Prognostic Value of Braden Activity Subscale for Mobility Status in Hospitalized Older Adults

Vincenzo Valiani, MD[1,2*], Zhiguo Chen, PHHP-BIO[1-3], Gigi Lipori, MT, MBA[4], Marco Pahor, MD[1], Carlo Sabbá, MD[2], Todd M. Manini, PhD, FACSM[1*]

[1]Department of Aging & Geriatric Research, University of Florida, Gainesville, Florida; [2]Clinica Medica Cesare Frugoni, Dipartimento Interdisciplinare di Medicina, University of Bari Aldo Moro, Bari, Italy; [3]Department of Biostatistics, University of Florida, Gainesville, Florida; [4]UF Health, University of Florida, Gainesville, Florida.

OBJECTIVES: To evaluate the predictive value of the Activity subscale of the Braden Scale for Predicting Pressure Sore Risk in assessing mobility impairment and recovery among hospitalized older adults.

DESIGN: Retrospective cohort study.

SETTING: UF Health Shands Hospital, University of Florida, Gainesville, Florida.

PATIENTS: 19,769 older adults (≥65 years) hospitalized between January 2009 and April 2014.

MEASUREMENTS: Incident mobility impairment and recovery were assessed with the Braden Activity subscale (BAS) score that nurses use to grade patients at every shift change (~3 times/d). Posthospital mortality rate and discharge disposition were used to assess the prognostic value of the BAS.

RESULTS: Of the 10,717 study patients observed "walking frequently" at admission, 2218 (20.7%) developed incident mobility impairment. Of the other 9052 study patients, who were impaired at admission, 4734 (52.3%) recovered to a state of walking occasionally or frequently. Older adults who developed mobility impairment during hospitalization had an odds of death higher than that of those who remained mobile (odds ratio [OR], 1.23; 95% confidence interval [CI], 1.08-1.39). This effect predominately occurred within the first 6 follow-up months. Older adults who recovered from mobility impairment had an odds of death lower than that of those who did not recover mobility in the hospital (OR, 0.54; 95% CI, 0.49-0.59). This effect was slightly stronger within the first 6 months after hospitalization.

CONCLUSIONS: Nurses' BAS assessment of mobility status during hospitalization provides substantial prognostic value in hospitalized older adults. The BAS could be an efficient and valuable source of information about mobility status for targeting posthospital care of older adults. *Journal of Hospital Medicine* 2017;12:396-401. © 2017 Society of Hospital Medicine

In-hospital mobility (walking and transferring) is an important modifiable factor for posthospital functional outcomes and mortality among older adults.[1-4] In fact, daily mobility assessment has been considered for a standard clinical evaluation of the hospitalized older adult.[5,6] This would provide a ready source for targeting patients at risk for mobility impairment and identifying strategies to prevent in-hospital mobility limitation and posthospital functional decline. Despite their potential importance, mobility assessment tools have not been readily adopted in the hospital setting.

There are various ways to assess mobility in hospital settings. Mobility tracking technology (radar and accelerometers) has demonstrated older adults have extremely low mobility during hospitalization. Although these objective methods provide an unbiased way to monitor physical activity level and track in-hospital mobility change,[6-8] and have provided important information about mobility in the hospital, they are largely impractical in real-world settings.

While mobility technology appears to be advancing, there is a potential to assess in-hospital mobility using commonly administered and inexpensive tools. Many hospitals ask staff to regularly rate physical function (Braden and Morse score) as part of their standard-of-care procedures. The rating scales used have the potential to provide valuable information about mobility variations without using special equipment or burdening patients. The Braden Scale for Predicting Pressure Sore Risk is a good example of a validated assessment instrument that is better than nurses' judgment, which is often confounded by nursing experience.[9] This scale, which has 6 subscales (Sensory Perception, Moisture, Activity, Mobility, Nutrition, Friction and Shear), has shown high sensitivity in detecting patient condition changes in the clinical setting.[10] The scale typically is used holistically to evaluate pressure ulcer risk, but the Activity subscale, which assesses mobility, could serve as a useful tool for predicting posthospital recovery and identifying needs for posthospital mobility interventions.

We conducted a study to evaluate the prognostic value of using the Braden Activity subscale (BAS) to identify in-hospital incident mobility impairment and recovery for

***Addresses for correspondence and reprint requests**: Vincenzo Valiani, MD, Department of Aging & Geriatric Research, University of Florida, 2004 Mowry Rd, Gainesville, FL 32611; Telephone: +39 3473618120; Fax: +39 0805478670; E-mail: v.valiani@ufl.edu, vincio86@gmail.com. Todd M. Manini, PhD, FACSM, Department of Aging & Geriatric Research, University of Florida, 2004 Mowry Rd, Gainesville, FL 32611; Telephone: 352-273-5914; Fax: 352-273-5920; E-mail: tmanini@ufl.edu

Received: August 27, 2016; **Revised:** February 2, 2017; **Accepted:** February 5, 2017

2017 Society of Hospital Medicine DOI 10.12788/jhm.2748

predicting mortality and discharge status among hospitalized older adults.

METHODS

The University of Florida Gainesville Health Science Center Institutional Review Board reviewed and approved the study protocol as exempt from human subjects' research.

Design and Setting

The design followed a retrospective cohort study in which hospitalized patients were evaluated at admission (baseline) and assessed throughout their stay for incident mobility impairment and recovery. Data were collected in older adults (≥65 years old) hospitalized at UF Health Shands Hospital (University of Florida), an 852-bed level I trauma center in Gainesville, Florida.

Data Sources

Patient data from electronic medical records were warehoused in an integrated data repository (IDR) between January 1, 2009 and April 20, 2014. The IDR aggregates clinical and administrative system data, which can subsequently be used for research. The data were compiled in a de-identified longitudinal dataset that included demographics, Charlson Comorbidity Index,[11] hospital length of stay, BAS scores (at admission, during hospitalization, at discharge), discharge disposition (including in-hospital death), and mortality after hospitalization (from the national Social Security Death Index).

Patients

The study population consisted of 19,769 older adults (≥65 years old) hospitalized between January 1, 2009 and April 20, 2014.

Outcomes

The major outcomes were patients' primary discharge disposition and posthospital mortality over 4.5-year follow-up. Discharge dispositions were divided into 9 categories: expired in hospital, other hospital admission, home, home care, hospice, rehabilitation, skilled nursing home, healthcare facility, or other, which included psychiatric facilities, court, or law enforcement.

Predictors

The BAS was used to identify incident mobility impairment and incident mobility recovery during hospitalization and subsequently was used to predict discharge disposition and mortality. The Braden scale,[12] which is commonly administered to predict pressure sores, has 6 subscales: Sensory Perception, Moisture, Activity, Mobility, Nutrition, and Friction and Shear. Each subscale has a score of 1 to 4, with higher scores representing higher activity levels. In particular, the BAS measures the mobility (walking and transferring) level of the hospitalized patient with a score of 1 ("patient is confined to bed"), 2 ("severely limited or nonexistent ability to walk; patient cannot bear his own weight and/or must be assisted into chair or wheelchair"), 3 ("patient walks occasionally during the day, but for very short distances, with or without assistance; he spends majority of each shift in bed or chair"), or 4 ("patient walks outside the room at least twice a day and inside the room at least once every 2 hours during waking hours"). The BAS is correlated with the total Braden scale[10] and has shown excellent interrater reliability (interclass correlation coefficient, 0.96) among hospital staff.[13] Analysis of the current dataset revealed excellent rater agreement across 3 working shifts ($\kappa = 0.76$ for first day of hospitalization in those hospitalized <3 days; $\kappa = 0.70$ for first day in those hospitalized ≥3 days).

UF Health Shands Hospital nursing staff administered the BAS at each shift change during a hospital stay (~3 times/d). Mobility scores were averaged across an entire day to reduce potential interrater variation. A daily average BAS score cutpoint was chosen to capture an absorbing mobility state. Average BAS score ≥3 was selected, as it indicates a patient is mobile most of the day, whereas average BAS score <3 indicates significant mobility impairment most of the day. The average daily score was calculated with a minimum of 3 determinations per day. Incident mobility impairment was defined as first transition from "being able to walk occasionally or twice a day outside or at least once every 2 hours during waking hours" to "severely limited or nonexistent ability to walk or confined to bed." Numerically speaking, daily average BAS score transition from ≥3 at admission to <3 during hospitalization constituted a mobility impairment event. Incident mobility recovery was evaluated in those patient hospital observations that were "severely limited or nonexistent ability to walk or confined to bed" at admission. Incident mobility recovery was defined as first transition to "ability to walk occasionally or twice a day outside or at least once every 2 hours during waking hours." A mobility recovery event was operationally defined as daily average BAS score transition from <3 at admission to daily average of ≥3 during hospitalization.

Data Analysis

Patient baseline characteristics are reported as counts, means, or medians. Chi-square statistics were used to test group differences for categorical variables, and analysis of variance was performed for continuous variables. Posthospital outcomes were evaluated descriptively and with time-to-event analyses. Kaplan-Meier curves and Wilcoxon *P* were also used to compare the survival probability for the mobility impairment and recovery groups. Although Cox proportional hazard regression is appropriate for these data, we found the proportionality assumption tenuous. As an alternative, logistic regression was used to model the probability of impairment/recovery outcomes. In addition, a survival time estimate that is robust to the proportionality assumption was derived according to Royston and Parmar[14,15] and Zhao et al.[16] This approach reports the difference between 2 survival curves using the restricted mean—a measure of average

TABLE 1. Selected Baseline Characteristics of Study In-Hospital Patients

Characteristic	Overall Sample (N = 19,769)	Normal Mobility at Admission (n = 10,717)	Impaired Mobility at Admission (n = 9052)
Admission age, y	74.65 ± 7.46	73.73 ± 7.00	75.73 ± 7.84
Diagnosis count	13.09 ± 6.76	11.75 ± 6.17	14.67 ± 7.09
Median (IQR) length of stay	4 (2, 7)	3 (2, 6)	5 (3, 9)
Charlson Comorbidity Index	2.39 ± 2.33	2.22 ± 2.31	2.59 ± 2.34
Myocardial infarction	2032 (10.28%)	1037 (9.68%)	995 (10.99%)
Congestive heart failure	3545 (17.93%)	1674 (15.62%)	2871 (22.67%)
Peripheral vascular disease	2606 (13.18%)	1139 (10.63%)	1467 (16.21%)
Cerebrovascular disease	2800 (14.16%)	1021 (9.53%)	1779 (19.65%)
Dementia	706 (3.57%)	197 (1.84%)	509 (5.62%)
Diabetes	5225 (26.43%)	2679 (25.00%)	2546 (28.13%)
Cancer	3076 (15.56%)	1895 (17.68%)	1181 (13.05%)

NOTE: Except where indicated otherwise, values are n (%) for categorical variables and mean ± SD for continuous variables. All comparisons statistically different at $P < 0.001$. Abbreviation: IQR, interquartile range.

TABLE 2. Odds Ratios, Confidence Intervals, and Restricted Mean Survival Time

Mobility	OR (95% CI) for Total Follow-Up Time	Survival Time for Total Follow-Up Time[a]	OR (95% CI) for ≤6 Months	Survival Time for ≤6 Months[a]	OR (95% CI) for >6 Months	Survival Time for >6 Months[a]
Decline	1.23[b] (1.08, 1.39)	39.7 (38.9, 40.4)	1.67[b] (1.40, 1.96)	2.1 (1.9, 2.3)	1.01 (0.86, 1.29)	45.4 (44.9, 45.9)
Recovery	0.54[b] (0.49, 0.59)	42.2 (41.7, 42.7)	0.38[b] (0.34, 0.43)	2.4 (2.2, 2.5)	0.84[b] (0.73, 0.96)	46.0 (45.7, 46.3)

[a]Survival time calculated as months using restricted mean survival time as outlined in Methods section.

[b]Statistically different at $P < 0.05$.

NOTE: Values are adjusted for covariates age, sex, race, and hospital length of stay. Abbreviations: CI, confidence interval; OR, odds ratio.

survival using the area under the survival curve from time point zero to last observed follow-up time. All models were adjusted for age, sex, race, and hospital length of stay. Analyses were performed with R 3.1.1.[17] All analyses were 2-tailed, and an α of 0.05 was considered statistically significant.

RESULTS

Table 1 lists the baseline characteristics of the hospitalized patients: 10,717 (54%) with normal mobility at admission and 9052 (46%) admitted with impaired mobility. Compared with patients admitted with normal mobility, those with impaired mobility at admission were older, mean (SD) 75.73 (7.84) years versus 73.73 (7.00) years; spent more days in the hospital, median 5 days versus 3 days; and had a higher Charlson Comorbidity Index, mean (SD) 2.59 (2.34) versus 2.22 (2.31). Patients with impaired mobility at admission had a significantly higher prevalence of myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, and diabetes. However, cancer was significantly more prevalent among patients admitted with normal mobility compared with those admitted with impaired mobility.

Of the 10,717 patients with normal mobility at admission, 2218 (20.7%) had incident mobility impairment over a median follow-up of 3 days (interquartile range, 2-5 days). Of the 9052 patients admitted with impaired mobility, 4734 (52.3%) recovered from their impairment over a median follow-up of 5 days (interquartile range, 3-9 days).

The Kaplan-Meier curves in Figure 1 show survival probability between patients who did and did not develop incident mobility impairment during hospitalization, as well as between patients who did and did not recover incident mobility. Table 2 lists the odds ratios (ORs) and restricted mean survival times for patients who developed impairment and patients who recovered. The results are provided for the entire follow-up period and for before and after 6 months of follow-up. Older adults who became mobility impaired in the hospital had an odds of death higher than that of those who remained mobile (OR, 1.23; 95% confidence interval [CI], 1.08-1.39). This effect predominately occurred within the first 6 follow-up months (OR, 1.67; 95% CI, 1.40-1.96). Older adults who recovered from mobility impairment had an odds of death lower than that of those who did not recover mobility in the hospital (OR, 0.54; 95% CI, 0.49-0.59). This effect was slightly stronger within the first 6 months after hospitalization but remained significant after 6 months. Figure 2 shows the percentages of different discharge dispositions for mobility impairment and recovery. Older adults with mobility impairment were more likely to die in the hospital or to be discharged to hospice. Otherwise, patients who recovered their mobility during hospitalization were more likely to be discharged home and to home care.

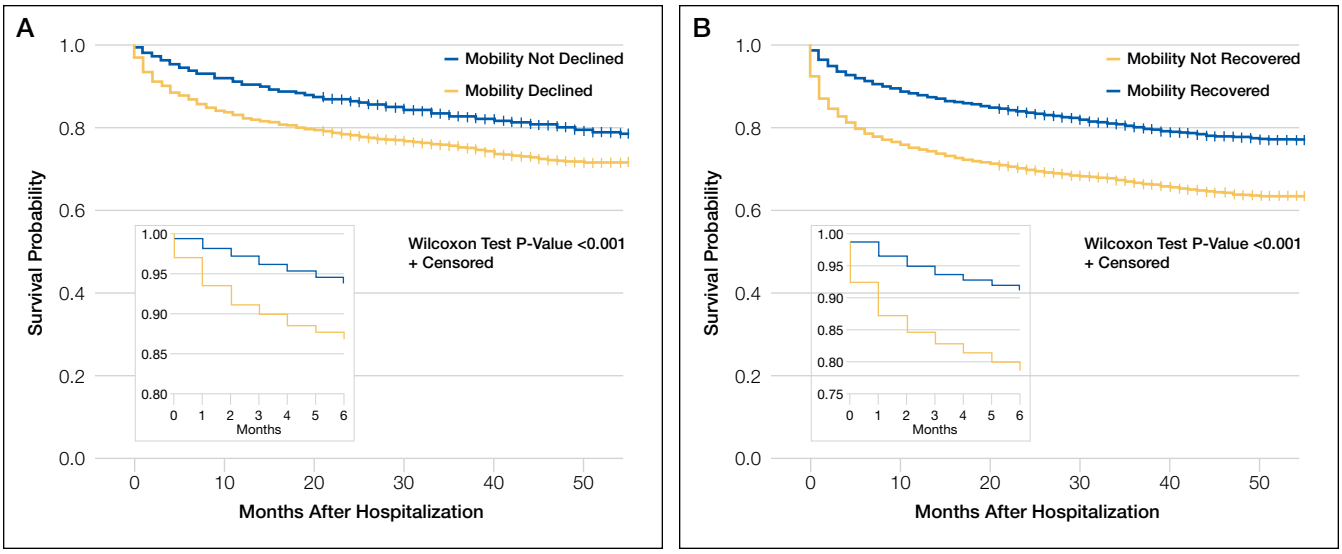

FIG. 1. Kaplan-Meier plot of survival probability (A) between patients with and without incident mobility impairment during hospitalization and (B) between patients with and without incident mobility recovery during hospitalization.

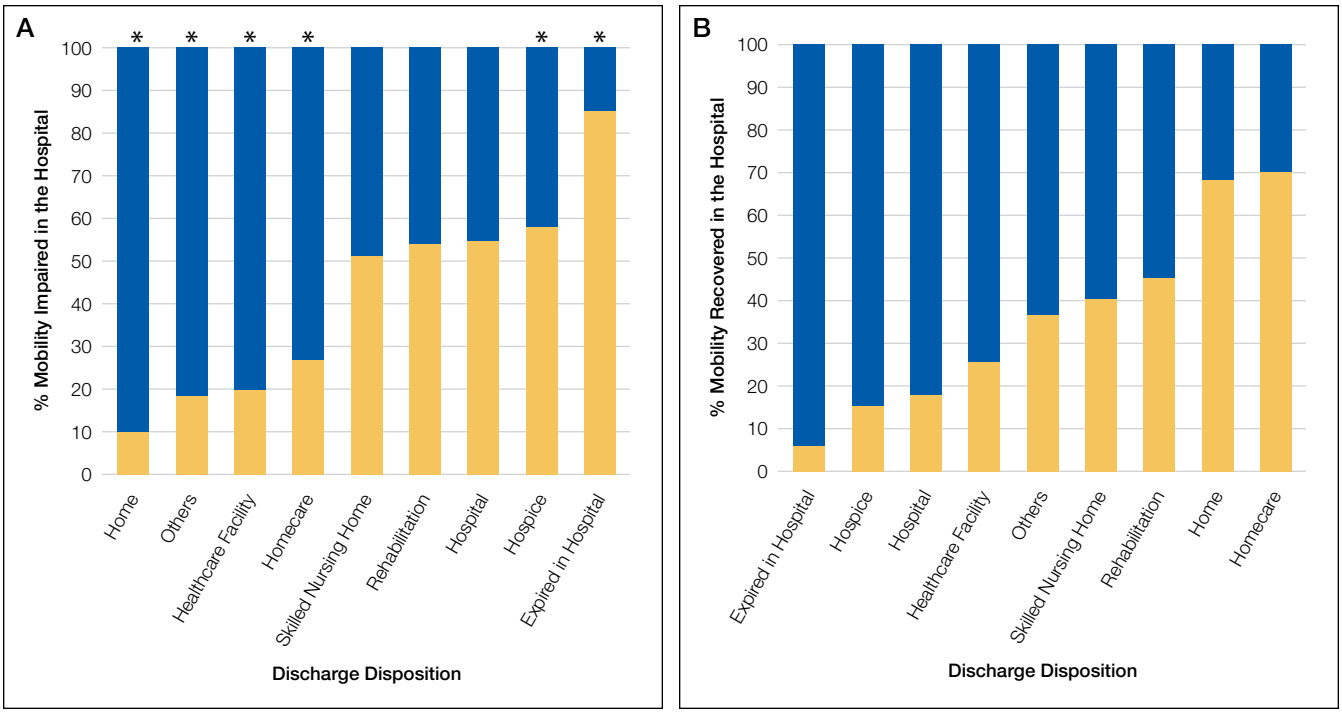

FIG. 2. Percentage of patients discharged to various locations for (A) incident mobility impairment and (B) incident mobility recovery during hospitalization. *Proportions significantly different from chance alone ($P < 0.05$). All percentages in B are statistically different ($P < 0.05$).

DISCUSSION

In this study, we evaluated the predictive value of the BAS in assessing incident mobility impairment and recovery during hospitalization among older adults. Patients admitted with impaired mobility were older, spent more days in the hospital, and had more comorbidities than those admitted with normal mobility. Compared with older adults who did not develop incident mobility impairment during hospitalization, those who became mobility impaired had a higher posthospital mortality risk and a higher prevalence of in-hospital death and hospice discharge. In addition, compared with older adults who did not recover mobility in the hospital, those who recovered mobility had a lower posthospital mortality risk and a higher prevalence of home discharge. It is interesting that incident in the hospital appears to have a finite effect. The association was largely erased 6 months after discharge. This was also observed in patients who recovered their mobility in the hospital, but to a lesser extent. Overall, the results suggest that

developing mobility impairment or recovering from mobility impairment in the hospital is an important predictor of discharge status and posthospital mortality.

The large number of patient observations and repeated evaluation of in-hospital mobility made this analysis possible. To our knowledge, this is the first large-scale study to evaluate the predictive value of the BAS in assessing mobility impairment and recovery during hospitalization among older adults. Such a test provides a simple and efficient assessment of in-hospital mobility changes that are sensitive to discharge locations and posthospital mortality risk.

Poor mobility in the hospital is associated with higher posthospital mortality. Kasotakis et al.[18] evaluated the predictive value of a nursing staff–assessed clinical mobility score for surgical critically ill patients whose functional mobility was unimpaired on presentation. The Surgical Intensive Care Unit Optimal Mobility Score has been shown to be a reliable and valid tool for predicting mortality in a relatively young population (average age, 60 years). Using accelerometer technology with older adults, Ostir et al.[7] found that each 100-step increase was associated with 2% and 3% lower risk of death over 2 years in the first and last 24 hours of hospitalization, respectively. The present mortality results show that mobility patterns in the hospital are crucially important for patients' health the first 6 months after discharge. This finding suggests that developing mobility impairment in the hospital is a sign for significant and rapid health decline. It also suggests that interventions need to be started relatively early in order to reduce the risk of death. In contrast, patients who recover mobility in the hospital obtain a substantial mortality risk reduction. In-hospital interventions to enhance mobility recovery and prevent mobility impairment could have a large impact on posthospital adverse events, particularly for older patients, who are susceptible to disease complications.

Regarding discharge disposition, Sommerfeld and von Arbin[19] found that the ability to rise from a chair (a component of mobility) during hospitalization was a strong predictor of early discharge home. Similarly, Vochteloo et al.[20] found that limited mobility as assessed with a questionnaire was associated with discharge to a location other than home among patients with hip fracture. We utilized existing information, collected at a relatively high resolution (3 times per day) that is often readily available without added patient burden. This is particularly important in the hospital setting, where added assessments in frail older adults and in those with multimorbid conditions is challenging. Although our approach is appealing, we should note that BAS scores were modified to reduce interrater variation and capture more absorbing mobility states over a hospitalized day, and that a similar approach would be required to replicate these results and provide clinical value to the BAS as a prognostic indicator of posthospital mortality.

Despite the strengths of this study, it had notable limitations. Pooling BAS scores could have modified the interpretation and clinical implications of the results. Although we had a large number of patient observations, this retrospective analysis may have had biases that were not completely considered. In addition, the results of this single-center study cannot be generalized across all hospital systems. The Braden activity sub score has demonstrated good validity and reliability for activity changes[13], but this measure was not objectively ascertained as demonstrated by others using accelerometers[6-7]. Moreover, the medical records used did not provide prehospital patient mobility status, limiting adjustments for prehospital mobility function. Despite these limitations, this study represents an important initial step in validating a simple and efficient clinical tool for identifying in-hospital mobility impairment and recovery and predicting posthospital adverse outcomes.

BAS assessment of incident mobility impairment and recovery in the hospital setting has prognostic value in predicting discharge disposition, in-hospital death, and posthospital mortality risk. That the majority of the effect appears to occur within the first 6 months after discharge suggests that interventions to improve mobility should be started during hospitalization or expeditiously after discharge. Overall, this study's results showed that a simple and efficient mobility status assessment can become a valuable clinical and administrative tool for targeting and improving mobility in the hospital and after discharge in older adults.

Acknowledgments

This work was supported by the National Institutes of Health and the National Center for Advancing Translational Sciences (NIH/NCATS) Clinical and Translational Science Award to the University of Florida (UL1 TR000064) and by the University of Florida's Claude D. Pepper Center (P30AG028740-R6, significant contributions from the Data and Applied Science Core and Biostatistical Core).

Disclosure: Nothing to report.

References

1. Zisberg A, Shadmi E, Gur-Yaish N, Tonkikh O, Sinoff G. Hospital-associated functional decline: the role of hospitalization processes beyond individual risk factors. *J Am Geriatr Soc*. 2015;63(1):55-62.
2. Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc*. 2003;51(4):451-458.
3. Hirsch CH, Sommers L, Olsen A, Mullen L, Winograd CH. The natural history of functional morbidity in hospitalized older patients. *J Am Geriatr Soc*. 1990;38(12):1296-1303.
4. Inouye SK, Peduzzi PN, Robison JT, Hughes JS, Horwitz RI, Concato J. Importance of functional measures in predicting mortality among older hospitalized patients. *JAMA*. 1998;279(15):1187-1193.
5. Zisberg A, Shadmi E, Sinoff G, Gur-Yaish N, Srulovici E, Admi H. Low mobility during hospitalization and functional decline in older adults. *J Am Geriatr Soc*. 2011;59(2):266-273.
6. Brown CJ, Redden DT, Flood KL, Allman RM. The underrecognized epidemic of low mobility during hospitalization of older adults. *J Am Geriatr Soc*. 2009;57(9):1660-1665.
7. Ostir GV, Berges IM, Kuo YF, Goodwin JS, Fisher SR, Guralnik JM. Mobility activity and its value as a prognostic indicator of survival in hospitalized older adults. *J Am Geriatr Soc*. 2013;61(4):551-557.
8. Fisher SR, Graham JE, Brown CJ, et al. Factors that differentiate level of ambulation in hospitalised older adults. *Age Ageing*. 2012;41(1):107-111.
9. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, Alvarez-Nieto C. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs*. 2006;54(1):94-110.
10. Sardo P, Simões C, Alvarelhão J, et al. Pressure ulcer risk assessment: retrospective

analysis of Braden scale scores in Portuguese hospitalised adult patients. *J Clin Nurs*. 2015;24(21-22):3165-3176.
11. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-383.
12. Bergstrom N, Braden BJ, Laguzza A, Holman V. The Braden Scale for Predicting Pressure Sore Risk. *Nurs Res*. 1987;36(4):205-210.
13. Wang LH, Chen HL, Yan HY, et al. Inter-rater reliability of three most commonly used pressure ulcer risk assessment scales in clinical practice. *Int Wound J*. 2015;12(5):590-594.
14. Royston, Parmar MK. The use of restricted mean survival time to estimate the treatment effect in randomized clinical trials when the proportional hazards assumption is in doubt. *Stat Med*. 2011;30(19):2409-2421.
15. Royston P, Parmar MK. Restricted mean survival time: an alternative to the hazard ratio for the design and analysis of randomized trials with a time-to-event outcome. *BMC Med Res Methodol*. 2013;13:152.
16. Zhao L, Claggett B, Tian L, et al. On the restricted mean survival time curve in survival analysis. *Biometrics*. 2016;72(1):215-221.
17. R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing; 2014. http://www.R-project.org. Published 2014. Accessed April 25, 2017.
18. Kasotakis G, Schmidt U, Perry D, et al. The Surgical Intensive Care Unit Optimal Mobility Score predicts mortality and length of stay. *Crit Care Med*. 2012;40(4):1122-1128.
19. Sommerfeld DK, von Arbin MH. Disability test 10 days after acute stroke to predict early discharge home in patients 65 years and older. *Clin Rehabil*. 2001;15(5):528-534.
20. Vochteloo AJ, Tuinebreijer WE, Maier AB, Nelissen RG, Bloem RM, Pilot P. Predicting discharge location of hip fracture patients; the new discharge of hip fracture patients score. *Int Orthop*. 2012;36(8):1709-1714.