysiology of heart failure.* In: Libby P, Bonow RO, Mann DL,Zipes DP. Braunwald´s heart disease: a textbook of cardiovascular medicine. 8th ed. Philadelphia: Saunders. pp. 9901-09.

[22] Guyatt, G. H., Sullivan, M. J., Thompson, P. J., Fallen, E. L., Pugsley, S. O., Taylor, D. W., & Berman, L. B. (1985). The 6-minute walk: A new measure of exercise capacity in patients with chronic heart failure. *Canadian Medical Association Journal, 132*(8), 919-923.

[23] Salzman, S..H. (2009). The 6-Min Walk Test: Clinical and Research Role, Technique, Coding, and Reimbursement. *Chest, 135*(5), 1345-1352.

[24] Beatty, A.L., Schiller, N.B., & Whooley, M.A. (2012). Six-Minute Walk Test as a Prognostic Tool in Stable Coronary Heart Disease Data from the Heart and Soul Study. *Archives of Internal Medicine, 172*(14), 1096-1002.

[25] Guazzi, M., Dickstein, K., Vicenzi, M., & Arena, R. (2009). Six-minute walk test and cardiopulmonary exercise testing in patients with chronic heart failure: a comparative analysis on clinical and prognostic insights. *Circulation Heart Failure, 2*(6), 549-555.

[26] McKelvie, R.S. (2008). Exercise training in patients with heart failure: clinical outcomes, safety, and indications. *Heart Failure Review, 13*(1), 3-11.

[27] Russell, S.D., Saval, M.A., Robbins, J.L., Gottlieb, S.S., Handberg, E.M., … Chandler, B., HF-ACTION Investigators New York Heart Association functional class predicts exercise parameters in the current era. American Heart Journal, 158(4S), 24-30. doi:10.1016/j.ahj.2009.07.017; 10.1016/j.ahj.2009.07.017

[28] Arslan, S., Erol, M.K., Gundogdu, F., Sevimli, S., Aksakal, E., Senocak, H., Alp, N. (2007). Prognostic value of 6-minute walk test in stable outpatients with heart failure. *Texas Heart Institute Journal, 34*(2), 166-169.

[29] Castel, M.A., Mendez, F., Tamborero, D., Mont, L. Magnani, S., Tolosana, J.M., …Brugada, J. (2009). Six-minute walking test predicts long-term cardiac death in patients who received cardiac resynchronization therapy. Europace, 11(3): 338–342. doi:10.1093/europace/eun362; 10.1093/europace/eun362

[30] Alahdab, M.T., Mansour, I.N., Napan, S., & Stamos, T.D. (2009). Six Minute Walk Test Predicts Long-Term All-Cause Mortality and Heart Failure Rehospitalization in African-American Patients Hospitalized With Acute Decompensated Heart Failure. *Journal of Cardiac Failure, 15*(2), 130-135. doi:10.1016/j.cardfail.2008.10.006; 10.1016/j.cardfail.2008.10.006

[31] Baldasseroni, S., Mossello, E., Romboli, B., Orso, F., Colombi, C., Fumagalli, S., … Marchionni, N. (2010). Relationship between cognitive function and 6-minute walking test in older outpatients with chronic heart failure. *Aging Clinical and Experimental Research, 22*(4), 308-313.

[32] Rostagno, C., & Gensini, G.F. (2008). Six minute walk test: a simple and useful test to evaluate functional capacity in patients with heart failure. *Internal Emergency Medicine, 3*(3), 205-212. doi:10.1007/s11739-008-0130-6; 10.1007/s11739-008-0130-6

[33] Heckman, G.A., Patterson, C.J., Demers, C., St Onge, J., Turpie, I.D., McKelvie, R. S. (2007). Heart failure and cognitive impairment: challenges and opportunities. *Clinical Interventions in Aging, 2*(2), 209-218.

[34] De Jong, M., Moser, D.K., & Chung, M.L. (2005). Predictors of health status for heart failure patients. *Progress in Cardiovascular Nursing, 20*(4), 155-162.

[35] Petrucci, R. J., Truesdell, K. C., Carter, A., Goldstein, N. E., Russell, M. M., Dilkes, D., . . . Narula, J. (2006). Cognitive dysfunction in advanced heart failure and prospective cardiac assist device patients. *The Annals of Thoracic Surgery, 81*(5), 1738-1744. doi:10.1016/j.athoracsur.2005.12.010

[36] Sauve, M. J., Lewis, W. R., Blankenbiller, M., Rickabaugh, B., & Pressler, S. J. (2009). Cognitive impairments in chronic heart failure: A case controlled study. *Journal of Cardiac Failure, 15*(1), 1-10. doi:10.1016/j.cardfail.2008.08.007

[37] Qiu, C., Winblad, B., Marengoni, A., Klarin, I., Fastbom, J., & Fratiglioni, L. (2006). Heart failure and risk of dementia and alzheimer disease: A population-based cohort study. *Archives of Internal Medicine, 166*(9), 1003-1008. doi:10.1001/archinte.166.9.1003

[38] Zuccala , G., Cattel, C., Manes-Gravina, E., Di Niro, M., Cocchi, A., Bernabei, R. (1997).Left ventricular dysfunction: a clue to cognitive impairment in older patients with heart failure. *Journal of Neurology, Neurosurgery, and Psychiatry, 63*(4), 509-512.

[39] Feola, M., Rosso, G. L., Peano, M., Agostini, M., Aspromonte, N., Carena, G., . . . Valle, R. (2007). Correlation between cognitive impairment and prognostic parameters in patients with congestive heart failure. *Archives of Medical Research, 38*(2), 234-239. doi:10.1016/j.arcmed 2006.10.004

[40] Athilingam, P., D'Aoust, R.F., Miller, L., & Chen, L. (2013). Cognitive Profiles Varies in Persons with Systolic and Diastolic Heart Failure. *Journal of Congestive Heart failure, 19*(1), 44-50. doi: 10.1111/chf.12001.

[41] Levy, D., Kenchaiah, S., Larson, M.G., Benjamin, E.J, Kupka, M.J., Ho, K.K., … Vasan, R.S. (2002). Long-term trends in the incidence of and survival with heart failure. *New England*

Journal of Medicine, 347(18), 1397-1302.

[42] The Criteria Committee of the New York Heart Association. (1994). *Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Great Vessels.* 9th ed. Boston, Mass: Little, Brown & Co. pp 253-256.

[43] Douglas, P.S. (1996). Justifying echocardiography: the role of outcomes research in evaluating a diagnostic test. *Journal of American Society of Echocardiography, 9*(4): 577-581.

[44] Ross, R.M., Murthy, J.N., Wollak, I.D., & Jackson, A.S. (2010). The six- minute walk test accurately estimates mean peak oxygen uptake. *BMC Pulmonary Medicine, 26,* 10:31. doi:10.1186/1471-2466-10-31; 10.1186/1471-2466-10-31

[45] The American Thoracic Society (2002). Guidelines for the six-minute walk test. ATS Committee on proficiency standards for clinical pulmonary function laboratories. *American Journal of Respiratory Critical Care Medicine, 166(*1), 111–117.

[46] Brooks, D., Solway, S., & Gibbons, W.J. (2003). ATS Statement on six-minute walk test. *American Journal of Respiratory Critical Care Medicine,* 167(9), 1287.

[47] Pires, S.R., Oliveira, A.C., Parreira, V.F., & Britto, R.R. (2007). Six-minute walk test at different ages and body mass indexes. *Brazilian Journal of Physical Therapy, 11,* 1413-1455. http://dx.doi.org/10.1590/S1413-35552007000200010

[48] Enright, P.L., & Sherrill, D.L. (1998). Reference equations for the six-minute walk in healthy adults. *American Journal of Respiratory Critical Care Medicine, 158*(5), 1384-1387.

[49] Casanova, C., Celli, B.R., Barria, P., Casas, A., Cote, C., de Torres, J.P… Aguirre-Jaime, A. (2011). The 6-min walk distance in healthy subjects: reference standard from seven countries. Six-MinuteWalk Distance Project (ALAT). *European Respiratory Journal, 37*(1), 150-156. doi:10.1183/09031936.00194909; 10.1183/09031936.00194909

[50] Nasreddine, Z. S., Phillips, N. A., Bedirian, V., Charbonneau, S., Whitehead, V., Collin, I., . . . Chertkow, H. (2005). The Montreal cognitive assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society, 53*(4), 695-699. doi:10.1111/j.1532-5415. 2005.53221.x

[51] Gauthier, S., Reisberg, B., Zaudig, M., Petersen, R.C., Ritchie, K., Broich, K., …Winbald, B. (2006). International psychogeriatric association expert conference on mild cognitive impairment. Lancet, 367(9518), 1262-1270.

[52] Athilingam, P., King, K.B, W, Burgin, S., Ackerman, M., Cushman, L., &Chen, L. (2011). Montreal Cognitive Assessment may be an appropriate tool to assess cognitive dysfunction in heart failure. *Heart Lung, 40*(6): 521-529.

[53] Cameron, J., Worrall-Carter, L., Page, K., Stewart, S., & Ski, C.F. (2012). Screening for mild cognitive impairment in patients with heart failure: Montreal Cognitive Assessment versus Mini Mental State Exam. *European Journal of Cardiovascular Nursing, 12,* 508-515. doi: 10.1177/1474515111435606

[54] McLennan, S.N., Mathias, J.L., Brennen, L.C., & Stewart, S. (2011). Validity of the Montreal Cognitive Assessment (MoCA) as a Screening Test for Mild Cognitive Impairment

(MCI) in a Cardiovascular Population. *Journal of Geriatric Psychiatry Neurology, 24*(1), 33-38.

[55] Godefroy, O., Fickl, A., Roussel, M., Auribault, C., Bugnicourt, J.M., Lamy, C., … Petitnicolas, G. (2011). Is the Montreal Cognitive Assessment Superior to the Mini-Mental State Examination to detect Post stroke Cognitive Impairment? A Study with neuropsychological evaluation. *Stroke, 42*(6), 1712-1716. doi:10.1161/STROKE AHA.110.606277; 10.1161/STROKEAHA.110.606277

[56] Miller, M. D., Paradis, C. F., Houck, P. R., Mazumdar, S., Stack, J. A., Rifai, A. H., . . . Reynolds, C. F., 3rd. (1992). Rating chronic medical illness burden in geropsychiatric practice and research: Application of the cumulative illness rating scale. *Psychiatry Research, 41*(3), 237-248.

[57] Grubb, N.R., Simpson, C., & Fox, A.A. (2000). Memory function in patients with stable, moderate to severe heart failure. *American Heart Journal, 140*(1), 1E–5E.

[58] Arena, R., Guazzi, M., Myers, J., Chase, P., Bensimhon, D., Cahalin, L., …Forman, D.E. (2011). Exercise oscillatory ventilation reflects diminished quality of life and perceived functional capacity in patients with heart failure. *International Journal of Cardiology, 153*(2), 213-214. doi:10.1016/j.ijcard.2011.09.072; 10.1016/j.ijcard.2011.09.072

[59] Withama, M.D., Argoa, I.S., Johnstonb, D.W, Struthers, A.D., & McMurdo, M.E. (2006). Predictors of exercise capacity and everyday activity in older heart failure patients. *European Journal of Heart Failure, 8*(2), 203-207. doi:10.1016/j.ejheart.2005.03.008

[60] Koren-Morag, N., Goldbourt, U., & Tanne, D. (2008). Poor functional status based on the New York Heart Association classification exposes the coronary patient to an elevated risk of ischemic stroke. *American Heart Journal, 155*(3), 515-520. doi:10.1016/j.ahj.2007.10.032; 10.1016/j.ahj.2007.10.032

[61] Curtis, L.H., Greiner, M.A., Hammill, B.G., DiMartino, L.D., Shea, A.M., Hernandez, A.F., Fonarow G.C. (2009). Representativeness of a national heart failure quality-of-care registry: comparison of OPTIMIZE-HF and non-OPTIMIZE-HF Medicare patients. *Circulation. Cardiovascular Quality Outcomes, 2*(4), 377-384. doi: 10.1161/CIRCOUTCOMES.1 08.822692.

[62] Cleland, J.G.F, Freemantle, N., Ghio, S., Fruhwald, F., Shankar, A., Marijanowski, M., … Tavazzi, L. (2008). Predicting the long-term effects of cardiac resynchronization therapy on mortality from baseline variables and the early response a report from the CARE-HF (Cardiac Resynchronization in Heart Failure) Trial. *Journal of American College of Cardiology, 52(*6), 438-445. doi:10.1016/j.jacc.2008.04.036; 10.1016/j.jacc.2008.04.036

[63] Packer, M., Fowler, M.B., Roecker, E.B., Coats, A.J., Katus, H.A., Krum, H., DeMets, D.L. (2002). Effect of carvedilol on the morbidity of patients with severe chronic heart failure: results of the carvedilol prospective randomized cumulative survival (COPERNICUS) study. *Circulation, 106*(17), 2194-2149.

[64] Lindenfeld, J., Feldman, A.M., Saxon, L., Boehmer, J., Carson, P., Ghali, J.K., … Bristow, M. (2007). Effects of cardiac resynchronization therapy with or without a defibrillator on survival and hospitalizations in patients with New York Heart Association class IV heart failure.

Circulation, 115(2), 204-212. doi:10.1161/ CIRCULATION AHA.106.629261

[65] Wang, T.J., Levy, D., Benjamin, E.J., & Vasan, R.S. (2003). The epidemiology of "asymptomatic" left ventricular systolic dysfunction: implications for screening. *Annals of Internal Medicine, 138(*11), 907–916.

[66] Azevedo, A., Bettencourt, P., Alvelos, M., Martins, E., Abreu-Lima, C., Hense, H. W., & Barros, H. (2008). Health-related quality of life and stages of heart failure. *International Journal of Cardiology, 129*(2), 238-244. doi:10.1016/j.ijcard.2007.07.091

[67] Moser, D.K., & Watkins, J.F. (2008). Conceptualizing Self-care in Heart Failure: A Life Course Model of Patient Characteristics. *Journal of Cardiovascular Nursing, 23*(3), 205 -218. doi: 10.1097/01.JCN.0000305097.09710.a5.

[68] Cameron, J., Worrall-Carter, L., Page, K., Riegel, B., Lo, S.K., Stewart S. (2010). Does cognitive impairment predict poor self-care in patients with heart failure? *European Journal of Heart failure, 12*(5),508-515.

[69]   Howlett, J.G., McKelvie, R.S., Costigan, J., Ducharme, A., Estrella-Holder, E., Ezekowitz, J.A. ,… Zeiroth, S. Canadian Cardiovascular Society. (2010). The 2010 Canadian Cardiovascular Society guidelines for the diagnosis and management of heart failure update: Heart failure in ethnic minority populations, heart failure and pregnancy, disease management, and quality improvement assurance programs. *Canadian Journal of Cardiology, 26*(4), 185-202.