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Research Article

The Association Between Life-Space and Health Care Utilization in Older Adults with Heart Failure

Alexander X. Lo,[1,2] Kellie L. Flood,[2,3] Richard E. Kennedy,[2,4] Vera Bittner,[5] Patricia Sawyer,[2,3] Richard M. Allman,[6] and Cynthia J. Brown[2,3,4]

[1]Department of Emergency Medicine, [2]Comprehensive Center for Healthy Aging, and [3]Division of Gerontology, Geriatrics and Palliative Care, Department of Medicine, University of Alabama at Birmingham. [4]VA Geriatric Research, Education, and Clinical Center, Birmingham, Alabama. [5]Division of Cardiovascular Disease, Department of Medicine, University of Alabama at Birmingham. [6]Geriatrics and Extended Care Services, Office of Patient Care Services, Veterans Health Administration, Washington, DC.

Address correspondence to Alexander X. Lo, MD, PhD, Department of Emergency Medicine, University of Alabama at Birmingham, 619 19th Street South, OHB-251, Birmingham, Alabama 35249. Email: alexanderlo@uabmc.edu

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Abstract

Background: Life-space is associated with adverse health outcomes in older adults, but its role in health care utilization among individuals with heart failure is not well understood. We examined the relationship between life-space and both emergency department (ED) utilization and hospitalization.
Methods: Participants were community-dwelling older adults with a verified diagnosis of heart failure who completed a baseline in-home assessment and at least one follow-up telephone interview. Life-space was measured at baseline and at follow-up every 6 months for 8.5 years. Poisson models were used to determine the association between life-space, measured at the beginning of each 6-month interval, and health care utilization, defined as ED utilization or hospitalization in the immediate ensuing 6 months, adjusting for sociodemographic and clinical confounders.
Results: A total of 147 participants contributed 259 total health care utilization events involving an ED visit or a hospital admission. Multivariate analysis demonstrated an inverse association between life-space and health care utilization, where a clinically significant 10-point difference in life-space was independently associated with a 14% higher rate of ED utilization or hospitalization (incidence rate ratio 1.14, 95% CI 1.04–1.26, $p = .004$).
Conclusions: Life-space may be a useful identifier of community-dwelling older adults with heart failure at increased risk of ED visits or hospital admissions in the ensuing 6 months. Life-space may therefore be a potentially important component of intervention programs to reduce health care utilization.

Key Words: Life-space—Heart failure—Health care utilization

Heart failure (HF) is a significant public health problem, with nearly 6 million prevalent cases, 1 million hospitalizations, and over $50 billion in total costs annually (1,2). HF is the leading cause of hospitalization in older adults ≥65 years of age, who account for 75% of all HF hospitalizations (1,3). Nearly 1 million HF patients seek care in the emergency department (ED) each year (4), with

80% being hospitalized (5) and 25% readmitted within 30 days (2,6). However, nearly 90% of Medicare HF readmissions were determined to be unplanned and potentially *preventable* (6). The mandate to reduce HF hospitalizations and particularly hospital readmissions under the Affordable Care Act (7) necessitates a better understanding of factors associated with hospitalization. Among older adults, impaired mobility in the form of slower gait speed has been reported to predict hospitalization, particularly among older adults with HF (8,9). These findings point to an important association between mobility and hospitalization among older adults with HF. One validated measure of mobility is life-space, which unlike simpler measures of mobility-related tasks, such as lower extremity strength, provides a more accurate indicator of community participation that directly impacts the management of one's chronic illness, such as the ability to visit the doctor or to acquire medications (10). Life-space has been shown to influence important health outcomes (11,12), but its association with health care utilization, particularly ED utilization or hospitalization, among older adults with HF has not been reported. The objective of this study was to investigate the relationship between life-space and subsequent ED visits or hospital admissions in a population-based cohort of community-dwelling older adults with HF.

Methods

Study Design

The University of Alabama at Birmingham (UAB) Study of Aging is a prospective cohort study of 1,000 community-dwelling older adults designed to investigate subject-specific risk factors for mobility decline associated with aging. The UAB Institutional Review Board approved the study protocol. Details of the study methods have been previously described (13).

Participants

Participants represent a stratified random sample of community-dwelling Medicare beneficiaries in central Alabama, aged ≥65 years, and were oversampled to achieve balance in terms of race, gender, and rural/urban residence (13). Trained interviewers conducted baseline in-home interviews at the time of enrollment and telephone follow-up interviews every 6 months for the subsequent 8.5 years following baseline enrollment. Follow-up interviews assessed vital status, life-space, ED utilization, and hospital admissions. For participants unable to complete follow-up assessments, designated contact persons were interviewed. The current analysis uses data from 147 participants in the UAB Study of Aging who had a verified diagnosis of HF at baseline or new diagnosis reported during follow-up. Diagnoses of HF at baseline were verified through self-report and prescription medications, physician or clinic questionnaires, and hospital discharge summaries.

Study Variables

Life-Space

We used the validated UAB Study of Aging Life-Space Assessment tool to measure life-space over the 4 weeks preceding assessment (10,13). Life-Space Assessment composite scores ranged from 0 to 120 with higher scores representing greater mobility.

We examined the association between 10-point differences in life-space composite scores and health care utilization. The 10-point difference was based on a previously reported adjusted change in life-space (10.3 points) associated with nonsurgical hospitalizations (14). An example of a 10-point difference would be an older person who previously reported no assistance to go into the neighborhood daily and to town 1–3 times a week (e.g., 64 points) but who now requires a cane to go into town less than once a week (e.g., 54 points). The Life-Space Assessment has been shown to be reliable and sensitive to changes over time (10), and although persons may differ on how they define distances between specific life-space levels, these definitions are consistent over time for the individual (15). Life-space was assessed at baseline and at each 6-month interval over the 8.5 years of follow-up. Thus, participants who were alive and had no missing 6-month assessments could contribute up to 16 data intervals to this analysis.

Sociodemographic Factors

Age, gender, race, rural residence, education, income, and marital status were self-reported at baseline.

Comorbidity Score

A comorbidity score was calculated based on the Charlson Comorbidity Index (16), without consideration of severity and using only verified diagnoses for this calculation.

Depression or Depressive Symptoms

Depressive symptoms were assessed at the baseline interview using the 15-item Geriatric Depression Scale (17,18). Scores of 5 or more symptoms present were suggestive of depression.

Cognitive Function

Cognitive function was measured at baseline using the Mini-Mental State Examination with scores ranging from 0 to 30 where higher numbers indicated greater cognitive function (19).

Primary Care Physician (PCP) Visits

Participants were asked at baseline, "Do you have a doctor you usually see for your general healthcare?" and if they answered in the affirmative, were then asked "When was the last time you saw this doctor?" with response categories that included "within the last month" and "within the last 6 months".

Transportation Difficulty

Persons responding positively to either question: "Over the past four weeks, have you had any difficulty getting transportation to where you want to go?", or "Do you limit your activities because you don't have transportation?" were defined as having transportation difficulty.

Main Outcome Measure

ED and Hospital Utilization

At every 6-month telephone interview, participants were asked, "Have you been to the Emergency Room in the last 6 months?" and "In the last 6 months, have you been hospitalized overnight?" we defined our outcome as either ED utilization or hospitalization given the closely intertwined relationship between ED utilization and hospitalization in HF, where 80% of adults with HF presenting to an ED are hospitalized (5) and 80% of hospitalized HF patients are admitted from the ED (20).

Statistical Analysis

Participants were censored at the time of death or nursing home admission so that results would be relevant to community-dwelling

older adults. We examined the relationship between life-space at every 6-month interval and health care utilization in the 6 months immediately following the life-space measurement. If a participant died during a 6-month interval, information on life-space and health care utilization (ED visits or hospitalizations) was obtained from designated contacts. We used means and percentages to describe baseline characteristics and bivariate analyses (chi-square and *t*-tests) to compare the differences in these characteristics between participants with and without a history of ED utilization or hospitalization in the 12 months prior to baseline. A multivariate Poisson log-linear (count) model with zero inflation (21) was constructed for the outcome (ED utilization or hospitalization) over each 6-month follow-up interval, using life-space score measured at the beginning of each 6-month interval as the main predictor variable and adjusted for potential confounding variables measured at baseline. Generalized linear mixed models were used to account for correlation among intervals for the same participant over the 8.5 year study period. A cutoff of 0.5 for the Pearson correlation was used to identify predictors with high collinearity and remove them from the model. For example, Charlson comorbidity score and the number of medications were highly collinear (variance inflation factor 0.54) and therefore the number of medications was removed from our models. Effect estimates from the multivariate models were exponentiated to provide incidence rate ratios. Statistical significance was reported using 95% confidence intervals and *p* values. All statistical analyses were conducted using IBM SPSS statistics software version 21 (IBM Corporation, Somers, NY) and R version 3.0.3 (R Core Development Team, Vienna, Austria).

Results

Of the 1,000 participants in the UAB Study of Aging, 130 had a verified diagnosis of HF at baseline. The differences in sociodemographic and clinical characteristics between those with HF and the remainder who did not have HF at enrollment are shown in Table 1. The most remarkable observation was the markedly lower life-space in those with HF, and the lack of a difference in terms of ED visits or hospitalizations, at baseline.

A univariate analysis of these 130 persons with HF, comparing those who reported any ED utilization or hospitalization in the 12 months prior to baseline with those who reported none, found that African American race and higher baseline Mini-Mental State Examination score were associated with a history of ED utilization or hospitalization. Baseline life-space was not significantly different between utilizers of the ED or hospital compared with nonutilizers (Table 2).

We identified 17 additional persons with incident HF during the follow-up period, and these were added to the 130 persons identified at baseline for the follow-up analysis. Over the 8.5 years of follow-up, these 147 persons contributed 1,175 total follow-up intervals that included (i) a life-space score at the beginning of the 6-month interval and (ii) information on any ED utilization or hospitalization during the interval. All 147 persons had at least one follow-up interval. In total, there were 259 ED visits or hospitalizations for the 147 persons over the study period. In multivariate analysis, life-space was independently associated with ED utilization or hospitalization in the ensuing 6 months following assessment, where the observed inverse risk relationship indicated that a 10-point decrease in life-space translated into a 14% higher rate of ED visits or hospitalizations (Table 3). Transportation difficulty at baseline was also independently associated with increased ED utilization or hospitalization over the follow-up period. African American race demonstrated a trend toward fewer ED visits or hospitalizations compared to whites ($p = 0.053$), even though there were no differences between African Americans and whites in terms of having seen a PCP in the 6 months prior to baseline (93% vs 94%, $p = .81$).

Further analyses to clarify the relation between transportation difficulty and other sociodemographic and clinical characteristics showed that those who reported transportation difficulty were less likely to be married (21% vs 46%, $p = .013$) and more likely to live alone (64% vs 33%, $p = .004$) than those who did not. However, transportation difficulty was not associated with age, race, gender, education, rural residence, or having a PCP. The correlation between transportation difficulty and life-space at baseline was only modest (Pearson correlation 0.36, $p < .001$), indicating that although transportation difficulty and life-space may share common influences, transportation difficulty was not a substitute measure for life-space.

Discussion

This study showed that life-space was independently associated with increased health care utilization in the ensuing 6-month period among community-dwelling older adults with HF. To our knowledge, this is the first study to characterize the association between life-space and health care utilization in older adults with HF. This finding highlights the importance of *functional* mobility in older adults with HF as a potentially amenable risk factor, which could reduce avoidable ED visits and hospitalizations. Although the utility of life-space in identifying older adults at risk for increased health care utilization extends beyond HF, we focused on HF in this study because HF is the leading cause of hospitalizations in older adults, is prioritized by the Affordable Care Act (7) for hospital readmissions reduction, and is a useful model condition for complex chronic diseases in older adults given its impact on health care utilization (22).

Previous reports on gait speed and the 6-minute walk test, and their respective association with increased hospitalization, support our hypothesis of mobility as a potential screen to identify individuals at risk for increased health care utilization (8,23,24). Life-space, compared with other tests of lower extremity function, may arguably be more pertinent to the management of a complex chronic condition, as it represents the individual's ability to travel to medical appointments, obtain medications at the pharmacist, participate in activities to enhance their quality of life, and maintain their independence.

The community-dwelling older adults with HF in this cohort demonstrated similar sociodemographic and clinical characteristics to those described in nationally representative estimates (25). Age (26), race (27), gender (28), education (29), marital status (30), transportation difficulty (31,32), comorbidity burden (33), and a doctor visit in the past month (34) were included as potential confounders for the multivariate model based on their documented association with health care utilization. Despite the well-documented importance of age, socioeconomic disadvantage, and increased comorbidity burden on health care utilization in HF (2,29,33), the observed effect of life-space in this study clearly demonstrates that life-space makes contributions to the prediction of health care utilization above and beyond other well-recognized risk factors. This finding offers the clinician a tool to identify older HF patients at increased risk of requiring emergency care or hospitalization and allows for efficient direction of requisite resources in order to intervene. Life-space also is easy to ascertain in the ED setting and can assist in optimizing the management and disposition of ED patients.

Table 1. Comparison of baseline characteristics between older adults with and without a verified diagnosis of heart failure (HF) upon enrollment in the UAB Study of Aging

	HF, *N* = 130		No HF, *N* = 870		*p* Value
	N	Mean (*SD*) or %	*N*	Mean (*SD*) or %	
Age	130	77.3 (7.4)	870	75.0 (6.5)	**.0002**
Sex, female	51	39.2%	448	51.4%	**.0089**
Race, African American	76	58.4%	424	48.7%	**.038**
Rural residence	74	56.9%	440	50.5%	.18
<Seventh grade education	30	23.0%	174	20.0%	.43
Income <$12,000	71	54.6%	346	39.8%	**.0015**
Married	52	40.0%	461	52.9%	**.0056**
Life-space*	130	50.4 (22.8)	870	66.1 (24.5)	**<.001**
Number of comorbidities	130	3.6 (1.9)	870	2.3 (1.5)	**<.001**
Mini-Mental State Examination†	130	22.7 (5.5)	870	25.3 (4.6)	**<.001**
Geriatric Depression Scale‡	129	3.2 (2.7)	870	2.2 (2.2)	**<.001**
Transportation difficulty	33	25.3%	138	15.8%	**.010**
Number of medications	130	6.4 (3.2)	870	3.9 (3.1)	**<.001**
Doctor visit in past month	72	56.2%	333	40.5%	**.0009**
Number of ED visits	130	0.6 (0.8)	870	0.5 (0.7)	.069
Number of hospitalizations	130	0.9 (1.2)	870	0.8 (1.1)	.16

Notes: *Scores range from 0 (least mobile) to 120 (most mobile).
Bold values indicate significant *p* values.
†Mini-Mental State Examination scores ranging from 0 (lowest cognitive function score) to 30 (highest cognitive function score).
‡Geriatric Depression Scale scores ranging from 0 (no depressive symptoms) to 15 (most depressive symptoms).

Table 2. Cross-sectional comparison of baseline characteristics between individuals with HF with and without a history of ED utilization or hospitalization in the 12 months prior to study enrollment (baseline)

	HF with ED/ Hospitalization (*N* = 76)		HF without ED/ Hosp. (*N* = 54)		*p* Value
	N	Mean (*SD*) or %	*N*	Mean (*SD*) or %	
Age	76	76.9 (7.1)	54	78.0 (7.9)	.40
Sex, female	32	42.1%	19	35.1%	.42
Race, African American	39	51.3%	37	68.5%	**.048**
Rural residence	41	53.9%	33	61.1%	.42
<Seventh grade education	20	26.3%	10	18.5%	.29
Income <$12,000	40	52.6%	31	57.4%	.59
Marital status	34	44.7%	18	33.3%	.19
Life-space	76	49.5 (21.7)	54	51.6 (24.4)	.62
Number of comorbidities	76	3.9 (1.8)	54	3.3 (2.1)	.097
Cognitive function (Mini-Mental State Examination)	76	24.4 (4.7)	54	20.3 (5.8)	**<.001**
Depression (Geriatric Depression Scale)	76	3.3 (3.0)	54	3.1 (2.2)	.63
Number of medications	76	6.6 (3.3)	54	6.1 (3.0)	.38
Doctor visit past month	45	60.0%	27	50.9%	.31
Transportation difficulty	22	28.9%	11	20.3%	.26

Notes: ED = emergency department; HF = heart failure.
Bold values indicate significant *p* values.
Life-space was measured using the life-space assessment tool with scores ranging from 0 to 120. Cognitive function was measured using the Mini-Mental State Examination with scores ranging from 0 to 30. Depression was measured using the 15-item version of the Geriatric Depression Scale with scores ranging from 0 to 15.

We observed a trend between African American race and decreased health care utilization in this study. Prior studies using Medicare, Veterans Health Administration and regional Health Maintenance Organization data have found African American or black race to be independently associated with increased ED utilization (35), hospitalization (27,28), and visits to a PCP or cardiologist (36), despite evidence that blacks have lower follow-up care by a cardiologist (37). Additionally, a single-center survey of ED patients reported that African Americans were twice as likely as whites to identify the ED as their usual place of health care (38). Our results may not have reached significance due to the unique characteristics of our sample. Alternatively, our results may reflect a predictive model that succeeded in partitioning out several distinct contributory components of socioeconomic disadvantage in this population, such as education, marital status, and transportation difficulty, and perhaps suggests that the previously reported increase in health care utilization risk observed in African Americans may been confounded by variables related to social deprivation that were captured by our model.

One example of social deprivation is transportation difficulty, which can cause individuals to either miss or delay their medical visits (32) and serve as an indicator of poor access to care in other studies (31). In our study, transportation difficulty resulted in greater

Table 3. Multivariate analysis of the association of life-space mobility on prospective ED utilization or hospitalization among older adults with HF over the follow-up period

Model	Incidence rate ratios (95% CI)	*p* Value
Life-space mobility (10-point difference)	1.14 (1.04–1.26)	**.004**
Age at beginning of follow-up interval	0.98 (0.95–1.02)	.32
Race (African American vs. white)	0.63 (0.40–1.01)	.05
Gender (male vs female)	1.11 (0.67–1.82)	.69
Education level at baseline		
< 7th grade	Reference	
7th–11th grade	0.62 (0.36–1.07)	.09
12th grade	0.62 (0.34–1.15)	.13
>12th grade	0.54 (0.27–1.08)	.08
Marital status	1.54 (0.91–2.62)	.11
Charlson comorbidity count at baseline	1.07 (0.96–1.18)	.22
Mini-Mental State Examination	1.04 (0.99–1.10)	.07
Doctor visit within one month of baseline	1.12 (0.75–1.67)	.57
Transportation difficulty at baseline	1.62 (1.01–2.62)	**.04**

Notes: ED = emergency department; HF = heart failure.

Bold values indicate significant *p* values.

The multivariate model involved 147 adults with HF and 1,175 follow-up intervals. Life-space mobility was measured at the beginning of any 6-month interval that involved an ED visit or an overnight hospital stay. For individuals with no ED visits or hospital stays, the earliest available life-space measure was used. The incidence rate ratios and *p* values are calculated from a repeated measures Poisson (count) model with zero inflation.

than 60% increase in ED utilization or hospitalization, even after accounting for life-space, race, marital status, comorbidity burden and having visited a doctor 1 month prior to baseline assessment, emphasizing the importance of access to care even among individuals who may have adequate general mobility, spousal support, fewer comorbidities, and a PCP.

Limitations of this study include the fact that life-space is a tool that utilizes self- (or surrogate) report and without other sources (e.g., activity diary) to formally validate these reports. We may have missed some ED utilization or hospitalizations because participants could not recall all of them; however, we would anticipate that participants would remember hospitalizations within 6 months, as these are often major events. In univariate and multivariate analyses on the association between the study variables and ED utilization or hospitalization, data on covariates were collected only at baseline, whereas the ED utilization or hospitalization episode may have occurred at any time during the follow-up period. It is reasonable to expect that some of the characteristics measured at baseline may have changed over time, and social circumstances such as income or transportation difficulty at baseline do not necessarily reflect the income or transportation capabilities throughout the entire follow-up period. Furthermore, the temporal gap between these characteristics and the outcome may weaken the hypothesis of a causal relationship.

The strengths of this study include our ability to measure life-space in this racially balanced, population-based sample of community-dwelling older adults and determine health care utilization every 6 months, thus providing a more robust temporal relationship between life-space and ED utilization or hospitalization within a 6-month window, and therefore lends validity to the hypothesis that life-space can predict health care utilization in community-dwelling older adults with HF.

These results also suggest the potential importance of preserving life-space in older adults with HF. Further research is needed to clarify the mechanism by which changes in life-space lead to health care utilization, whether it signals the beginning of difficulties with disease management and/or an amenable change in social circumstance such as transportation status that impacts health care utilization. Future studies should focus on life-space changes across smaller time windows in order to better understand the natural history of HF that accompanies these life-space changes. This would then allow for development of improved HF risk prediction models that emphasize geriatric syndromes, such as mobility, and which may help optimize health care utilization in the face of a financially strained health care system (39).

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Conflicts of Interest

The authors have no conflicts of interest to disclose.

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