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Cognitive Function and Treatment Adherence in Older Adults with Heart Failure

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Abstract

Objective—Treatment recommendation and guidelines for patients with heart failure (HF) can be complex, and past work has shown HF patients to demonstrate low rates of adherence to recommended health behaviors. While previous work has identified several medical, demographic, and psychosocial predictors of HF persons' capacity to adhere to treatment recommendations, little is known about the contribution of cognitive impairment to reported treatment adherence in this population.

Methods—149 persons with HF (68.08 years; SD = 10.74) completed a brief fitness assessment and neuropsychological testing. Treatment adherence was assessed using the Heart Failure Compliance Questionnaire, a brief measure that asks participants to report their adherence to a variety of recommended health behaviors (i.e., medication management, diet, exercise, among others).

Results—16.1% of participants reported poor overall adherence, with particularly high rates of non-adherence to dietary and exercise recommendations. Hierarchical regression analyses adjusting for possible confounds revealed reduced performance on attention ($\beta = .26, p = .01$), executive function ($\beta = .18, p = .04$), and language ($\beta = .22, p = .01$) were associated with poorer overall adherence. Follow-up analyses showed these cognitive domains were associated with behaviors such as keeping doctor appointments, medication management, and dietary recommendations ($p < .05$ for all).

Conclusion—The current findings demonstrate that cognitive function is an independent contributor to adherence in older adults with HF. Prospective studies that objectively measure treatment adherence are needed to clarify these findings and identify possible strategies to improve outcomes in this population.

Keywords

attention; executive function; heart failure; treatment adherence; cognitive impairment

1. Introduction

Heart failure (HF) has reached epidemic proportions in the United States. HF affects nearly six million Americans and an estimated 660,000 new cases of HF are diagnosed each year (1,2). Indeed, HF is a major public health and economic burden costing the United States an estimated \$35 billion a year (2). HF is also the most common reason for rehospitalization (3), and is associated with elevated rates of mortality (4,5) and reduced quality of life (6).

Poor treatment adherence is common among persons with HF (7–9), including difficulties adhering to medication regimens (23) and dietary and exercise recommendations (10,11). Inability to adhere to treatment plans is not surprising in this population, as HF patients are often asked to manage complex treatment regimens, including management of medications, symptom monitoring, dietary and fluid restrictions, and structured exercise training (12–15). In turn, poor treatment adherence is a significant contributor to re-hospitalization and reduced health outcomes in HF patients (16,17). For example, poor adherence to health care regimen among HF patients is associated with greater hospitalization, worsening HF symptoms (18–22), and increased risk of all-cause mortality (23).

Past work has identified a growing number of medical and demographic factors that contribute to poor adherence. Medical factors include HF severity, sensory impairment (24,25), depression and anxiety (26,27), comorbid conditions (28–30), fatigue (31,32) and previous hospitalization (33,34). Demographic variables such as older age (31), lower education and socioeconomic status (10,18,35), and reduced health literacy (36) have also been linked to poorer treatment adherence.

It seems likely that cognitive impairment also adversely affects the ability of HF patients to adhere to treatment protocols. HF patients are at elevated risk for Alzheimer's disease and up to as many as 75% of HF patients have been shown to exhibit cognitive impairment on testing (37–39). Specifically, relative to controls HF patients commonly exhibit impairments in a range of cognitive functions, including attention, executive function, language and memory (40–42). Impairments are not limited to single domains, as many HF patients (i.e., >20%) demonstrate deficits in multiple areas of cognitive function, with increasing HF severity associated with elevated risk of cognitive deficits (40). Although unclear, past work suggests that HF patients are at increased susceptibility of cognitive impairment as a result of the pathophysiological effects of cerebral hypoperfusion (43). Indeed, reductions of cerebral blood flow in this population have been linked with greater neuropathology, including white matter hyperintensities (44). However, medical comorbidity may also play a role in the development of cognitive impairment in this population, as comorbid hypertension, diabetes, history of myocardial infarction, depression, and anxiety are prevalent and have each been linked with cognitive dysfunction in patients with HF (39, 41, 45–48).

Given the prevalence of cognitive impairment and neuropathological changes associated with HF, it is not surprising that HF patients have difficulty with self-care and treatment adherence. Cognitive impairment is associated with poor adherence among other medical

populations, including HIV patients (49,50), hypertensive elderly (51), and patients with diabetes mellitus (52). Moreover, cognitive impairment among older adults with HF has been linked with other poor outcomes, including decreased functional independence (53), reduced health related quality of life (54), and increased risk of mortality (55).

Despite these findings, little is known about the relationship between cognitive impairment and adherence to recommended health behaviors among older adults with HF. The current study examined whether cognitive functioning was independently associated with poorer self-reported adherence to treatment recommendations. Specifically, we examined whether attention/executive function, memory, and language were independently associated with HF patients' reported ability to adhere to health recommendations common to this condition, including keeping doctor appointments, medication management, dietary restrictions, exercise regimens, and abstaining from smoking and alcohol. On the basis of the prevalence of cognitive impairment in HF patients and previous findings demonstrating a link between cognitive dysfunction and poor adherence rates among other medical populations, we hypothesized that HF patients with greater deficits in cognitive function would exhibit reduced ability to adhere to key self-care behaviors unique to HF management.

2. Methods

2.1 Participants

A sample of 149 consecutive persons with HF was selected from an NIH funded study on cognitive function in HF (NIH study HLO89311). Data collection for this study has been ongoing since January 2009. Participants were recruited from primary care and cardiology practices at Summa Health System in Akron, Ohio, and reflect the HF population receiving treatment at that facility. The inclusion criteria were age of 50–85 years, English as a primary language, and a diagnosis of New York Heart Association (NYHA) class II or III at the time of enrollment. NYHA history was confirmed by medical record review. NYHA is one of the most commonly used systems to classify symptoms of heart disease and is based on the following scale: 1) no limitation of physical activity; 2) slight limitation of physical activity, and ordinary physical activity may result in adverse symptomatology; 3) marked limitations of physical activity and less than ordinary physical activity results in adverse symptomatology; and 4) inability to perform physical activity without discomfort and symptoms may occur at rest (56). Despite such inclusion criteria, left ventricular ejection fraction (LVEF) was ascertained for each participant through medical record review to better characterize the sample. The current sample of HF participants had an average LVEF of 41.04 (SD = 14.75)

Strict inclusion/exclusion criteria were chosen for entry into the NIH funded study to maximize generalizability to other samples and to capture the independent contribution of HF on cognitive function. Thus, participants of the current study met all criteria for parent study entry. Potential participants were excluded for a diagnostic history of significant neurological disorder (e.g. stroke, transient ischemic attack, epilepsy, multiple sclerosis, Parkinson's disease, Alzheimer's disease), head injury with >10 minutes loss of consciousness, severe psychiatric disorder (e.g. schizophrenia, bipolar disorder), substance abuse/dependence (i.e., alcohol and/or illicit drug abuse/dependence), and renal failure. A diagnostic history of all exclusionary conditions was confirmed through a medical record review. In addition to these criteria for entry into the NIH parent study, the current analyses also excluded participants (n = 3) who exhibited a profile on neuropsychological testing consistent with dementia (i.e., namely, scores of 0 on any of the California Verbal Learning Test-II indices). Participants averaged 68.08 (SD = 10.74) years of age, 36.9% were women, and 80.5% white, 14.1% African American, and 5.4% Native American/Alaskan Eskimo. See Table 1 for demographic and medical information.

2.2 Measures

2.2.1. Treatment Adherence—Treatment adherence was assessed using the Heart Failure Compliance Questionnaire (10). The Heart Failure Compliance Questionnaire begins with the following instruction, “This survey asks for your view about how well you follow your medical treatments.” The questionnaire then asks participants to rate their adherence to six different health behaviors, including keeping doctor appointments, medication management, adherence to dietary recommendations, following exercise regimens, and smoking and alcohol abstinence. Specifically, participants were asked to rate their adherence to keeping doctor appointments in the past three months, and adherence to medication management, dietary recommendations, exercise regimens, and smoking and alcohol abstinence in the past week. As an example, for medication management the questionnaire asks, “In the past week, would you estimate that you have taken your medications...” Participants then rated their adherence to each of these health behaviors based on a scale of 0 (none of the time) to 4 (all of the time). Scores for alcohol and smoking are reversed due to negative phrasing of the questions. All scores were converted to a 0 to 100 scale and the mean score of the six health behaviors was conducted to obtain an overall adherence composite. A score of 75% or greater for the overall adherence composite and for each of the individual health behaviors was indicative of being compliant (i.e., participants responded to adhere most of the time or all of the time) (10). Content validity of this questionnaire has been established using a panel of expert nurses in HF, behavioral nurse scientists, and other experts in psychosocial and sociological research (10).

2.2.2 Neuropsychological Measures—All neuropsychological tests used in the current study demonstrate good psychometric properties, including excellent reliability and validity. Given previous work demonstrating that HF patients commonly exhibit impairments in attention, executive function, memory, and language (40–42) the following neuropsychological tests were administered to assess cognitive function in the current sample:

- Attention: Trail Making Test A (57), Digit Symbol Coding (58),
- Executive function: Trail Making Test B (59), Letter Number Sequencing (LNS) (60), Stroop Color Word Interference Effect (61,62).
- Memory: The California Verbal Learning Test-II (CVLT-II) short delay free recall, long delay free recall, and total recognition hits (63).
- Language: Boston Naming Test (BNT) (64), and Animal Fluency (65).

2.2.3 Demographic, Medical, and Psychosocial History—Medical comorbidity, along with other demographic and medical characteristics, was collected through a review of participants’ medical charts and self-report. Specifically, to characterize the sample and corroborate self-report, a medical record review was conducted for all participants to ascertain a diagnostic history of hypertension, diabetes, myocardial infarction, elevated cholesterol, coronary artery bypass graft surgery (CABG), depression, and anxiety. Multi-comorbidity adversely affects treatment adherence in HF patients (27–30), and therefore, prevalent comorbid conditions in HF that have been linked with cognitive function served as covariates in the current analyses to control for the effects of medical comorbidity on treatment adherence. These conditions include: hypertension, diabetes, myocardial infarction, depression, and anxiety. Refer to Table 1.

2.2.4 HF Severity—Left ventricular ejection fraction (LVEF) was used in the current study to assess HF severity. LVEF for each participant was obtained through a review of participant’s medical charts at Summa Health System. LVEF served as a covariate in the

current analyses, as previous work has shown HF severity to be a determinant of self-care behaviors in this population and is associated with cognitive function (40,66).

2.3 Procedures

The Kent State University and Summa Health System Institutional Review Board (IRB) approved the study procedures, and all participants provided written informed consent prior to study enrollment. Participants completed demographic, medical and psychosocial self-report measures, including the Heart Failure Compliance Questionnaire. A medical record review was also performed to corroborate self-report. A trained research assistant administered a brief neuropsychological test battery to all heart failure participants to assess attention, executive function, memory, and language. All testing was performed in a clinical examination room at Summa Health System—the study location of the larger NIH study from which the current participants were selected.

2.4 Statistical Analyses

All neuropsychological raw test scores were screened for outliers prior to analyses and there were no violations in normality. To facilitate clinical interpretation, all raw scores of the neuropsychological measures assessing cognitive function were transformed to T-scores (a distribution with a mean of 50, and a standard deviation of 10) using normative data correcting for age. Composite scores for the domains of attention, executive function, memory, and language were means of the T-scores for each test within that domain.

A hierarchical regression analysis with attention, executive function, memory, and language in block 2 and medical and demographic variables in block 1 (i.e., age, gender (0 = female; 1 = male), education, LVEF, and history of hypertension, diabetes, myocardial infarction, depression, and anxiety (0 = negative history; 1 = positive history for all)) was first conducted to determine whether the overarching construct “cognitive function” was associated with treatment adherence. Following this analysis, four separate multiple linear hierarchical regression analyses were performed for each cognitive domain using the overall adherence composite as the dependent variable. For each model, medical comorbidity, demographic, and psychosocial characteristics were entered into the first block, including age, gender, years of education, LVEF, and history of hypertension, diabetes, myocardial infarction, depression, and anxiety. Attention, executive function, memory, and language were individually entered into block 2 creating four separate models. This four model approach was conducted to determine the incremental predictive validity of each cognitive domain on overall HF adherence in the absence of possible multicollinearity among the cognitive variables.

3. Results

Reported Treatment Adherence

The sample averaged 83.95 (SD = 11.59) on the overall adherence composite, and 16.1% of the sample scored < 75% (i.e., were non-adherent). Poor reported adherence was particularly common for dietary (31.5%) and exercise (49.0%) recommendations. The sample reported generally being adherent for keeping doctor appointments (> 90%), taking medications (> 90%), and abstaining from smoking (> 90%) and alcohol (> 90%). See Table 2.

Predictors of Treatment Adherence Among Older Adults with HF

A hierarchical regression analysis was conducted to identify predictors of adherence in the sample of persons with HF. Block 1 with demographic, medical comorbidity, and psychosocial characteristics was significantly associated with overall treatment adherence ($F(9,139) = 2.77$, $R^2 = .15$, $p = .01$). As shown in Table 3, history of myocardial infarction

was significantly associated with reported adherence ($\beta = .23, p = .01$). A trend emerged for education ($\beta = .16, p = .07$) and LVEF ($\beta = .14, p = .10$). Increased education, a positive history of myocardial infarction, and increased LVEF were associated with greater adherence. See Table 3.

Cognitive Function and Treatment Adherence Among Older Adults with HF

The combined effect of the cognitive function variables in block 2 (attention, executive function, memory, and language) had significant incremental validity over demographic and medical characteristics ($F(4,135) = 2.86$, change in $R^2 = .06, p = .03$). However, overall treatment adherence was not significantly associated with the individual cognitive function variables when their mutual inter-relationships are adjusted for: Attention ($\beta = .19, p = .10$), executive function ($\beta = .03, p = .79$), memory ($\beta = -.05, p = .54$), or language ($\beta = .15, p = .11$).

Association between Individual Cognitive Domains and Treatment Adherence

When entered individually in block 2 several domains of cognitive function were significantly associated with overall adherence after controlling for age, gender, education, LVEF, and history of hypertension, diabetes, myocardial infarction, depression, and anxiety, including attention ($\beta = .26, p = .01$), executive function ($\beta = .18, p = .04$), and language ($\beta = .22, p = .01$). Reduced functioning in each domain was associated with poorer adherence. No relationship emerged between memory test scores and adherence ($\beta = .01, p = .91$). See Table 4 for a full summary of hierarchical regressions.

Follow-up partial correlations adjusting for medical comorbidity, demographic, and psychosocial characteristics were conducted to clarify the relationship between neuropsychological measures of attention, executive function, and language with the overall adherence composite. Regarding measures of attention and executive function, overall adherence was significantly associated with Trail Making Test A ($r(138) = .17, p = .04$), Digit Symbol Coding ($r(138) = .23, p = .01$), Letter Number Sequencing ($r(138) = .18, p = .03$). No such pattern emerged for the Stroop Color Word Interference Effect ($r(138) = .08, p = .35$) or Trail Making Test B ($r(138) = .13, p = .13$). In each case, poorer test performance was associated with worse score on the overall adherence composite. In regards to language measures, decreased performance on Animals was significantly associated with poorer overall adherence ($r(138) = .19, p = .03$) and a similar trend emerged for the Boston Naming Test ($r(138) = .16, p = .05$). See also Table 5 for cognitive test performance in the current sample.

Relationship Between Cognitive Function and Health Behavior Adherence

After adjusting for medical comorbidity, demographic variables, and psychosocial characteristics, partial correlations were conducted to examine the relationship between attention, executive function, language ability, and memory with adherence to the six different health behaviors. Poorer attention was significantly associated with decreased adherence to keeping doctor appointments ($r(138) = .29, p < .001$) and medication management ($r(138) = .25, p < .01$). Reduced executive function was also associated with worse adherence to keeping doctor appointments ($r(138) = .29, p < .001$) and a trend emerged for medication management ($r(138) = .15, p = .08$). Poorer language ability was significantly associated with decreased adherence to medication management ($r(138) = .28, p < .01$) and dietary recommendations ($r(138) = .17, p = .04$). Memory performance was not significantly associated with adherence to any of the health behaviors ($p > .05$ for all).

4. Discussion

Although many HF participants in the current sample self-reported adherent behaviors, poor reported treatment adherence was noted for dietary and exercise recommendations. Past studies have identified several medical and demographic predictors of poor treatment adherence among HF patients, including depression (26), medical comorbidity (28–30), and lower education and socioeconomic status (10,18,35). The current study extends these findings by showing that cognitive impairment is also associated with greater reported difficulty in adhering to treatment regimens among persons with HF. Several aspects of these findings merit brief review.

The present study suggests that reduced attention and executive functioning in the sample of HF persons is associated with greater patient reported difficulties adhering to treatment recommendations. Specifically, HF persons with poorer attention and executive functioning reported greater difficulties with medication adherence and maintaining doctor appointments. Consistent with these findings, past work has shown reduced attention and executive functioning is associated with poor treatment adherence (i.e., medication management) among patients with diabetes mellitus and hyperlipidemia (67). Frontal functions (i.e., attention and executive function) of the brain consist of advanced cognitive processes, including planning, organizing, and monitoring behavior (68,69). Frontal brain regions, which mediate these mental abilities, are particularly vulnerable to damage among HF patients as a result of ischemia, infarction, and hypoxemia (70). These pathological changes may place HF patients at risk for poor adherence, due to their need to adapt to multiple lifestyle changes and the complex medication regimen, including the ability to schedule, plan and perform multiple tasks simultaneously (67,71,72). For example, white matter hyperintensities within frontal brain regions are common among HF patients (73) and have been linked with poorer performance on neuropsychological examinations of prefrontal functioning and treatment adherence among hypertensive elderly (74). As such, cognitive function may mediate the relationship between white matter hyperintensities and treatment adherence, though this awaits empirical test. Prospective studies further examining the link between neuropathology, frontal functioning, and treatment adherence in HF patients are needed to validate our findings and identify mechanisms for poor adherence in this population.

The current findings also indicate a possible role for deficits in language functioning in HF patients' difficulty adhering to dietary recommendations and their medication regimens. A possible explanation for this pattern involves health literacy. It is possible that even subtle impairment in language functioning leads to reduced health literacy and an inability to adhere to treatment regimen (i.e., comprehend instructions and medical advice, and articulate health concerns and symptoms) (75). However, a more likely explanation involves executive function. Animal fluency was significantly associated with reduced treatment adherence in the current sample, which is a task commonly defined as a higher-ordered language task (76). Thus, similar to the above, it appears frontal systems functioning extends into the language domain to adversely affect treatment adherence in this population. Future work is needed to clarify the factors that promote and prevent adherence to dietary and exercise recommendations among HF patients, including the degree to which these deficits are reversible.

Though not directly examined in the current study, cognitive functioning may also play an important role in the day-to-day monitoring and management of HF symptoms. As noted above, higher-order mental abilities such as attention and executive function are required for successful self-management, including decision-making and action response to worsening symptoms (32). Symptom monitoring (i.e., fluid overload, edema, shortness of breath,

weight gain) is a significant constituent of HF treatment guidelines, and interpretation and response to symptoms can be traced to the functions of the prefrontal cortex (77). In turn, qualitative work theorizes that optimal functioning of the frontal lobes is necessary for HF patients to make timely decisions about changes in HF symptoms (i.e., dyspnea), and to avoid decompensation and hospitalizations (78). Empirical studies are needed to examine the interaction between frontal functioning and treatment adherence on psychosocial outcomes in HF, including quality of life, rehospitalizations, and mortality. It is possible that some HF patients may have difficulties with both completion of their prescribed regimen, and accurately monitoring their symptoms over time.

Surprisingly, memory was not significantly associated with treatment adherence in the current sample of older adults with HF. The reason for this finding is unclear, as it would be expected that poorer memory performance would impede HF patients' ability to adhere to key treatment regimens. For example, reduced memory has been linked with greater number of missed medical appointments and poorer adherence to medication regimens among other medical populations (79,80). However, there are several potential explanations for our findings. First, past work suggests that memory impairments in heart failure may manifest through interaction with other factors such as older age and low ejection fraction (81). Given the relatively intact ejection fraction of the current sample of HF, it is possible cardiac dysfunction in the current sample was not yet severe enough to produce memory impairments that affect daily functioning. Additionally, limitations of the current study may have also confounded the relationship between memory and treatment adherence. Perhaps most noteworthy, is the use of self-report to assess treatment adherence. For instance, populations with prominent memory deficits (i.e., mild cognitive impairment) tend to over-report their abilities to perform instrumental daily living tasks (82). It is possible that a similar pattern may be occurring in the current sample, and prospective studies examining memory function and treatment adherence using objective measures (i.e., electronic monitoring devices) are needed.

Although patients with greater cognitive impairment reported increased difficulties adhering to treatment regimens (i.e., dietary and exercise recommendations), many of the HF participants in the current study claimed excellent adherence to medication management, keeping doctor appointments, and substance use abstinence (i.e., > 90% for all). Particularly surprising were the elevated rates of reported adherence to medication management in the current sample, as previous work suggests HF patients may be susceptible to medication non-compliance (13,83). In fact, past work showed that HF patients greatly over-estimated their adherence to medication regimens when compared to HF patients whose medication adherence was electronically monitored (84). The exact reason for the higher than expected rates of reported adherence in the current sample is unclear. One possible explanation may involve anosognosia, as other populations with known cognitive dysfunction (i.e., Alzheimer's disease) have been shown to have poor insight into their limited ability to perform activities of daily life (85). Another possibility, related to the above discussion, is that patients have poor understanding of their treatment regimen and mistakenly believe they are correctly adhering to treatment recommendations. It is also possible that participants are knowingly exaggerating their reported levels of adherence, as HF patients self-report of adherence to treatment may be favorably skewed due to patients' tendency to please their clinicians (86). Finally, many patients with HF receive assistance in completing everyday activities as a result of strong social support networks in this population (10). Not surprisingly, increased social support has been identified as a significant predictor of greater treatment compliance among cardiac patients (87,88). Further work is much needed to clarify these and other explanations for the high rates of reported adherence in this sample of HF patients, particularly prospective studies examining cognitive function and objectively measured adherence.

Although mentioned above, the current study's use of self-report to assess treatment adherence presents with limitations and warrants further attention. First, self-report may confound results in any medical population due to factors such as subjectivity, retrospective memory errors, and/or social desirability (89). The limitations of self-report may be further exacerbated in a population with cognitive deficits. For example, patients with cognitive impairment have a tendency to over-report their functional abilities (82) likely a result of unawareness of deficits. In fact, a previous study that assessed treatment adherence in HF patients using both objective and self-report measures found that patients commonly overestimated their adherence rates (i.e., self-report was sensitive to the detection of adherence, though not to non-adherence) (90). Similarly, past studies using objective measures of adherence identified higher rates of poor adherence to medication management than the current study revealed (i.e., 13%-20% were non-adherent) (91,92). Thus, although self-report is inexpensive, feasible, and has been shown to be reliable in assessing treatment adherence (93), future work examining cognitive function and treatment adherence using objective measures is strongly encouraged to validate our findings.

Several other limitations of the current study deserve brief discussion. First, the current study consisted of cross-sectional data, and prospective studies are needed to examine the causal nature between cognitive impairment and treatment adherence among patients with HF. Future studies should also examine the underlying neural mechanisms that produce the cognitive impairments found in persons with HF, including the possible role of white matter hyperintensities on HF patients ability to adhere to treatment recommendations. Additionally, the current study did not examine specific types of HF etiology (i.e., systolic and/or diastolic). Although past research has shown both systolic and diastolic HF to be associated with reduced cognitive functioning (94), future work is needed to identify differences in rates and contributors to treatment adherence among patients with systolic and diastolic HF. Similarly, the current study defined many of the clinical covariates (i.e., anxiety and depression) through diagnostic history. However, current depressive and anxiety symptomatology appear to play a key role in treatment adherence (95), and future studies are needed to clarify the effects of acute and chronic like psychiatric conditions on cognitive function and treatment adherence in HF. Furthermore, our sample was relatively homogenous in race and gender, and future work that examines cognitive function and treatment adherence in larger more diverse samples of HF persons would increase the external validity of our findings. Finally, the present study did not have a control group for comparison on key variables, including neuropsychological test performance and adherence rates. Although previous work has shown HF patients to perform worse on cognitive tests relative to control (40–42), future work should also utilize a control group with HF patients to validate our findings regarding a possible link between cognitive dysfunction and poorer treatment adherence in this population.

In summary, poorer cognitive function is associated with lower reported adherence among older adults with HF. Such findings may help to account for the elevated mortality risk in HF patients with cognitive impairment (55). If replicated, clinician assessment of cognitive function among HF patients may provide key insight into patients' ability to adhere to treatment recommendations. Prospective studies that objectively measure treatment compliance (i.e., electronic monitoring) are much needed to clarify the relationship between cognitive functioning and HF patients' actual ability (as opposed to perceived ability) to adhere to treatment regimens.

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Abbreviations

HF	Heart Failure
LVEF	Left Ventricular Ejection Fraction
NYHA	New York Heart Association

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Table 1

Demographic, Clinical, and Cognitive Characteristics of 149 Older Adults with Heart Failure

DEMOGRAPHIC CHARACTERISTICS	
<i>N</i>	149
Age, mean (SD)	68.08 (10.74)
Years of Education, mean (SD)	13.37 (2.95)
Women (%)	36.9
Race (% white)	80.5
HEART FAILURE SEVERITY	
Overall Sample LVEF, mean (SD)	41.04 (14.75)
MEDICAL CHARACTERISTICS (% Positive Diagnostic History)	
CABG	31.5
Diabetes	34.2
Hypertension	71.8
Elevated Total Cholesterol	69.1
MI	52.3
Depression	21.5
Anxiety	13.4

LVEF = Left Ventricular Ejection Fraction; CABG = Coronary artery bypass graft; MI = Myocardial Infarction

Table 2

Descriptive Statistics of Adherence Behaviors Among 149 Older Adults with HF

Health Behavior	Adherence, mean (SD)	% Below 75
Doctor Appointments	94.80 (16.76)	3.4
Medication Management	96.14 (11.52)	1.3
Dietary Recommendations	69.80 (24.01)	31.5
Exercise Regimens	57.72 (33.12)	49.0
Smoking Absistence	94.13 (21.04)	6.7
Alcohol Abstinence	91.11 (23.62)	7.4
Overall Adherence	83.95 (11.59)	16.1

Note. A score below 75 is indicative of non-adherence.

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Block 1 of the Hierarchical Multiple Linear Regression Models Examining the Predictive Validity of the Demographic and Medical Variables on Overall Adherence (*b*(*SE b*)

Table 3

	Age	Gender	Edu.	LVEF	DM	HTN	MI	Depression	Anxiety	R ²	F
Overall Adherence	.00 (.09)	1.12 (2.03)	.62 (.34)	.11 (.07)	-3.19 (1.98)	-2.73 (2.11)	5.23 (1.85)	-2.21 (2.59)	4.79 (3.01)	.15	2.77
P	.99	.58	.07	.10	.11	.20	.01	.40	.11	--	.01

Abbreviations: Edu = Years of Education; LVEF = Left Ventricular Ejection Fraction; DM = Diabetes Mellitus; HTN = Hypertension; MI = Myocardial Infarction

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Table 4

Hierarchical Multiple Linear Regression Models Examining the Incremental Predictive Validity of Cognitive Function on Overall Adherence (*N* = 149)

Overall Adherence	
	<i>b</i> (<i>SE b</i>)
<u>Model 1 Block 2</u>	
Attention	.34(.12)
<i>R</i> ²	.20
<i>F</i> for ΔR^2	7.90
<i>P</i>	.01
<u>Model 2 Block 2</u>	
Executive Function	.23(.11)
<i>R</i> ²	.18
<i>F</i> for ΔR^2	4.21
<i>P</i>	.04
<u>Model 3 Block 2</u>	
Memory	.01(.10)
<i>R</i> ²	.15
<i>F</i> for ΔR^2	.01
<i>P</i>	.91
<u>Model 4 Block 2</u>	
Language	.23(.09)
<i>R</i> ²	.19
<i>F</i> for ΔR^2	6.49
<i>P</i>	.01

Table 5

Descriptive Statistics of Cognitive Test Performance ($N = 149$)

	Raw Test Performance, mean (SD)	Range of Raw Scores	T-score, mean (SD)
<i>Attention</i>			
TMTA (seconds)	40.69 (14.88)	18 to 113	50.21 (10.45)
Digit Symbol Coding	50.46 (14.16)	18 to 96	47.83 (9.30)
<i>Executive Function</i>			
TMTB (seconds)	127.67 (77.19)	35 to 300	43.45 (19.41)
LNS	8.89 (2.50)	3 to 16	50.76 (9.27)
Stroop Color Word	.10 (7.43)	-21 to 24	50.05 (7.38)
<i>Memory</i>			
CVLT SDFR	7.55 (3.20)	2 to 15	47.65 (10.41)
CVLT LDFR	8.09 (3.26)	1 to 16	47.55 (10.14)
CVLT Recognition	13.60 (2.05)	7 to 16	44.66 (12.15)
<i>Language</i>			
Boston Naming Test	53.54 (5.72)	31 to 60	49.54 (14.64)
Animals	19.54 (5.07)	8 to 34	55.01 (11.28)

TMTA = Trail Making Test A; TMTB = Trail Making Test B; LNS = Letter Number Sequencing; Stroop Color Word = Stroop Color Word Interference Effect; CVLT = California Verbal Learning Test; SDFR = Short Delay Free Recall; LDFR = Long Delay Free Recall