Original Investigation

Comparison of Posthospitalization Function and Community Mobility in Hospital Mobility Program and Usual Care Patients
A Randomized Clinical Trial

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IMPORTANCE Low mobility is common during hospitalization and associated with loss or declines in ability to perform activities of daily living (ADL) and limitations in community mobility.

OBJECTIVE To examine the effect of an in-hospital mobility program (MP) on posthospitalization function and community mobility.

DESIGN, SETTING, AND PARTICIPANTS This single-blind randomized clinical trial used masked assessors to compare a MP with usual care (UC). Patients admitted to the medical wards of the Birmingham Veterans Affairs Medical Center from January 12, 2010, through June 29, 2011, were followed up throughout hospitalization with 1-month posthospitalization telephone follow-up. One hundred hospitalized patients 65 years or older were randomly assigned to the MP or UC groups. Patients were cognitively intact and able to walk 2 weeks before hospitalization. Data analysis was performed from November 21, 2012, to March 14, 2016.

INTERVENTIONS Patients in the MP group were assisted with ambulation up to twice daily, and a behavioral strategy was used to encourage mobility. Patients in the UC group received twice-daily visits.

MAIN OUTCOMES AND MEASURES Changes in self-reported ADL and community mobility were assessed using the Katz ADL scale and the University of Alabama at Birmingham Study of Aging Life-Space Assessment (LSA), respectively. The LSA measures community mobility based on the distance through which a person reports moving during the preceding 4 weeks.

RESULTS Of 100 patients, 8 did not complete the study (6 in the MP group and 2 in the UC group). Patients (mean age, 73.9 years; 97 male [97.0%]; and 19 black [19.0%]) had a median length of stay of 3 days. No significant differences were found between groups at baseline. For all periods, groups were similar in ability to perform ADL; however, at 1-month after hospitalization, the LSA score was significantly higher in the MP (LSA score, 52.5) compared with the UC group (LSA score, 41.6) (P = .02). For the MP group, the 1-month posthospitalization LSA score was similar to the LSA score measured at admission. For the UC group, the LSA score decreased by approximately 10 points.

CONCLUSIONS AND RELEVANCE A simple MP intervention had no effect on ADL function. However, the MP intervention enabled patients to maintain their prehospitalization community mobility, whereas those in the UC group experienced clinically significant declines. Lower life-space mobility is associated with increased risk of death, nursing home admission, and functional decline, suggesting that declines such as those observed in the UC group would be of great clinical importance.

TRIAL REGISTRATION clinicaltrials.gov Identifier: NCT00715962

JAMA Intern Med. doi:10.1001/jamainternmed.2016.1870
Published online May 31, 2016.

Invited Commentary

Supplemental content at jamainternalmedicine.com

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Hospitalization among older adults is associated with functional loss, including declines in ability to perform activities of daily living (ADL) and limitations in community mobility.[1-7] Approximately 40% of older adults experience a decline in the ability to perform ADL, with one-third failing to recover within a year after discharge.[6] The effect of hospitalization on community mobility may be even more concerning. Among a cohort of community-living older adults, hospitalization for a nonsurgical indication was associated with a clinically significant decline in community mobility with little evidence of recovery after up to 2 years of follow-up.[7]

Low mobility, defined as being limited to a bed or chair, is also common during hospitalization and is associated with a decline in the ability to perform ADL and the need for new nursing home admission, even after controlling for illness severity and comorbidity.[8] Although the mean length of stay for older adults is only 5.5 days,[9] the low mobility that occurs may contribute to the functional decline observed at hospital discharge given the added potential effect of illness and inflammation.[10-13] One study[13] found decreases in all functional capacity parameters, including strength, pulmonary function, and submaximal exercise tolerance, after 5 days of hospitalization in a cohort of patients not restricted to bed. Thus, older adults who experience low mobility during hospitalization are at substantially increased risk of serious declines in strength and function, which may lead to long-term mobility disability.[14]

Although a number of cohort studies[15-17] have found the potential beneficial effects of hospital mobility, no studies to date have used a randomized clinical trial design to determine the effect of a hospital mobility program in a general medical population.[18] The purpose of this study is to examine the effect of an in-hospital mobility program (MP) on posthospitalization function and community mobility 1 month after discharge among a cohort of older adults hospitalized for medical illness.

Key Points

Question What is the effect of an in-hospital mobility program on posthospitalization function and community mobility among a cohort of hospitalized older adults?

Findings In this randomized clinical trial that included 100 hospitalized older patients, those in a mobility program were less likely to experience a decline in community mobility when compared with usual care and were able to maintain their prehospitalization community mobility status.

Meaning An easy-to-implement mobility program that included offering assistance with ambulation twice a day linked with a behavioral intervention that focused on goal setting and addressing mobility barriers prevented loss of community mobility 1 month after hospital discharge.

Methods

Participants

Participants were 100 patients 65 years or older admitted to the medical wards of the Birmingham Veterans Affairs Medical Center (BVAMC) from January 12, 2010, through June 29, 2011, who were analyzed with intent to treat. Data analysis was performed from November 21, 2012, to March 14, 2016. The wards did not use any geriatric-specific programs, such as the Hospital Elder Life Program,[19] at the time of this study. Patients were identified Monday through Friday, and a trained research assistant performed a brief screening interview with the physician to establish key inclusion criteria, including age of 65 years or older, having a medical (vs surgical) reason for admission, and not being imminently terminal (death expected in the next 30 days). Common admission diagnoses included pneumonia, heart failure, and chronic obstructive pulmonary disease exacerbations. The presence of delirium or dementia was evaluated using the Confusion Assessment Method (CAM)[20] and the Mini-Cognitive Assessment (Mini-Cog),[21,22] respectively. Inclusion criteria were having a negative screening result for cognitive impairment (Mini-Cog score, ≥3), not being delirious (CAM score, 0), self-report of being ambulatory with or without an assistive device in the 2 weeks before admission, not having a significant language barrier that required a translator, and not previously enrolled in the study. The institutional review board of the Birmingham Veterans Affairs Medical Center approved the informed consent forms and all study protocols. The trial protocol can be found in the Supplement. Written informed consent was obtained from all participants.

Eight patients did not complete the study. During hospitalization, among MP participants, 3 were transferred to the intensive care unit (ICU), 1 became delirious, and 1 died, whereas 1 usual care (UC) participant withdrew consent. Patients who were transferred to the ICU or became delirious were withdrawn from the study and received no further intervention. Two patients died before the 1-month follow-up telephone call (1 from each group). A priori, on the basis of previous work,[10] we determined that a sample size of 45 per group provided 90% power to detect a 2-hour difference in time spend out of bed at the $\alpha = .05$ level. A study flow diagram is provided in the **Figure**.

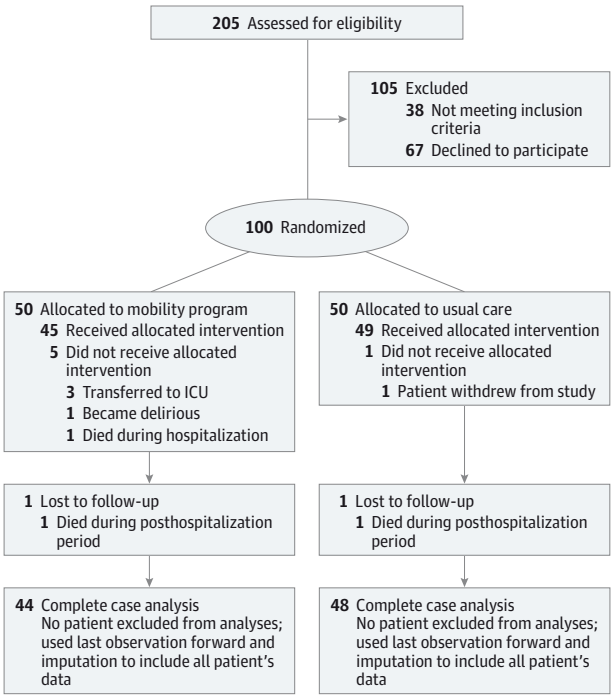
Assessments

Participants completed assessments before randomization to document demographics, functional status, mobility, and comorbidities. Experienced clinical researchers who underwent intensive training and interrater reliability assessments conducted the initial assessments. After randomization, assessments were completed throughout the hospitalization by a separate group of masked assessors. Approximately 4 weeks after discharge, all patients were contacted by telephone and asked to self-report on their function and mobility.

Functional Outcome Assessment

Participants were asked at baseline to rate their ability to perform basic ADLs (bathing, dressing, feeding, toileting, grooming, transferring, and walking) on admission and retrospectively for the 2 weeks before admission. This assessment was repeated at hospital discharge and by telephone 1 month after discharge. For each ADL, participants were asked whether

Figure. CONSORT Flow Diagram



Progress of the hospitalized patients through the phases of this clinical trial. ICU indicates intensive care unit.

they were independent, required some assistance, or required total assistance, and a summary score was created. The ADL summary score ranged from 7 (independent for each ADL) to 21 (required total assistance for each ADL).[23]

Community Mobility Assessment

At baseline and 1 month after hospital discharge, the University of Alabama at Birmingham Life-Space Assessment (LSA) was completed. The LSA is a tool that measures community mobility based on the distance through which a person reports moving during the 4 weeks that precede the assessment.[24,25] Life-space levels range from within one's bedroom to beyond one's town. A life-space composite score is calculated based on level, degree of independence in achieving each level, and frequency of attaining each level. Life-space composite scores range from 0 to 120, with higher scores representing greater mobility.[24] The LSA test-retest reliability had an interclass correlation of 0.96.

Frequency and independence of movement were incorporated into the LSA to capture important changes in mobility not captured by other assessments. The LSA has been validated as an important clinical measure of community mobility, predicting death, nursing home admissions, and hospitalization in some populations and reflecting important changes in mobility after hospitalizations.[7,26-28]

Hospital Mobility Assessment

Our initial trial registration described time out of bed using accelerometers as our primary outcome.[29] However, technical failures in this measure precluded use of accelerometer data. Therefore, this report focuses on outcomes from other aims in the protocol.

Sociodemographic Variables

Age was abstracted from the patient's medical records. Sex and race were self-reported and classified based on self-report. Options for race were not defined by the investigator. Race was assessed to ensure that results included an appropriate distribution.

Cognitive Assessments

Before informed consent was obtained, the presence of delirium and dementia was evaluated using the CAM[20] and Mini-Cog,[21,22] respectively. The CAM allows rapid assessment of the presence of delirium.[20] The Mini-Cog is a brief cognitive screening measure that includes a 3-item memory recall and a clock drawing test.[21,22] This test has sensitivity and specificity similar to the Mini-Mental State Examination.[30] The research assistants also used the CAM at each patient visit throughout the hospital stay to ensure that patients in either group did not develop incident delirium.

On study admission, participants were screened for depression using the Geriatrics Depression Scale Short Form, a 15-item screening tool used to assess for the presence of depression.[31,32] A score greater than 5 is considered a positive screening result.

Daily 24-Hour Fall Reporting

During the hospital stay, patients were asked to provide a daily 24-hour fall report.

Medical Records Data

Medical records were abstracted for hospital length of stay, information to determine the Charlson comorbidity index,[33] and illness severity using the Acute Physiology and Chronic Health Evaluation II.[34] Data regarding orders for physical therapy were also collected.

Intervention

After completion of the baseline assessments, patients were randomized to the MP or UC group using a block randomization strategy where for every block of 10, a total of 5 were allocated to each study arm. To achieve allocation concealment, sequentially sealed envelopes with assignments based on the randomization schedule were used. All members of the research team who transferred and walked with patients received in-depth training in safe patient handling techniques by BVAMC physical therapists. Proficiency and competency were documented using objective standards.

Hospital MP

A standard hospital mobility protocol was developed in which MP participants began with assisted sitting, then standing, progressing to weight shifting, stepping in place, and then ambulation as tolerated with the assistance of the research assistant. A rolling walker was provided if needed. Gait belts were used to ensure safe ambulation. The MP patients were seen up

to twice a day for 15 to 20 minutes each session 7 days a week. Although the MP patients were encouraged to walk at each session, they could refuse any or all sessions. The research assistant attempted to make at least 3 visits for each scheduled walk. If a patient was away at a test or busy with another health care professional, the research assistant returned at a later time to walk with the patient.

Behavioral Intervention Integration to the MP

In addition to assistance with walking, a behavioral intervention strategy was integrated to encourage MP patients to increase time spent out of bed. The goal was to encourage additional activity (outside provided walks) through use of an out-of-bed protocol based on social cognitive theory. Social cognitive therapy explains human behavior in terms of a dynamic, 3-way interaction among personal factors, environmental influences, and behavior.[35] A basic premise of social cognitive therapy is that people learn not only through their own experience but also through observing the actions of others and the result of those actions.

The level of out-of-bed activity was dependent on the individual patient and incorporated activities patients were deemed able to do independent of cueing or assistance during each walking session. For example, if a patient could stand at the bedside independently but required standby assistance for walking, he or she would be encouraged to sit on the side of the bed and stand for 3 to 5 minutes every 2 hours as able. The patient would be instructed not to attempt to walk without nursing assistance. To reinforce this behavior, the patient and research assistant set daily goals regarding the amount of time the patient would try to spend out of bed. To assist in self-monitoring of out-of-bed mobility, the MP patients were provided with a diary that could be used to document each time they sat up or walked. This diary was used by the research assistants to reinforce positive behavior and to set goals for the following day.

In addition to goal setting, patients were encouraged to discuss any barriers to mobility they were experiencing. Using an interview guide, the research assistant asked about mobility challenges and prompted patients to develop potential solutions to these challenges. For example, if the patient noted pain as a mobility challenge, the patient would be prompted for potential solutions. If the patient was unable to verbalize any solutions, the research assistant would suggest talking with the physician or nurse or using distraction techniques to reduce the challenge.

Usual Care

The UC patients received visits by the research assistant to control for the daily attention that MP patients receive. The visits were approximately 15 to 20 minutes long and occurred up to twice a day 7 days a week. The UC patients were provided with a diary that looked identical to those for the MP patients; however, the UC group was asked to document frequency of visitors, both family and health care professionals.

Physicians were able to order physical therapy services for the MP and UC groups. This referral was neither encouraged nor discouraged by the research team and did not affect the number of visits the research assistant made to the patient. Information was gathered from the medical record regarding frequency of physical therapy referrals.

Statistical Analysis

We used *t* tests and χ^2 tests to test for significant differences between the MP and UC groups for continuous and categorical variables, respectively. Because more patients in the MP group (n = 6) than the UC group (n = 2) were withdrawn because of death or ICU transfer before study end, there is the potential for biased results. Therefore, a sensitivity analysis was performed using 2 methods: (1) complete analysis with the reduced sample (ie, those patients with available data) and (2) multiple imputations (N = 25) using Markov chain Monte Carlo methods that assumed an arbitrary missing pattern for ADL and, separately, a monotone missing pattern for LSA. We examined group differences in ADL and LSA at specific time points using multivariate linear regression. Other covariates in multivariate models included age, race, and sex. For comparisons from multiple imputations, regression coefficients and their corresponding covariance matrices were combined, and statistical inferences about the regression model based on a *t*-distribution were generated. Mixed models were used to examine changes in ADL during 4 assessment periods, between the MP and UC groups, and tested for the presence of significant group-time interaction by including a group-time product term in the model. Analysis of covariance (ANCOVA) was used to test for significant changes in LSA from time of admission by including baseline admission values for LSA in multivariate models. Other covariates included in multivariate models included age, race, and sex. Our use of multiple imputations for ADL and LSA was based on a missing at random assumption (ie, an ignorable response mechanism) and that missing values were not related to ADL or LSA.

Results

Characteristics of the study cohort are given in **Table 1**. Overall, the group had a mean (SD) age of 73.9 (6.96) years, 97 (97.0%) were male, and 19 (19.0%) were black. No significant differences were found between the MP and UC groups for any baseline characteristics. The mean (SD) length of stay was 4.06 (3.29) days, with a range of 1 to 21 days. When the 5 patients who were withdrawn from the study because of ICU transfer, delirium, or death were removed from analysis, the mean (SD) length of stay was 3.6 (2.3) days. The mean (SD) baseline LSA scores of the 5 withdrawn patients compared with the rest of the cohort were 40.3 (9.4) and 53.3 (25.9), respectively ($P = .03$). No other significant differences were found between those who were withdrawn and the rest of the cohort.

The MP group completed 122 of the potential 238 walks (51.3%). Reasons for lack of completion included patient refusal (45 [18.9%]), patient unavailable because of tests or procedures (39 [16.4%]), staff not available (27 [11.3%]), and other (5 [2%]). Although 45 walks were refused during the study, 28 refusals (62.2%) came from 4 patients. Failure to complete a walk with the research team did not preclude the

Table 1. Characteristics of Study Population

Characteristic	UC (n = 50)	MP (n = 50)	*P* Value
Age, mean (SD), y	73.4 (7.0)	74.4 (6.9)	.48
Male, No. (%)	49 (98)	48 (96)	.56
Black, No. (%)	8 (16)	11 (22)	.44
LOS, mean (SD) [median], d	3.6 (2.4) [3.0]	4.6 (4.0) [3.0]	.13
GDS score, mean (SD)	5.0 (3.0)	4.7 (3.2)	.63
Charlson comorbidity index, mean (SD)	4.1 (2.6)	4.4 (2.4)	.55
APACHE II score, mean (SD)	15.3 (11.8)	14.3 (10.6)	.67
Physical therapy ordered during hospitalization, No. (%)	17 (34)	22 (44)	.30

Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation II; GDS, Geriatric Depression Scale; LOS, length of stay; MP, mobility program; UC, usual care.

Table 2. Analysis of Mean ADL and Life-Space Assessment Scores by Intervention Group[a]

Variable	Mean (SD)		*P* Value
	MP	UC	
ADL			
2 Weeks prior	8.0 (0.21)	8.0 (0.26)	.83
Admission	8.4 (0.27)	8.7 (0.33)	.47
Discharge	8.1 (0.29)	8.0 (0.25)	.96
After hospitalization	8.2 (0.30)	8.2 (0.32)	.99
Life-Space Assessment			
Admission	53.9 (4.15)	51.5 (2.99)	.46
After hospitalization	52.6 (4.39)	41.8 (3.15)	.02

Abbreviations: ADL, activities of daily living; MP, mobility program; UC, usual care.

[a] Multiple imputation methods were used to substitute missing values with imputed values.

patient completing additional walks independently. For the behavioral intervention component, which included goal setting and discussion of mobility barriers, the MP group completed 108 of the 135 visits (80.0%). The UC group completed 184 of the 223 visits (82.5%).

To assess safety of the in-hospital MP, patients were asked to provide a daily 24-hour fall report. The MP group reported no falls, whereas 2 patients in the UC group had a total of 3 falls while hospitalized.

Table 2 presents imputed estimates of mean self-reported ADL by group for the 2 weeks before admission, at admission, at discharge, and 1 month after hospitalization; in addition, imputed estimates of mean LSA scores measured at admission and 1-month after hospitalization are reported. For all periods, groups were similar in their ability to perform ADL ($P = .62$); furthermore, ability to perform ADL did not significantly change over time ($P = .77$), and there were no significant group-time interactions ($P = .76$). For LSA measured 1 month after hospital discharge, based on replacing missing LSA values with those derived from multiple imputation values, mean (SD) significant differences were found in LSA scores for the MP group (LSA score, 52.6 [4.39]) compared with the UC group (LSA score, 41.8 [3.15]) ($P = .02$).

Results from the ANCOVA reveal that after adjustment for baseline admission values and other covariates, the MP group had a 10-point higher 1-month posthospitalization LSA score compared with the UC group ($P = .02$) (**Table 3**). For the UC group, the LSA score decreased by approximately 10 points based on complete case analysis and imputation for missing values. In both analyses, posthospitalization LSA differences were significantly higher in the MP group compared with the UC group. The sensitivity analysis suggests that missing values had little effect on group differences in LSA scores because results of complete case analysis were similar to those derived from replacing missing data with imputed values.

Discussion

This study provides evidence that an easy-to-implement MP that included offering assistance with ambulation twice a day linked with a behavioral intervention that focused on goal setting and addressing mobility barriers prevented loss of community mobility 1 month after hospital discharge. Those who received UC experienced a clinically significant 10-point decrease in community mobility as measured by LSA. An example of a 10-point decrease would be an older person who previously reported no assistance to go into town 1 to 3 times a week (LSA score, 64) but who now requires a cane to go into town and goes less than once a week (LSA score, 54). In addition, the hospital mobility program appears to be safe, with 3 falls reported in the UC group but no falls reported in the MP group.

The loss of community mobility observed among our UC cohort is similar to findings from a cohort study of life-space recovery after hospitalization among 1000 community-dwelling older adults. That study found that patients with a nonsurgical hospitalization, on average, experienced a similar 10.3-point (95% CI, −14.3 to −6.3) decrease in LSA score after adjustment for demographic covariates and ADL impairments with little evidence of recovery even after up to 2 years of follow-up.[7] Lower life-space mobility is associated with increased risk of death, nursing home admission, functional decline, and cognitive impairment,[24-28,36] suggesting that

Table 3. Group Differences in ADL and Life-Space Assessment Scores Between the MP and UC Groups, Adjusting for Admission Values, Age, Sex, and Race

Variable	Imputation[a]	*P* Value
ADL[b]		
Discharge	−0.21	.67
After hospitalization	0.05	.76
Life-Space Assessment[c]		
After hospitalization	10.0	.02

Abbreviations: ADL, activities of daily living; MP, mobility program; UC, usual care.

[a] Multiple imputation methods were used to substitute missing values with imputed values.

[b] On the basis of mixed-model analysis of multiple imputations (n = 25) adjusted for age, sex, and race.

[c] Analysis of covariance of 25 multiple imputations (n = 25) adjusted for baseline admission values; model also includes age, sex, and race.

declines such as those observed in the UC group would be of great clinical importance.

Functional decline is common after hospitalization.[1-7] Unlike prior studies[1-6] of ADL decline, we did not observe a significant change in ability to perform ADL after hospitalization. However, study patients did not have dementia or delirium, which may have affected our findings. In addition, the study was not powered to see significant ADL changes.

In qualitative studies,[37,38] concern regarding falls has been raised as a barrier to mobility. However, this study found that falls were more likely to occur in the UC than the MP group, lending strength to the potential use of mobility as an intervention to reduce hospital falls. In 1 prospective cohort study[39] of an in-hospital fall prevention program, participants received mobility-related interventions, including provision of mobility devices, encouragement of early mobility, and frequent toileting assistance. Falls were lowest in patients with the highest mobility scores, but patients at all mobility levels gained from the intervention. Further research is needed to determine the potential efficacy of using increased hospital mobility as a fall prevention tool.

A number of studies[15,16,40,41] have examined the effect of hospital mobility on in-hospital outcomes. Mundy et al[40] compared UC with early progressive mobilization in a cohort of patients with community-acquired pneumonia and found that those who were mobilized early were able to leave the hospital sooner (adjusted absolute difference, 1.1 days; 95% CI, 0.0-2.2 days) and had no significant differences in mortality rates, emergency department visits, or subsequent hospitalizations. Preliminary results of a Veterans Affairs clinical demonstration of a supervised walking program found a reduction in length of stay and a higher likelihood of discharge to home among those who participated compared with those who declined.[16] A nurse-driven mobility protocol found improvement in Barthel index scores and a reduced length of stay among study participants.[15] There is additional evidence that hospital patients who walk in the hallways at least daily are at lower risk of ADL and instrumental ADL decline during and after hospitalization.[41]

Although a number of studies[15,16,40,41] have found the potential beneficial effects of hospital mobility, this is the first, to our knowledge, to use a randomized clinical trial design in a cohort of general medical patients and to examine outcomes beyond those occurring during hospitalization. In addition, the intervention is easy to implement and has the potential to be incorporated into UC at any hospital. Specifically, by focusing on a walking intervention with a behavioral component that encourages out-of-bed mobility and goal setting, the intervention does not require the specialized skills of a physical therapist but rather can be delivered by a mobility aide or possibly by well-trained volunteers.

Because this study was performed in a Veterans Affairs hospital with mostly male patients, it may not be generalizable. In addition, study patients did not have dementia or delirium, so the level of out-of-bed mobility may be higher than that seen in a general medicine population. However, this group had a significant burden of comorbidities and was acutely ill, as indicated by their comorbidity count and Acute Physiology and Chronic Health Evaluation II scores. Although this is a small study that needs replication, it provides evidence of the safety and efficacy of a hospital mobility program.

Conclusions

A hospital MP that included assistance with ambulation and a behavioral intervention to encourage mobility was safe and effective. Patients in the MP group were less likely to experience a decline in community mobility when compared with UC and were able to maintain their prehospitalization community mobility status. Currently, there is no standard of care regarding mobility in hospitalized older adults. This study provides evidence of the positive effect of mobility during hospitalization among older adults, although the findings require replication before large-scale implementation can be recommended.

ARTICLE INFORMATION

Accepted for Publication: March 15, 2016.

Published Online: May 31, 2016. doi:10.1001/jamainternmed.2016.1870.

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Author Contributions: Drs Brown and MacLennan had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
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Statistical analysis: MacLennan, Razjouyan.
Obtained funding: Brown.
Administrative, technical, or material support: Brown, Foley, Lowman, Razjouyan, Najafi, Allman.
Study supervision: Brown.

Conflict of Interest Disclosures: Dr Brown reported working as a consultant for Novartis. No other disclosures were reported.

Funding/Support: This study was supported in part by Veterans Affairs Career Development Award E6326-W (Dr Brown).

Role of the Funder/Sponsor: The funding source had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and the decision to submit the manuscript for publication.

Previous Presentation: This study was presented in part at the American Geriatrics Society Annual Meeting; May 4, 2013; Grapevine, Texas.

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