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Reduced Cognitive Function Predicts Functional Decline in Patients with Heart Failure over 12 months

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Abstract

Background—Impaired activities of daily living (ADL) are common in heart failure (HF) patients and contribute to the elevated mortality and hospitalization rates in this population. Cognitive impairment is also prevalent in HF, though its ability to predict functional decline over time is unknown.

Aims—This study examined the longitudinal pattern of activities of daily living in HF persons and whether reduced baseline cognitive status predicts functional decline in this population.

Methods—110 persons with HF completed the Lawton-Brody Activities of Daily Living Scale and were administered the Modified Mini-Mental Status Examination (3MS) at baseline and a 12-month follow-up. Three composite scores were derived from the Lawton-Brody, including total, instrumental, and basic ADLs.

Results—HF patients reported high rates of baseline impairments in instrumental ADLs, including shopping, food preparation, housekeeping duties, laundry, among others. Repeated measures analyses showed significant declines in total and instrumental ADLs from baseline to the 12-month follow-up in HF ($p < .05$). Hierarchical regression analyses showed that poorer baseline performance on the 3MS predicted worse total ADL performance at 12-months ($\beta = .15$, $p = .049$), including greater dependence in shopping, driving, feeding, and physical ambulation ($p < .05$ for all).

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Conclusion—The current results show that HF patients report significant functional decline over a 12-month period and brief cognitive tests can identify those patients at highest risk for decline. If replicated, such findings encourage the use of cognitive screening measures to identify HF patients most likely to require assistance with ADL tasks.

Keywords

Heart failure; activities of daily living; cognitive function; functional decline

1. Introduction

Heart failure (HF) currently affects nearly 6 million Americans and is associated with increased mortality risk, recurrent hospital admission, and poor quality of life [1,2}. Nearly 80% of HF patients also require assistance in completing activities of daily living (ADL), including help with housekeeping duties (e.g., cooking, cleaning), shopping, driving, and management of medications and finances [3,4]. This pattern is troubling, as impaired ability to perform ADLs, particularly medication management, is a significant contributor to mortality risk, disability, re-hospitalization, and admission to geriatric wards in this population [5,6].

Past studies have begun to identify risk factors for reduced ADL function in HF, including older age, being female, dyspnea, reduced muscle strength, fatigue, and depression [7-9]. Cognitive impairment is also likely a significant contributor to decreased independence in ADL performance in HF. HF is associated with increased risk for neurological changes (e.g., Alzheimer's disease) and up to 75% exhibit milder impairments on cognitive tests assessing global cognition, attention, executive function, and memory [10,11]. Such impairments have been linked with reduced ADL performance in other medical and neurological populations (e.g., Alzheimer's disease, diabetes) [12].

A recent study found that poorer performance on a brief screening measure of global cognitive status was associated with reduced ADL performance in a sample of older adults with HF [4]. However, no study has examined whether cognitive screening measures (e.g., Modified Mini Mental State Examination; 3MS) can identify HF patients at highest risk for ADL decline over time. We hypothesized that ADLs would significantly decline over time in older adults with HF and cognitive impairment would predict accelerated ADL decline in this population.

2. Methods

2.1 Participants

The sample consisted of 110 persons with HF recruited for a larger longitudinal NIH-funded research study examining the effects of cardiac rehabilitation (CR) on neurocognitive function in older adults with HF. As part of the larger study's protocol, a control group of HF participants were recruited from outpatient cardiology clinics that were not enrolled in CR. All participants completed cognitive and psychosocial assessments at baseline and 12-month follow-up. The current sample consisted of 110 HF patients not enrolled in CR that completed the assessments at each time point. This sample size of 110 was derived following exclusion of participants due to missing data across time points and/or lost to attrition across the 12-month period due to factors such as failure to meet exclusion criteria at the follow-ups (n = 2), death (n = 4), poor health (n = 4), drop-outs (n = 8), lost to follow-up (n = 3), and/or failure to complete follow-up in a reasonable amount of time (n = 2).

Strict inclusion/exclusion criteria for the larger study were implemented that was assessed through participant self-report and corroborated by medical record review. For inclusion, participants must have been between the ages of 50-85 years, English speaking, and had a diagnosis of New York Heart Association (NYHA) HF class II, III, or IV at the time of enrollment. Potential participants were excluded for a history or current diagnosis of a significant neurological disorder (e.g. dementia, stroke), head injury >10 minutes loss of consciousness, severe psychiatric disorder (e.g. schizophrenia, bipolar disorder), substance abuse/dependence, and/or renal failure.

2.2 Measures

2.2.1 Activities of Daily Living—The self-report version of the Lawton Brody Activities of Daily Living Scale was used to assess basic and instrumental ADLs [13]. Instrumental ADLs include complex activities such as transportation, traveling, management of finances, telephone use, meal preparation, housekeeping, laundry, shopping, and medication maintenance. Basic ADLs include feeding, dressing, grooming, bathing, toileting, and ambulation. Instrumental ADL scores range from 0 to 16, while, basic ADL scores range from 0 to 12, yielding an overall range between 0-28. Any response that indicated receiving assistance was deemed impaired on that activity and a higher total score signifies more intact functionality [13]. Total ADLs consisted of the sum of instrumental and basic ADLs. The Lawton Brody scale demonstrates strong inter-rater reliability ($r = .85$), and concurrent validity with other measures of functional status that assess physical health, orientation and memory, behavioral and social adjustment, and ADLs [14].

2.2.2 Cognitive Function—The Modified Mini Mental State Examination (3MS) was used to assess global cognitive status. It is a widely used and validated brief screening measure that assesses aspects of attention, orientation, memory, language, and calculation [15]. Scores on this measure range from 0-100 with higher scores reflective of better performance. The 3MS is distinct from other brief cognitive screening measures (e.g., MMSE) as it taps into aspects of executive function. This is advantageous in a HF population, as patients with HF commonly exhibit impairments on cognitive tests assessing executive and other frontal systems function (e.g., attention) [16].

2.2.3 Demographic and Medical History—Demographic and medical characteristics were ascertained through participant self-report and medical record review.

2.3 Procedures

The local Institutional Review Board (IRB) approved the study procedures and all participants provided written informed consent prior to study enrollment. During a baseline assessment, participants completed demographic and psychosocial self-report measures, including the Lawton Brody Activities of Daily Living Scale. Participants were also administered the 3MS to assess global cognitive status and then completed other study procedures. This protocol was repeated at 12-month follow-up to examine possible changes over time.

2.4 Statistical Analyses

Three separate repeated measures analysis of covariance (ANCOVA) were performed to examine instrumental, basic, and total ADL performance over time (i.e., baseline and 12-month follow-up). Age, sex, and diagnostic history of depression, hypertension, and diabetes were included as covariates in order to account for their known influence on ADLs. For instance, past work shows that patients with diabetes, hypertension, and/or depression are at increased risk for disability and decline in ADLs [17-19]. A hierarchical regression analysis was then performed to determine the predictive validity of the 3MS for 12-month total ADLs. Specifically, block 1 contained baseline ADL performance and medical and demographic variables, including age, sex (1 = male; 2 = female), and diagnostic history of depression, hypertension, and diabetes (1 = positive diagnostic history; 0 = negative diagnostic history). Baseline 3MS performance was then entered in block 2 to determine its incremental predictive validity for 12-month total ADL performance. This same regression model was then performed to clarify the effects of the 3MS on specific instrumental and basic ADLs.

Finally, follow-up analyses were conducted to examine whether change in 3MS performance corresponds with ADL function over time. Specifically, partial correlation analyses controlling for baseline 3MS performance, baseline ADL function, and the above medical and demographic factors examined the association between change scores in 3MS with 12-month basic, instrumental, and total ADL function.

3. Results

Medical and Demographic Characteristics

Participants averaged 69.87 (SD = 9.12) years of age, were 36.4% female, and 84.5% Caucasian. Examination of participants' medical records indicated that the sample had an average left ventricular ejection fraction of 42.25 (SD = 16.00). See Table 1 for participant demographic and medical characteristics.

Reported ADL Function

At baseline, HF patients exhibited rates of ADL dependence comparable to those observed in patients with mild to moderate cognitive impairment [20]. In terms of baseline instrumental ADLs, 26.4% reported receiving assistance in shopping, 27.3% food preparation, 35.5% housekeeping duties, and 37.3% for laundry. Of note, 8.2% reported increased assistance for driving, 7.3% medication management, and 11.8% for financial management. Although impairment in basic ADLs was less common, 20.9% of the sample reported requiring assistance with physical ambulation.

A similar pattern of reported ADL performance emerged at the 12-month follow-up, however, chi-square analyses showed that many more HF participants significantly reported greater assistance with nearly all ADLs at 12-months compared to baseline. Specifically, dependence in telephone use nearly quadrupled at a 12-month follow-up and greater assistance was also observed on various other ADL tasks at this one year time point, including shopping (30.0%), food preparation (35.5%), housekeeping duties (41.8%), driving (10.9%), finances (12.7%), dressing (4.5%), physical ambulation (27.3%), among others. Contrary to expectations, HF patients also reported significantly less dependence in medication management, grooming, and bathing at the 12-month follow-up. See Table 2. Repeated measures ANCOVA adjusting for medical and demographic variables showed that HF patients reported significant declines in total ADL (Λ = .95, F(1,104) = 5.16, p = .03) and instrumental ADL (Λ = .96, F(1,104) = 3.87, p = .05) performance from baseline to 12-month follow-up. No such pattern emerged for basic ADL performance (Λ = .98, F(1,104) = 2.55, p = .11). Refer to Table 3.

Predictive Validity of the 3MS on Reported ADL Function at One-Year Follow-up

Hierarchical regression analyses were then performed to determine the predictive validity of the 3MS for total ADLs. Block 1 with medical and demographic characteristics predicted total ADL performance at 12-months (F(1,102) = 16.10, R^2 = .48, p < .001). Older age at baseline (β = -.17, p = .03) and worse baseline total ADL performance (β = .66, p < .001) emerged as significant predictors of poorer 12-month total ADL function.

After adjusting for baseline ADL performance and medical and demographic characteristics the 3MS demonstrated significant predictive validity for total ADLs at 12-months (F(1,102) = 14.76, R^2 = .50, β = .15, p = .049). See Table 4. Decreased scores on the 3MS at baseline predicted poorer total ADL function at the one-year follow-up. To clarify this effect, follow up regression analyses showed that worse baseline 3MS scores predicted increased ADL dependence at 12-months for shopping (F(1,102) = 5.16, R^2 = .26, β = .18, p = .04), driving (F(1,102) = 28.38, R^2 = .64, β = .19, p < .01), feeding (F(1,102) = 1.53, R^2 = .10, β = .25, p = .01), and physical ambulation (F(1,102) = 9.45, R^2 = .39, β = .23, p < .01). The 3MS did not predict performance of any other instrumental or basic ADLs (p > .05 for all). Regression analyses controlling for medical and demographic variables in addition to baseline factors also showed that worse 3MS performance at 12-months was associated with poorer total ADL function (F(1,101) = 13.63, R^2 = .52, β = .18, p = .07).

3MS and ADL Function Over Time

The current sample exhibited a mean baseline 3MS of 92.38 (SD = 5.31) with scores ranging from 76 to 100. At the 12-month follow-up, 3MS slightly improved with a mean of 93.59 (SD = 5.33) and scores ranging from 79 to 100. Despite such improvements in average 3MS performance, 34.5% of the sample exhibited declines and 11.0% remained stable on the 3MS over time. Partial correlations controlling for baseline factors and medical and demographic characteristics showed that declines in 3MS performance corresponded to significant declines in basic ADLs (r(99) = .22, p = .03) and a trend for total ADLs (r(99) = .18, p = .07), but not instrumental ADLs (r(99) = .12, p = .23).

4. Discussion

Recent cross-sectional work shows that ADLs are commonly impaired in HF and are associated with severity of cognitive dysfunction [4]. The current study extends these findings by showing that ADL function declines over time in HF and performance on a cognitive screening test predicts poorer ADL function at a one-year follow-up in this population. Several aspects of these findings warrant brief discussion.

Findings from the current study suggest that poorer performance on a cognitive screening test is a significant predictor of poorer ADL function at one-year follow-up in HF, including greater dependence in shopping, feeding, driving, and physical ambulation. Although we found that, on average, 3MS scores improved over time, many participants demonstrated decline in performance. Cognitive function is heterogeneous in HF and there is extant evidence for both decline and improvement over time in this population [16,21]. In-turn, the declines in ADL performance in the current study appear to be driven by such persons, as reduced cognitive function corresponded to poorer ADL ability over time. Future work is needed to further clarify the corresponding trajectories of cognitive and ADL function in HF patients.

Indeed, past work suggests that the high prevalence of cognitive impairment in HF places this population at risk for functional decline. For instance, the performance of instrumental ADLs requires complex cognitive abilities, including organization, planning, and monitoring of behavior [22]. These mental abilities are largely mediated by frontal brain regions particularly susceptible to injury due to cerebral hypoperfusion commonly found in HF patients [23,24]. Given the link between cognitive impairment and poor outcomes including hospital re-admissions [25], future studies should examine whether cognitive screening in persons with HF can guide clinician based interventions to increase functional independence and lead to improved outcomes.

Notably, performance on the 3MS emerged as a significant predictor of driving independence in this sample of older adults with HF. HF patients frequently exhibit impairments in global cognitive status and across multiple domains of cognitive function, including attention, executive function, and memory [10]. Similar impairments have been shown to be sensitive predictors of reduced driving ability in populations with neurological conditions (e.g., Alzheimer's disease and mild cognitive impairment) as well as healthy older adults [26-28]. These findings suggest that HF patients may be at elevated risk for unsafe driving, though few studies have directly examined driving abilities in this population. This is unfortunate, as drivers with significant cognitive impairment are up to 8× greater risk of crashing than cognitively intact elderly [29]. Future work is needed to identify the prevalence of impaired driving in HF and identify office-based assessments that predict risk for unsafe driving in this population.

The current study shows that reported ADL function, particularly instrumental ADL performance, declines over a one-year period in HF patients. Interestingly, a recent study showed that HF patients exhibit impairments in basic ADL performance (e.g., bathing, dressing, walking, toilet use) in the first year following diagnosis and such deficits persist over time [30]. Similarly concerning, HF patients are at increased risk for Alzheimer's disease and other forms of dementia [11] and persons with these conditions show declines on similar functional abilities to those seen in the current study [31]. Consistent with this notion, impaired instrumental ADLs have also been shown to be a sensitive predictor of increased risk of dementia [32] and future work should explore this possibility in HF patients.

Greater instrumental ADL dependence has also been shown to predict elevated mortality risk in HF [33]. This is perhaps not surprising given that instrumental ADLs consists of tasks important for self-care maintenance such as medication management. For instance, poor adherence to treatment recommendations (e.g., medication regimens) in HF has been linked with recurrent hospital readmissions, mortality risk, and worsening HF symptoms [7,34,35]. Interestingly, the rate of impairment in simple tasks such as telephone use nearly quadrupled at the 12-month follow-up in this study, suggesting HF patients may be at significant risk for inability to perform critical self-monitoring and life-saving behaviors (e.g., calling 9-1-1 or making doctor appointments). Indeed, the exact reason for increased impairments in telephone use in this study is not entirely clear, though may involve deteriorating vision, increased arthritis of the fingers, or even technological barriers. Prospective studies should use extended follow-up periods (e.g., 2 years, 5 years) to help elucidate the exact rate of ADL decline in HF and subsequent poor outcomes (e.g., institutionalization).

Contrary to the above findings, we also found reported improvements in some ADLs over time, most notably for decreased assistance with medication management. Based on our findings, it is also possible that these findings may reflect those participants that demonstrated improvements in cognitive function over time. Another explanation may involve biases that accompany self-reported medication adherence in this population. Adherence to medications is a critical treatment recommendation in HF and participant's responses are often favorably skewed in order to please their healthcare providers [36]. For instance, reported impairments in medication management in the current sample were relatively low at baseline (7.3%) and only slightly improved at 12-months (5.5%). These rates are in contrast to the 20% of HF patients found to be non-adherent to medication regimens when objective assessments are employed [37]. Given the importance of medication adherence in the management of HF, it is also possible that reduced assistance with medications over the 12-month period may be secondary to the implementation of behavioral interventions that target improved medication adherence (e.g., pillbox organizers). The current sample exhibited a relatively high load of medications to manage, thus factors such as behavioral routine or slight decreases in the number of medications managed at the 12-month follow-up (e.g., improved clinical status) may have also contributed to better medication management in this sample.

Past work among other populations (e.g., diabetes) shows that patients with functional disabilities receive greater assistance with managing medical behaviors [38]. HF patients in this study exhibited declines in basic functioning (e.g., physical ambulation) over time and family members may have become slightly more active in assisting with medication management, among other tasks. Such assistance may have resulted in better perceived ADL ability by the HF participants. Consistent with this pattern, increased use of respite services such as home health aids may have also accounted for observed improvements in the above ADLs. Additional longitudinal studies are much needed to clarify the course of ADLs in HF and the underpinnings for possible improvements in key ADLs in this population.

The findings of the current study are limited in several ways. First, future studies that assess cognition and ADLs at multiple time points are needed to clarify the exact rate of ADL decline over time in this population. Moreover, the 3MS is a well-validated screening measure easily tailored to clinical settings, though future studies should examine the longitudinal association between cognition and ADL performance in HF using comprehensive neuropsychological test batteries. The exact mechanisms that underlie cognitive impairment and ADL decline also remain unclear and future work should investigate whether markers such as cerebral atrophy or brain hypoperfusion contribute to greater ADL dependence over time in HF. Similarly, while the current study attempted to control for key demographic and medical factors that may influence cognitive and ADL function, larger studies that control for a range of medical comorbidites that are common in this population (e.g., chronic obstructive pulmonary disease) would help to elucidate our findings. In addition, longitudinal studies with extended follow-ups should clarify the impact of worsening HF severity on ADL function over-time, as past work shows that HF severity is inversely associated with cognitive function in this population [39].

Finally, recurrent hospital readmissions are prevalent in HF and may accelerate cognitive and functional decline in this population. Thus, future work should examine whether factors that improve HF status (e.g., cardiac rehabilitation) also correspond to better cognitive and ADL function. The current study also assessed ADL function using a self-report measure and future studies that employ informant and/or objective assessment of ADLs in HF are needed to fully elucidate ADL function over time in this population. Future studies should also investigate other types of self-care behaviors in HF patients over time, including adherence to key treatment recommendations in this population such as regular exercise and dietary monitoring.

In brief summary, the current study shows that HF patients report significant functional decline over a 12-month period and brief cognitive tests can identify those patients at highest risk for decline. If replicated, such findings encourage the use of cognitive screening measures to help guide clinician based interventions to target improved ADL ability in HF.

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Implications for Practice

- Functional decline is common in HF
- Cognitive screening may detect reduced ADL ability in HF
- Clinician intervention should target improved ADL in HF

Table 1

Demographic and Clinical Characteristics of 110 Older Adults with Heart Failure

DEMOGRAPHIC CHARACTERISTICS	
Age, mean (SD)	69.87 (9.12)
Years of Education, mean (SD)	13.60 (2.65)
Female (%)	36.4
Race (% Caucasian)	84.5
MEDICAL CHARACTERISTICS	
Overall Sample LVEF, mean (SD) (*N* = 108)	42.25 (16.00)
NYHA Class (%II,%III,%IV)	84.2,14.9,0.9
*Number of Medications, mean (SD)	9.76 (4.58)
Diabetes (% yes)	34.5
Hypertension (% yes)	69.1
Depression (% yes)	20.9
Coronary artery disease	76.3
Myocardial infarction (% yes)	50.0
Elevated total cholesterol (% yes)	67.3
Sleep apnea (% yes)	22.7

LVEF = Left Ventricular Ejection Fraction;

*$N = 103$

Table 2

Baseline and 12-Month Reported ADL performance (*N* = 110)

	Baseline ADL % Impaired	12-Month ADL % Impaired	Chi-square
Telephone Use	1.8	8.2	22.86**
Shopping	26.4	30.0	19.29**
Food Preparation	27.3	35.5	14.01**
Housekeeping	35.5	41.8	18.66**
Laundry	37.3	43.7	31.47**
Driving	8.2	10.9	61.33**
Medication Management	7.3	5.5	54.44**
Finances	11.8	12.7	42.37**
Toileting	2.7	5.5	4.65*
Feeding	0.9	0.9	.01
Dressing	3.6	4.5	19.77**
Grooming	7.3	0.9	16.13**
Physical Ambulation	20.9	27.3	31.89**
Bathing	2.7	1.8	17.16**

Note.

** $p < .01$

Table 3

ADL Performance Over 12-Months in Heart Failure (*N* = 110)

	Baseline M(SD)	12-month M(SD)	*F*
Instrumental ADL	13.68 (2.78)	13.25 (2.79)	3.87*
Basic ADL	11.57 (.93)	11.59 (.90)	2.55
Total ADL	25.25 (3.24)	24.84 (3.20)	5.16*

Note.

* $p \leq .05$;

ADL = Activities of Daily Living

Table 4

Hierarchical Multiple Linear Regression Models Examining the Predictive Validity of the 3MS on Total ADL Function (N = 110)

	Total ADL β(SEb)
Block 1	
Baseline ADL	.66(.07)**
Age	-.17(.03) *
Sex	.03(.53)
Hypertension	.02(.50)
Diabetes	-.10(.48)
Depression	-.15(.61)
R^2	.48
F	16.10
Block 2	
3MS	.15(.04) *
R^2	.50
F for ΔR^2	3.97

Note.

*denotes $p < 0.05$;

ADL = Activities of Daily Living

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