Cognitive Impairment is Independently Associated with Reduced Instrumental ADLs in Persons with Heart Failure

Michael L. Alosco, B.A.[1], **Mary Beth Spitznagel, Ph.D.**[1,2], **Ronald Cohen, Ph.D.**[3], **Lawrence Sweet, Ph.D.**[4], **Lisa H. Colbert, Ph.D.**[5], **Richard Josephson, M.D.**[6,7,8], **Donna Waechter, Ph.D.**[2], **Joel Hughes, Ph.D.**[1,2], **Jim Rosneck, M.S.**[2], and **John Gunstad**[1,2]

[1]Department of Psychology, Kent State University, Kent, OH, USA

[2]Department of Psychiatry, Summa Health System, Akron City Hospital, Akron, OH, USA

[3]Department of Cardiology, Rhode Island Medical Center, Providence, RI, USA

[4]Department of Psychiatry and Human Behavior, Brown Medical School, Providence, RI, USA

[5]Department of Kinesiology, University of Wisconsin, Madison, WI, USA

[6]University Hospitals Case Medical Center and Department of Medicine, Cleveland, OH, USA

[7]Harrington-McLaughlin Heart & Vascular Institute, Cleveland, OH, USA

[8]Case Western Reserve University School of Medicine, Cleveland, OH, USA

Abstract

Background—Heart failure (HF) is a disabling disease that often affects instrumental activities of daily living (instrumental ADLs). Despite high rates of disability in this population, little is known about the effects of cognitive impairment on instrumental ADLs in this population.

Objective—The current study examined whether cognitive functioning predicts instrumental ADL performance in persons with HF.

Participants and Methods—Persons with HF (N = 122; 68.49±9.43 years; 35.2% female) completed neuropsychological testing, fitness assessment, and self-reported instrumental and basic ADL function as part of a larger protocol. Neuropsychological tests included the Mini Mental State Examination and Trail Making Test A and B. The 2-minute step test estimated fitness. Instrumental and basic ADL function was based on self-report on the Lawton-Brody Activities of Daily Living Scale. Hierarchical regression analyses were used to determine the independent contribution of cognitive function to ADLs in HF.

Results—HF patients reported high rates of impairments in instrumental ADLs, though indicated requiring little or no assistance with basic ADLs. Cognitive function showed incremental predictive validity for driving (R^2 change = .07, p = .03) and medication management (R^2 change = .14, p<.001). In each case, poorer neuropsychological test performance was associated with poorer instrumental ADL function.

Address Correspondence to: Michael Alosco, B.A., Department of Psychology, Kent State University, Kent OH USA 44242; Phone 203-417-1892; Fax 330-672-3786; M.Alosco@gmail.com.

Conclusion—In persons with HF, cognitive performance is an independent predictor of independence in driving and medication management. Strategies to maintain or improve cognitive functioning in HF may help patients remain functionally independent in their daily living.

Keywords

heart failure; cognitive function; activities of daily living; aging

1. Introduction

Heart failure (HF) is a chronic disease that affects over five million people in the United States (1). With the increased proportion of older adults and high cardiovascular risk in the United States, the prevalence of HF is expected to quadruple in the next 30 years (2).

Persons with HF are at elevated risk for reduced ability to independently care for themselves. Clinical assessment of activities of daily living (ADLs) provides information regarding functional independence (3). ADLs are categorized into basic ADLs and instrumental ADLs. Basic ADLs include activities such as bathing, dressing, toileting and feeding (3). Instrumental ADLs include more complicated tasks that are required for independent living, including shopping (3), household chores (4) and medication management (5–6).

Impairments in instrumental ADLs, particularly medication management and transportation, are linked to higher risks of disability, rehospitalization, diminished quality of life and admission to geriatric wards (7–9). Within persons with HF, several predictors of reduced instrumental ADL function have been identified. HF patients who are older and are female experience the highest rates of disability in their daily living (10–11). Depression is common in persons with HF (12) and also associated with reduced independence in instrumental ADLs (13). Fatigue is also common and exacerbated by depressive symptoms and adversely impacts patients' ability to complete instrumental ADLs (14–15).

Though not discussed in the literature, another likely contributor to reduced functional independence in persons with HF is cognitive impairment. Cognitive impairment is associated with reduced ADLs in a wide range of conditions, including Type 2 diabetes, multiple sclerosis, Alzheimer's disease, and bipolar disorder (15–20).

An estimated 25% to 74% of patients with HF exhibit cognitive impairment (21, 22). Though the complete mechanisms have not been fully determined, reduced cardiac perfusion can lead to cerebral oxygen deprivation (23–24), ultimately frontal and temporal regions (25–26). This pattern is consistent with the observed deficits in executive function, attention, memory, and psychomotor speed found in this population (23, 26).

As discussed above, deficits in these cognitive abilities are known predictors of reduced instrumental ADL function in other populations (18–19), though no study has examined this possibility in persons with HF. We examined reported ADL function and neuropsychological test performance in a sample of HF outpatients and hypothesized that poorer cognitive function would be associated with greater ADL impairment, particularly on instrumental ADLs after adjusting for age, sex, depression, and cardiovascular fitness.

2. Methods

2.1 Participants

The current analyses consisted of 122 persons with HF (35.2% female) selected from a database of a large-scale NIH funded research study that examined the cognitive benefits of cardiac rehabilitation (CR) in HF patients. Retrospective observational analyses were conducted on the first 122 consecutive cases that completed the baseline neuropsychological assessment and had complete data. Participants were recruited from Summa Health System in Akron, Ohio, and reflect the HF population receiving treatment at that facility. For inclusion, participants were between the ages of 50–85 years of age, English-speaking, and had a diagnosis of New York Heart Association (NYHA) HF class II or III at the time of enrollment. Potential participants were excluded for history of significant neurological disorder (e.g. dementia, stroke), head injury >10 minutes loss of consciousness, severe psychiatric disorder (e.g. schizophrenia, bipolar disorder), substance use, renal failure, and sleep apnea. Participants averaged 68.49 ± 9.43 years of age, were 35.2% female, and 9.1% minority. See Table 1 for participant demographic and medical characteristics.

2.2 Measures

2.2.1 Activities of Daily Living—The Lawton Brody Activities of Daily Living Scale was used to assess the patient's performance of instrumental and basic ADLs. Basic ADLs include feeding, dressing, grooming, bathing, toileting, and ambulation. Instrumental ADLs include transportation, traveling, management of finances, telephone use, meal preparation, housekeeping, laundry, shopping, and medication maintenance. Basic ADL scores range from 0 to 12 and instrumental ADL scores range from 0 to 16 yielding an overall range between 0–28 with higher scores reflecting greater functional independence (27). Any response that indicated receiving assistance was deemed impaired on that activity.

2.2.2 Cognitive Functioning—Cognitive functioning was assessed using the Mini-Mental State Examination (MMSE), Trail Making Test A and Trail Making Test B. The MMSE was used to assess global cognitive status. It is a brief (5–10 minute) screening measure that is commonly used to provide an estimate of global cognitive function, tapping aspects of attention, orientation, memory, language, and calculation (28). Higher score on the MMSE is reflective of better global cognitive functioning (28). The psychometric properties of the MMSE are strong within a medical based population with a test-retest reliability ranging from $r = .80$ to $.95$ and an internal consistency of $r = .96$ (28,29). Trail Making Test A has individuals rapidly draw a line connecting numbered circles (30). Completion time is a reliable and valid measure of attention, complex visual scanning and psychomotor speed (31). Test-retest reliability is estimated at $r = 0.79$ (32). Trail Making Test B asks individuals to quickly connect alternating numbers and letters (30). Test completion time is a widely used measure of executive function, with strong psychometric properties (e.g. test-retest reliability up to $r = 0.89$) (31–32). For both Trail Making Test A and Trail Making Test B longer time of completion is indicative of worse performance. Trail Making Test A and B are both valid measures for the purposes of this study as they have previously been shown to predict instrumental ADLs in community-dwelling and cognitively impaired older adults (33–34).

2.2.3 Depressive Symptoms—Depression was assessed through the administration of the Beck Depression Inventory-II (BDI-II). The BDI-II is a commonly used measured of depressive symptoms with psychometric properties in persons with medical conditions (35). The BDI-II has been shown to have excellent internal consistency with item correlations ranging from $r = .54$ to $.74$ (35), in addition to test-retest reliability ranging from $r = .93$ to $r = .96$ (36). Additionally, evidence for divergent validity of the BDI-II is exemplified by its

negative correlation of $r = -.10$ to $r = -.46$ with measures of happiness, ego strength, and boldness (37). The BDI-II is commonly used in HF samples and is associated with increased risk of mortality in this population (38). Higher score on the BDI-II is indicative of increased depressive symptomatology.

2.2.4 Cardiovascular Fitness—Cardiovascular endurance was assessed with a 2-minute step test (39). The 2-minute step test requires the patient to march in place for 2 minutes. The patient is asked to bring each knee up to a marked target on the wall which is set at each individual's own midpoint between their hip and knee. The number of times the right knee met this point was counted. Increased step count within the 2-minutes was reflective of greater cardiovascular fitness.

2.2.5 Demographic and Medical History—Demographic characteristics and medical history were collected through a review of the medical charts and through self-report. Refer to Table 1.

2.3 Procedures

The local Institutional Review Board (IRB) approved the study procedures and all participants provided written informed consent prior to study enrollment. Data was stored and analyzed at Kent State University. Specifically, participants completed demographic, medical and psychosocial self-report measures, including ADL function and depression. A brief neuropsychological examination was conducted on all HF participants, including MMSE and Trail Making Test A and B to assess global cognitive function, attention, psychomotor speed, visual scanning, and executive function.

2.4 Statistical Analyses

A separate hierarchical multiple linear regression model was performed for each ADL (basic and instrumental) endorsed by >5% of study participants and those ADLs closely related to disability of HF patients in past studies (i.e. driving, medication management, finances). For each analysis, the demographic and medical predictors, which include participant age, sex, depression (as assessed by the Beck Depression Inventory-II), and fitness, were entered in the first block of the model. The measures of cognitive functioning (MMSE, and Trail Making Test A and B) were entered into the second block of the regression model. The method of entering the medical and demographic variables in block 1, and the cognitive functioning measures in block 2 was conducted to demonstrate that cognitive functioning explains some of the variance in the dependent variable (ADLs) that is not accounted for by the demographic and medical characteristics. Change in R^2 from block 1 to block 2 was examined to determine the significance of the incremental predictive validity of cognitive function over the demographic and medical predictors.

3. Results

Reported ADL function

Overall ADL scores were high with a mean of 25.19 out of a possible 28. However, HF patients in the current study frequently reported receiving assistance with more complex tasks. In terms of instrumental ADLs, 37.7% reported receiving assistance with laundry, 34.4% with housekeeping, 31.1% with food preparation, and 26.2% with shopping. In terms of those instrumental ADLs of particular interest, 5.7% reported receiving assistance with driving, 7.3% medication management, and 12.3% with financial matters.

Consistent with expectations, the sample of HF outpatients reported requiring little or no assistance with basic ADLs. Although 15.6% reported some limitations with ambulation, no

other activity was endorsed by more than 4% of participants. See Table 1 for means and standard deviations for all ADLs.

Predicting Reported ADL function

A series of regressions were conducted to identify predictors of ADL impairment in the sample of persons with HF. As shown in Table 2, demographic and medical characteristics predicted ability to complete a number of basic and instrumental ADLs. Being female was associated with better function in housekeeping, food preparation, and laundry. Better fitness (measured by the 2 minute step test) was associated with better ability to ambulate, drive, and housekeeping.

Cognitive Function as Independent Predictor of Reported ADL function

Hierarchical regression analyses adjusting for demographic and medical variables revealed that demographic variables remained important predictors of ADL function. However, as shown in Table 3, poorer cognitive test basic was associated with reduced independence in driving and medication management.

4. Discussion

Consistent with past work, risk factors such as demographic/medical characteristics and cardiovascular fitness predicted instrumental ADL impairment in persons with HF (10–11). Analyses also extend existing literature and demonstrate that cognitive function is an independent contributor to self-perceived instrumental ADL function in persons with HF, including medication management and driving. Several aspects of these findings warrant brief discussion.

Impairments in self-reported instrumental ADLs are common among HF patients. The current results shows that HF patients frequently reported receiving assistance with laundry, housekeeping, food preparation and shopping. As our sample is predominantly older adult males, impairments in these particular instrumental ADLs may be at least partly attributable to gender roles (as suggested in other populations; 3). However, given that these activities require physical exertion, it is also possible that the reported assistance actually represents a decline in function in some participants. Prospective studies are needed to better clarify the rate and nature of change of reported instrumental ADL function in persons with HF.

As in past studies, medical/demographic predictors of ADL impairment in the current study include gender and cardiovascular fitness (10–11). Persons with poorer cardiovascular fitness reported greater difficulty with ambulation, driving, and housekeeping activities. This finding is not surprising given the physical exertion required for completing these activities, or, in the case of driving, associated with them. However, these results highlight the many spheres of functioning that are adversely impacted by HF and encourage work to investigate whether improved fitness in persons with HF could ultimately alleviate ADL impairment.

An important finding of the current study is showing that cognitive function is an independent predictor of self-reported instrumental ADL function in persons with HF. Specifically, persons with poorer cognitive test performance reported greater difficulty with medication management and driving. Finding that cognitive function predicts these activities is noteworthy, as they are closely linked to re-hospitalizations and admissions to geriatric wards (40–42). Given that HF is the leading reason for readmissions (7) and lack of medication adherence being an important contributor to these stays (43), a better understanding of the role of cognitive function in HF outcomes is much needed.. For example, non-adherence to medication regimen is common among cognitively impaired patients (44) and may be attributable to executive dysfunction. Findings from neurological

samples indicate that difficulties in executive function, which includes planning, organizing, and monitoring of behavior, can lead to disability (18–19). Executive dysfunction is common in persons with HF (26) and further work is needed to determine its specific contribution to functional impairment in this population. Similarly, future studies will determine whether intervention to improved cognitive function leads to better outcomes, as improved cognitive functioning is linked to greater functional outcomes and better quality of life (45) in other samples.

The current findings are limited in several ways. Future studies are needed to more clearly determine the extent and nature of instrumental and basic ADL impairment in persons with HF, particularly studies that involve a combination of self-, informant-, and objectively-assessed measures of ADL impairment. Work examining other populations suggests that persons at risk for cognitive dysfunction often underreport their actual level of impairment (46–47) and a combination of assessment approaches would minimize this concern. Future studies should also clarify the impact of gender and gender roles on ADL function in this population. The current findings and past work identify gender as an important predictor of instrumental ADL function, though little is known about the degree to which impairments on some activities (e.g. laundry, housekeeping) reflect a lifelong behavior or an actual decline in function. For the number of variables being examined in the current study a larger sample size would be beneficial as to increase the power of analyses and allow for a more representative sample of older adults with HF. Finally, longitudinal studies of cognitive functioning in HF will help determine the factors that predict decline in instrumental ADL function at early stages. Such information could be used to better coordinate treatment options in this population.

In brief summary, the current results indicate high rates of impaired instrumental ADLs in persons with HF and demonstrate that cognitive impairment is an independent predictor of important tasks like medication management and driving. Regular screening for cognitive impairment in this population may provide useful information concerning patients' ability to perform important self-care behaviors such as medication management.

Summary and Implications

- Impairments in instrumental activities of daily living are common among heart failure patients

- Poorer cognitive function is associated with self-reported difficulties in driving and medication management

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Table 1

Demographic and Clinical Characteristics of 122 Older Adults with Heart Failure.

Demographic Characteristics	
N	122
Age, mean (SD)	68.49 (9.43)
Female (%)	35.2
Race (% Caucasian)	89.3
Medical Characteristics (%)	
CABG/Bypass Surgery	34.4
Diabetes	32.8
Hypertension	66.4
Cholesterol	64.8
MI	54.1
Heart Surgery	3.3
Test Performance, mean (SD)	
MMSE	27.70 (1.80)
TMTA	39.01 (13.46)
TMTB	115.79 (58.17)
2 Minute Step-test	61.48 (21.31)
BDI-II	7.65 (7.15)
ADL, mean (SD)	
Telephone Use	1.98 (.20)
Shopping	1.68 (.58)
Food Preparation	1.46(.84)
Housekeeping	1.61(.57)
Laundry	1.26(.96)
Transportation	1.94(.23)
Medication Management	1.91(.34)
Finances	1.79(.59)
Toileting	1.97(.18)
Feeding	1.98(.13)
Dressing	1.98(.16)
Grooming	1.96(.20)
Ambulation	1.84(.36)
Bathing	1.99(.09)
Instrumental ADL	13.61 (2.89)
Basic ADL	11.69 (.77)
Total ADL	25.19 (3.41)

CABG = Coronary artery bypass graft; MI = Myocardial Infarction; MMSE = Mini Mental State Examination; TMTA = Trail Making Test A; TMTB = Trail Making Test B; BDI-II = Beck Depression Inventory-II; ADL = Activities of Daily Living

Table 2

Block 1 of the Hierarchical Multiple Linear Regression Model Examining the Predictive Validity of the Demographic and Medical Variables on ADL Performance

Variable	Ambulation			Driving			Finances			Food Prep.			Housekeep			Laundry			Meds			Shopping		
	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Age	.01	.00	.15	.00	.00	.05	.00	.01	.06	−.01	.01	−.06	.01	.01	.14	−.02	.01	−.15	.00	.00	.21	.00	.01	.10
Sex	.02	.06	.03	−.02	.05	−.04	.30	.11	.23	.63	.15	.36**	.36	.10	.30**	.70	.17	.35**	.09	.07	.12	.21	.11	.17
2Min	.01	.00	.34*	.00	.00	.22*	.00	.00	.08	.00	.00	.06	.00	.00	.18*	.00	.00	−.03	.00	.00	.05	.01	.00	.18
BDI-II	−.01	.00	−.26	−.01	.00	−.16	.01	.01	.06	−.01	.01	−.07	−.01	.01	−.10	−.01	.01	−.08	.00	.01	.02	−.01	.01	.08
R^2	.22**			.09*			.06			.14*			.13*			.15**			.02			.07		

Notes:

* denotes $p < 0.05$;

** denotes $p < .001$

2Min = 2 Minute Step-test; BDIII = Beck Depression Inventory-II; Meds = Medications

Table 3

Hierarchical Multiple Linear Regression Model Examining the Incremental Predictive Validity of Cognitive Function on ADL Performance

Variable	Medications			Driving			Finances		
	B	**SE B**	**β**	**B**	**SE B**	**β**	**B**	**SE B**	**β**
Age	.01	.00	.21*	.00	.00	.08	.01	.01	.14
Sex	.08	.06	.12	−.01	.04	.02	.30	.11	.25**
2Min	.00	.00	−.10	.00	.00	.18	.00	.00	.00
BDI-II	.00	.01	.07	.00	.00	−.08	.01	.01	.09
MMSE	.01	.02	.05	−.03	.01	−.25**	.02	.03	.06
TMT-A	−.01	.00	−.24*	.00	.00	−.18	.00	.00	−.02
TMT-B	.00	.00	−.18	.00	.00	.17	.00	.00	−.19
R^2	.12*			.19*			.10		
F for ΔR^2	4.51*			4.52*			1.45		

Notes:

*
denotes p<0.05;

**
denotes p<.001

2Min = 2 Minute Step-test; BDI-II = Beck Depression Inventory-II; MMSE = Mini Mental State Examination; TMT-A = Trail Making Test A; TMT-B = Trail Making Test B