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Trajectories of Life-Space Mobility after Hospitalization

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Abstract

Background—Life-space mobility, reflecting participation patterns as well as physical ability, may be useful in assessing important functional changes after hospitalization.

Objective—(1) To assess effects of hospitalization on life-space; and (2) To identify differences in life-space trajectories associated with surgical and non-surgical hospitalizations.

Design—Longitudinal growth models were used to compare life-space mobility trajectories among participants in a prospective observational study.

Setting—Central Alabama

Patients—687 community-dwelling Medicare beneficiaries (age ≥ 65 years) with and without hospitalizations.

Measurements—The Life-Space Assessment (LSA) measures mobility and function by incorporating where a person goes, the frequency of going there, and the degree of dependence required to get there in the four weeks before the assessment. Scores range from 0–120 with higher scores reflecting greater mobility.

Results—Participants (N=687) had a mean (SD) age of 74.6 (6.3) years, 50% were African-American and 46% were male. After adjustment for covariates, LSA scores prior to hospitalization were not significantly different for surgical and non-surgical admissions. Immediately after hospitalization, adjusted LSA scores decreased in non-surgical patients by 10.31 points (95% CI –14.30 to –6.32) and in surgical patients by 22.45 points (95% CI –29.91 to –14.99). While surgical hospitalizations resulted in a greater immediate LSA point decline, the recovery of LSA scores in

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these patients was also greater compared to non-surgical hospitalizations by 4.72 points (95% CI 2.03 to 7.42) per log week post-discharge. Indeed, LSA score recovery after non-surgical hospitalizations was non-significantly different from the null (average recovery of 0.66 points [95% CI -0.6 to 1.91] per log week).

Limitations—Assessments of life-space mobility could not be captured immediately before and after hospitalization in each patient, but we provided estimates using growth curve models.

Conclusions—Non-surgical hospitalizations were associated with moderate life-space mobility declines with little evidence of recovery even after up to two years of follow-up. Surgical hospitalizations were associated with mobility recovery despite marked early declines.

Hospitalization leads to functional decline or loss of independence in about one-third of older adults (1–7). An accurate measure of post-discharge physical function requires more than an assessment of individual's specific activities of daily living (ADLs), however, because physical function encompasses an individual's much broader participation in the activities of society (8–10). The UAB Study of Aging Life-Space Assessment (LSA) provides such a measure of participation.

The LSA is a validated tool that measures mobility and reflects participation in society based on the distance through which a person reports moving during the four weeks preceding the assessment (11–14). Life-space “levels” range from within one's dwelling to beyond one's town. A life-space composite score is calculated based on life-space level, degree of independence in achieving each level, and the frequency of attaining each level. The LSA, incorporating where a person goes, the frequency of going there, and the use of equipment or help from another person, could be used to explicitly define the full continuum and changes in mobility among community-dwelling older adults after hospitalization (11–14). Limitations in life-space, as measured by the UAB Life-Space Assessment, reflect life-style as well as physical ability and may be a useful measure of global functional decline for recently hospitalized older patients, especially since life-space specifically relates to mobility and a person's participation in society.

The objectives of this study were: (1) To assess the initial and extended effects of hospitalization on life-space; and (2) To identify differences in life-space trajectories associated with surgical and non-surgical hospitalizations.

METHODS

Setting and Participants

The University of Alabama at Birmingham (UAB) Study of Aging is designed to understand subject-specific factors predisposing older adults to mobility decline and racial differences in mobility changes associated with aging. Study of Aging participants were a random sample of Medicare beneficiaries, age ≥ 65 years, living in central Alabama stratified by county, race and gender (11). Counties were classified as urban or rural based on population at the time of baseline interviews (15). Recruitment was set to achieve a balanced sample in terms of race, gender, and rural/urban residence. After obtaining informed consent, baseline in-home interviews were conducted between November 1999 and February 2001 by trained interviewers. Telephone follow-up interviews to assess life-space, hospitalizations, and vital status were conducted at six-month intervals. Proxy responses were included when necessary. The UAB Institutional Review Board approved the study protocol.

Potential participants for the present study included all participants in the UAB Study of Aging who had a 6-month follow-up interview, did not report any hospitalization during the initial 6-months of follow-up and were alive at the four-year follow-up interview. Figure 1 presents

the flow of potential participants from the parent study. Of the 687 participants who were alive at the four-year follow-up interview and reported no hospitalizations between baseline and the initial 6-month follow-up, 211 reported at least one hospitalization over the next 3.5 years and provided life-space data. For those 211 cases, life-space scores were analyzed as a function of that hospitalization until a second hospitalization was reported ($N = 56$) or through the 48-month post-baseline interview for those without a second hospitalization ($N = 155$). Participants were censored after the second hospitalization, so that the effects of a second hospitalization did not contribute to life-space estimates. The life-space mobility of hospitalized participants was compared to the life-space of the comparison group who did not report any hospitalizations.

Study Variables

Life-Space Mobility—The LSA measures mobility during the four weeks preceding the assessment by asking about movement to specific life-space levels ranging from within one's dwelling to beyond one's town (11–14). Frequency of movement and use of assistance, either from equipment or another person, were assessed. Specifically, participants were asked: "During the past 4 weeks, have you: 1) been to other rooms in your home besides the room where you sleep; 2) been to an area outside your home such as your porch, deck, or patio, hallway of an apartment building, or garage; 3) been to places in your neighborhood other than your own yard or apartment building; 4) been to places outside your neighborhood, but within your town; and 5) been to places outside your town?"

For each life-space level, participants were asked how many days within the week they attained that level and whether they needed help from assistive devices or another person to move to that level. A composite score was calculated based on life-space level, degree of independence in achieving each level, and the frequency of attaining each level. Life-Space composite scores ranged from 0 to 120 with higher scores representing greater mobility. Based on previous analysis of the psychometric properties of the LSA, test-retest reliability demonstrated an intraclass correlation coefficient (and 95% confidence interval) of 0.96 (0.95–0.97) for the measure. The LSA is sensitive to change over time. Frequency distributions demonstrated only 2% of persons would be unable to show an increase in life-space, while only 1% would be unable to show a decline (12).

Changes in the life-space composite score were assessed by comparing scores at each 6-month interview from the 6 to the 48-month interview. Although individuals may differ on how they define distances between specific life-space levels, for an individual participant these definitions are consistent over time (11).

Hospitalization—At each 6-month interview, participants were asked if they had been hospitalized overnight during the preceding 6-month period. If hospitalized overnight, they were asked why they were admitted, and admission and discharge dates. Self-reported reasons for hospital admission were coded by the interviewers based on information given by participants (16). These codes were independently reviewed by two reviewers (CJB, RMA) with a third reviewer (CSR) available to resolve disputes. Coded reasons for admission were categorized as surgical or non-surgical admissions. Surgical admissions included the following categories of surgeries: Cardiac, thoracic, gastrointestinal, orthopedic, vascular, and urologic. Information regarding whether the surgery was emergent versus non-emergent was not assessed. All other reasons given by participants for admission were categorized as non-surgical admissions, including those involving procedures like colonoscopy and angioplasty.

Sociodemographic Variables—Age, gender, race, and marital status were self-reported at baseline and the 48-month interview.

Comorbidity Count—We used a comorbidity count, giving one point for each disease category of the Charlson Comorbidity Index (17), without consideration of severity after verifying comorbidities through self-report and prescription medications, physician/clinic questionnaires, and hospital discharge summaries. Only verified diagnoses were used for this analysis.

Statistical Analysis

Characteristics of the study participants were described with appropriate descriptive statistics including frequencies, proportions, means, standard deviations, and medians. The effects of hospitalization on life-space composite scores over time were estimated and tested using multilevel growth curve analyses (18). All analyses were conducted using restricted maximum likelihood estimation as provided by SAS PROC MIXED (19) (SAS Institute, Cary, NC). A multilevel change model was used with level 1 consisting of longitudinal (within-person) trajectories of life-space as a function of time and other time-varying predictors and level 2 consisting of group intercepts and growth factors as well as between-subjects predictors of individual differences in those intercepts and growth factors. Models were based on 1,480 observations over time for the 211 cases with a hospitalization. This included 766 observations before the hospitalization and 714 observations after the hospitalization but before a second hospitalization. Of these 211 hospitalizations, 44 were surgical admissions and 167 were non-surgical admissions.

The models included three time-varying (level 1) predictors of LSA scores over time. First, the *time* associated with each life-space assessment was determined from the dates of the repeated LSAs and the date of hospitalization. A difference in days was calculated, which was negative for pre-hospital assessments and positive for those after hospitalization. Dividing by seven, these intervals in days were re-scaled to weeks. The coefficient for this *time* variable accounted for any general linear trend in life-space across the trajectory. Second, *hospitalization* was a dichotomous indicator set to zero for all pre-hospital assessments and 1 for all post-hospital assessments. This variable indexed the amount of immediate life-space change as a function of hospitalization. Third, *log recovery time* was measured by a variable set to zero for all assessments before hospitalization and set to the natural logarithm of one plus the number of weeks after discharge (i.e., $\log[\text{weeks after discharge} + 1]$) for all post-hospitalization assessments. This unit of time is equal to the natural logarithm of weeks after discharge plus one, which we refer to as “log weeks post-discharge.” This variable estimated the rate of mobility recovery after hospitalization using a logarithmic recovery function. Model fit comparisons (not presented) revealed the model with a logarithmic recovery function fit significantly better than a similar model with a linear recovery function.

To determine whether these longitudinal effects on life-space mobility varied as a function of the type of hospital admission, a level 2 predictor for type was included in the model (surgical admission = 1, non-surgical admission = 0). A main term for type of admission indicated whether the trajectories differed overall by the type of hospitalization. In addition, type of admission was allowed to predict the linear *time* term across the entire trajectory, the immediate *hospitalization* term, and the *log recovery time* term. These cross-level interaction terms allowed us to determine if the longitudinal effects differed significantly between surgical and non-surgical admissions. One model was estimated that included admission type as the only level 2 predictor, and a second model was estimated that included age at baseline, gender, race, rural status, comorbidity count, and number of ADL problems at baseline as additional level 2 (time-invariant) covariates.

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RESULTS

Table 1 shows baseline characteristics of participants in this analysis, based on hospitalization status (surgical hospitalization, non-surgical hospitalization, and not hospitalized). Participants admitted with a surgical diagnosis were more likely to be younger, male, and be less likely to report difficulty with activities of daily living compared to those admitted for a non-surgical reason or those without a hospital admission. Mean LSA scores at baseline ranged from 62.4 for participants with a non-surgical admission, to 75.8 for those with a surgical admission ($p=.001$). The mean length of stay for the hospitalized group was 7.5 (± 9.9) days, with a median of 4 days and a range of 1 to 71 days. The difference between surgical and non-surgical length of stay was not statistically significant ($p=0.4$). The most frequent reasons for the 167 non-surgical admission given by participants included stroke or mini stroke 10 (6%), heart problems or stent placement 9 (5%), pneumonia 8 (5%), myocardial infarction 7 (4%), and complications of diabetes 6 (4%). Reasons for the 44 surgical admission included total joint replacement 9 (20%), coronary artery bypass graft surgery 8 (18%), prostate surgery 6 (14%), rotator cuff or shoulder surgery 5 (11%), and gallbladder surgery 4 (9%).

The results of the multilevel growth curve analyses for the two hospitalization groups are summarized in Table 2 and illustrated in Figure 2. The estimated LSA score prior to hospitalization in patients with a non-surgical hospitalization after adjusting for covariates was 62.72 (95% CI 57.23, 68.21) points. Prior to adjustment for covariates, patients with a surgical hospitalization had LSA scores prior to hospitalization that were 7.58 points higher compared to patients with a non-surgical hospitalization, but the difference virtually disappeared in the adjusted model (average difference 1.73; 95% CI -4.46 to 7.91). On average, LSA scores decreased over time, but the temporal trend was not statistically significant. The adjusted average weekly change in LSA score in patients with a non-surgical hospitalization was -0.01 points per week (95% CI -0.03 to 0.01), with similar decline in patients with a surgical hospitalization (difference in average weekly change in LSA score comparing surgical to non-surgical patients -0.02 ; 95% CI -0.07 to 0.03).

Immediately after hospitalization, covariate-adjusted LSA scores decreased in non-surgical patients by 10.31 points (95% CI -14.30 to -6.32) and in surgical patients by 22.45 points (95% CI -29.91 to -14.99). An example of a 10-point decline would be an older person previously reporting no assistance to go into the neighborhood daily and to town 1–3 times a week (LSA score = 64), but who now requires a cane to go into town less than once a week (LSA score = 54); an example of a 23-point decline would be an older person who previously reported no assistance to go into the neighborhood daily and to town 4–6 times a week (LSA score = 72), but who now uses a walker to maintain the same frequency and distance of movement (LSA score = 49.5). The difference in LSA score change after hospitalization between surgical and non-surgical patients was also statistically significant (average difference -12.14 ; 95% CI -20.65 to -3.63).

While surgical hospitalizations resulted in a greater LSA point decline, the weekly recovery of LSA score in these patients was also greater compared to non-surgical hospitalizations by 4.72 points (95% CI 2.03 to 7.42) per log week post-discharge. Indeed, LSA score recovery after non-surgical hospitalizations was non-significantly different from the null (average recovery of 0.66 points [95% CI -0.60 to 1.91] per log week). For example, at 12 weeks post-discharge, life-space recovered by an average of 1.69 points in non-surgical patients and by 13.80 points in surgical patients. As illustrated in Figure 2, on average, within up to two years of the incident non-surgical hospitalization, these patients did not recover to their pre-hospital levels of life-space.

Sensitivity analyses of diagnostic subgroups (data not shown) both within and between surgical and non-surgical categorizations (e.g., separate comparisons of joint replacement, CABG, stroke, pneumonia, and joint surgery subgroups) revealed similar trajectories within surgical and non-surgical categories and consistent differences between surgical and non-surgical cases. Within group distributions of outcomes revealed general trends within the groups rather than a pattern where the average trend might be generated by extreme changes among a few participants. These supplemental analyses supported our general distinction between surgical and non-surgical admissions as presented here.

DISCUSSION

Findings from the current study suggest, on average, patients hospitalized for any reason experience an initial decline in life-space mobility as measured by the Life-Space Assessment. The group admitted for surgery had higher life-space scores prior to admission and recovered to at least their preadmission level of life-space within a year of hospitalization. This is in sharp contrast to participants admitted for a non-surgical reason. After adjusting for demographic covariates and ADL impairments, participants with a non-surgical admission had similar life-space scores prior to admission than those with a surgical admission, but failed to recover to baseline even after two years of follow-up despite having only moderate declines in life-space after hospitalization.

Participants admitted for a surgical procedure might be expected to have higher life-space as pre-operative functional status is a strong predictor of surgical outcomes and the severity of functional impairment can predict operative risk (20). Pre-operative screening, which includes evaluation of function, helps determine the best candidates for elective surgical procedures (20). The observed dramatic decline in life-space also is reasonable, given restrictions often imposed after an operation. Limitations of driving while healing from a sternotomy or total hip replacement are expected as part of the recovery process (21,22).

The impact of a non-surgical hospitalization on life-space is concerning, particularly because participants, on average, never regained their previous life-space level. Reasons for this lack of improvement may include having significant comorbidities for which the expected course of illness is progressive decline. For example, patients with heart failure often have exacerbations and remissions, with a general trend toward disability due to their illness (23, 24). For older patients, common hospital-related issues may also contribute to life-space declines (5,25). Deconditioning is common with 23–33% of older patients being limited to bed or chair during hospitalization (2,5,26,27). Inadequate nutrition based on maintenance energy requirements (28,29) and delirium may also contribute to life-space declines (30–33).

The consequences of the observed life-space mobility declines are numerous and include abrupt life-style changes for patients and their families. A loss of independence and self-esteem may be experienced by older adults who now are dependent on equipment or the help of another person to leave the home (34). This life-space decline may result in a decrease in the distance traveled from home, thus limiting participation in society (9). Mobility is a core function that reflects the life-style of community-dwelling older adults and is an important predictor of morbidity and mortality (35).

We report significant changes in life-space mobility after hospitalization. Some factors that impact life-space are not modifiable, such as acute illness severity. However, factors such as physical function and mental status are potential targets for intervention during hospitalization. Inouye et al. demonstrated a multifaceted intervention focused on six risk factors for delirium, including increasing mobility, reduced the incidence and duration of delirium in hospitalized older adults (36). Acute Care for the Elderly (ACE) units, using patient-centered care, discharge

planning, medication review and a specialized environment to maximize maintenance of ADL independence, have demonstrated reduced length of stay and hospital costs and an increased number of patients discharged to home (37,38). The post-hospital period may also be an important time for interventions to improve function and mobility in recently hospitalized older adults. Post-hospitalization studies that included physical therapy for older adults noted improvement in instrumental ADLs and walking ability (39,40). Thus, interventions are available to reduce adverse outcomes of hospitalization for older adults, potentially including the life-space mobility declines identified in the current study.

This study has a number of strengths including the racially balanced, population-based sample of community-dwelling older adults prospectively followed for over four years. The use of life-space, which is easily administered and detects both increases and decreases in community mobility and participation in society over time, is another strength. Assessments of life-space mobility were not captured immediately before and after hospitalization, however the use of longitudinal growth models allowed us to approximate these trajectories using the available data points from our biannual assessments. For the 211 hospitalized participants, life-space assessments occurred at some point during the six-months before and after the incident hospitalization. These time points, which occurred from 1 to 180 days before and after the incident hospitalization, were used to create the models presented. Some hospitalizations may have been missed due to failure to recall all hospitalizations. However, participants or their proxies would likely remember a hospitalization within 6 months as it is usually a major event. Using self-reported reasons for hospitalization limited our ability to determine emergent versus non-emergent surgeries, a difference that could influence life-space mobility recovery. Because admission reasons were self-reported, some misclassification was also possible. To address this concern categorization was limited to major surgical and non-surgical with the expectation that participants would likely remember any major surgical operations. Any other reason for hospitalization was then categorized as non-surgical. Data regarding use of rehabilitation services were not collected, which could impact on recovery of life-space after hospitalization.

We observed a high prevalence of life-space mobility declines after all hospitalizations. While participants with surgical hospitalizations made significant recoveries of their life-space mobility over time, those with non-surgical hospitalizations did not achieve this improvement to pre-hospital life-space status even after up to two years of follow-up. By using a global definition of function, as measured by the UAB Study of Aging Life-Space Assessment, we have demonstrated a significant proportion of patients are impacted by hospitalization and many never recover. This finding argues for further study into the processes of hospital care and development of interventions to lessen the negative impact of hospitalization on life-space mobility.

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Figure 1. Flow of potential participants

This figure shows the number of participants who were alive and participated through the four years of follow-up and that did or did not have an overnight hospitalization from the 6-month to the 48-month interview.

Figure 2. Trajectory of Adjusted Life-Space Mobility Decline and Recovery: Surgical Admissions Compared to Non-surgical Admissions

This figure shows the estimated trajectories of life-space mobility based on reason for admission after adjusting for covariates including age, gender, race, rural/urban status, comorbidities and ADL independence. Life-space mobility trajectories of participants hospitalized with a major surgical and non-surgical admission are shown in green and blue, respectively. For patients with a hospitalization, the calendar time for a hospitalization was centered at the median time to a first hospital admission (1.95 [IQR = 2.28]).

Table 1

Characteristics of Study Participants (N= 687)

	Participants with Surgical Hospitalization N = 44	Participants with Non- surgical Hospitalization N = 167	Participants Without Hospitalization N = 476	P value
	Mean $\pm$ s.d. or N (%)	Mean $\pm$ s.d. or N (%)	Mean $\pm$ s.d. or N (%)	
Age, Years	72.4 $\pm$ 3.9	76.1 $\pm$ 6.6	74.2 $\pm$ 6.3	.0003
Gender, Female	15 (34)	93 (56)	262 (55)	.02
Race, Black	17 (39)	72 (43)	255 (54)	.02
Rural Residence	19 (43)	80 (48)	242 (51)	.55
Comorbidity Score [*]	2.2 $\pm$ 1.2	2.3 $\pm$ 1.6	1.8 $\pm$ 1.4	.0002
Life-Space Assessment	75.8 $\pm$ 26.8	62.4 $\pm$ 24.9	68.4 $\pm$ 23.2	.001
Composite Score [†]				
Independent with all ADLs	26 (59)	78 (47)	312 (66)	.001

s.d. = Standard deviation ADLs = Activities of Daily Living

^{*} Comorbidity Score: Categories included congestive heart failure; previous heart attack or angina pectoris; valvular heart disease; peripheral vascular disease; hypertension; diabetes mellitus; respiratory problems; renal disease; liver disease; cancer other than skin cancer; any neurological disorder, including stroke, Parkinson's disease, seizures, or Alzheimer's disease; and stomach, bowel, or digestive problems.

[†] Score at 6-month assessment; see Methods section for detailed definitions

Table 2

Effect of Hospitalization on Adjusted Life-Space Assessment Scores

Life-Space Assessment Points (95% CI)*	Hospitalization Type		Difference	P for difference
	Surgical	Non-Surgical		
Before Hospitalization	62.72 (57.23, 68.21)	61.00 (58.16, 63.83)	1.73 (−4.46, 7.91)	0.55
Change Immediately After Hospitalization [†]	−22.45	−10.31	−12.14	0.005
Post-Discharge (change per log week) [†]	5.38 (3.03, 7.74)	0.66 (−0.60, 1.91)	4.72 (2.03, 7.42)	0.0006

* All estimates adjusted for the effects of gender sex, race, urban/rural residence, age at baseline (centered at age 75), comorbidity count at baseline (centered at 2), and number of ADL problems at baseline (centered at 1).

[†] Negative values reflect a decline in Life Space Points; positive values reflect an increase