

# Predictors of Regaining Ambulatory Ability During Hospitalization

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**BACKGROUND:** Loss of ambulatory ability with acute hospitalization is common and often does not improve by discharge.

**OBJECTIVES:** To define admission predictors of regaining ambulatory ability during hospitalization in patients with expected activity limitations.

**DESIGN:** Prospective cohort study.

**SETTING:** University teaching hospital.

**PARTICIPANTS:** Two hundred and eighty-six patients at least 55 years of age whose activity was expected to be limited to a bed or chair for at least the first 5 days of hospitalization or who had a hip fracture, who were ambulatory in the 4 weeks prior to hospital admission, and whose length of stay in the hospital was less than 32 days.

**MEASUREMENTS:** Baseline data collected from admission physician and nurse interviews and abstracted from the medical records included length of stay, demographic characteristics, global health measures, presence of specific diseases, and hospital-related factors hypothesized to affect ambulation. Nurses were asked weekly if patient activity was still expected to be limited to a bed or chair.

**RESULTS:** Despite initially being limited to a bed or chair, 42% had regained ambulatory ability by discharge. Recovery of ambulatory ability was independently associated with not being married (odds ratio [OR] = 3.0, 95% confidence interval [CI] 1.4-6.2), higher physician-rated life expectancy (OR = 1.9, 95% CI 1.3-2.8), absence of restraints (OR = 2.5, 95% CI 1.2-5.5), having a urinary catheter (OR = 2.2, 95% CI 1.2-5.5), having deep vein thrombosis (OR = 11.4, 95% CI 1.2-105.1), and having a higher level of bed mobility at admission (OR = 1.7, 95% CI 1.1-2.6).

**CONCLUSIONS:** Recovery of ambulatory ability is closely associated with physician-rated life expectancy and hospital-related factors, particularly those that affect mobility. Early recognition of who will recover ambulatory ability may help with discharge planning and potential interventions. *Journal of Hospital Medicine* 2006;1:277-284. © 2006 Society of Hospital Medicine.

**KEYWORDS:** frail elderly, hospitalization, recovery of function.

**F**unctional decline, defined as loss of the ability to care for oneself, commonly occurs during hospitalization, being experienced by up to 65% of older adults.<sup>1-4</sup> Frequently, recovery of functional ability does not occur by the time of discharge from the hospital, despite resolution of the medical condition responsible for admission to the hospital.<sup>1,5</sup> Causes of the declining ability to perform activities of daily living (ADLs) are multiple and include both acute illness and adverse events associated with hospitalization.<sup>4,6,7</sup> The functional decline experienced by older persons during hospitalization is a strong predictor of length of stay, nursing home placement, and mortality.<sup>8</sup> Loss of ambulatory ability specifically has been noted to occur in 17%-65% of hospitalized older

Supported in part by a VA Research Career Development Award, a training support grant from the Hartford Foundation-funded Southeast Center of Excellence in Geriatric Medicine, and a National Institute on Aging grant (5-R01-AG07178-03).

patients, usually within days of admission, with few recovering this ability prior to discharge.<sup>2,4,5,9</sup> Importantly, ambulatory ability is significantly associated with a decline in other ADLs.<sup>9</sup>

Although several studies have explored risk factors associated with general functional decline during hospitalization,<sup>4,7,10,11</sup> only one study specifically examined risk factors associated with loss of ambulatory ability. In a cohort of participants who were largely independently performing ADLs on admission to the hospital, Mahoney et al. found age  $\geq$  85 years, white race, use of a walker, and functional impairment prior to being hospitalized were significant predictors of newly having walking dependence.<sup>12</sup>

Ambulatory ability could also be affected by a variety of other factors not examined in the Mahoney et al. study; these include severity of illness, bed rest, and hospital-related treatments such as restraints or urinary catheters. In addition, little is known about predictors of recovery of ambulatory ability in patients expected to have activity limitations on admission who are dependent in most or all ADLs. The deconditioning associated with bed rest and reduced mobility has been described as one of the most predictable causes of functional decline, including loss of ambulatory ability, observed in older hospitalized patients.<sup>13</sup> In one study, patients whose activity was limited to a bed or chair during hospitalization were 5.6 times more likely to develop functional decline than those who walked at all, even after controlling for other covariates including severity of illness and comorbidity.<sup>14</sup> Those patients with both activity limitations and dependence in most or all ADLs represent an important subset of all hospitalized older patients who might be expected to be at higher risk of developing new ambulatory dependence. The ability to identify, at admission, those patients who will recover ambulatory ability may have important implications for discharge planning as well as for the development of preventive strategies.

The objective of the present study was to define patient demographic, illness severity, comorbid illness, and hospital-related variables that are independent and significant predictors of regaining ambulatory ability prior to hospital discharge in a cohort of patients who had significant activity limitations and functional impairment at the time of admission to the hospital.

## **METHODS**

### **Study Design**

This study was part of a larger prospective cohort study conducted at a tertiary-care teaching hospital that examined risk factors for pressure ulcers among patients with activity limitations.<sup>15</sup> All patients admitted to the medical wards from December 1988 to June 1991 were screened, and research nurses confirmed eligibility within 3 days. Candidates were at least 55 years of age and were expected to be limited to a bed or chair for at least the first 5 days of hospitalization according to the assessments of their primary nurses. Participants were also eligible if admitted with a hip fracture. In all, 286 patients were included in the present analysis. These patients were included because they had been ambulatory in the 4 weeks before admission, and so they would be expected to have the potential to either maintain or regain ambulatory ability prior to discharge. Thirty-one patients who otherwise would have been eligible for the present analysis were excluded because they had unusually long hospital stays, defined as longer than 31 days. These patients were excluded in order to remove outliers of this variable and because only the effects of relatively acute hospitalization were being studied. Study procedures were approved by the Institutional Review Board of the University of Alabama at Birmingham (UAB).

### **Baseline Data Collection**

For each patient, baseline data were collected from interviews with physicians and nurses at admission and were abstracted from the medical record. Chart review provided information on length of stay; the demographic variables age, sex, race, and marital status; and the presence of specified medical conditions or diseases that might affect a patient's ability to ambulate. These medical conditions and diseases were hip fracture, hypotension, deep vein thrombosis, major surgery and neurological disease defined as a history of hemiparesis regardless of cause, cerebrovascular accident without residual weakness, transient ischemic attack, Parkinson's disease, or seizures. Quartiles of the Comorbidity Damage Index of the Charlson<sup>16</sup> and the Acute Physiology Score (APS) of the APACHE II<sup>17</sup> were used as global measures of comorbidity and illness severity, respectively. Each patient's primary physician was asked to estimate the patient's life expectancy on a 4-point scale (<6 months, from 6 months

to <1 year, 1-5 years, >5 years). It was ascertained from each patient's primary nurse whether a urinary catheter or physical restraints were in use. Confusion was assessed according to how nurses gauged patient mental status on a 4-point scale, from 1 = stuporous/comatose to 4 = alert, defined as being fully responsive and oriented. Any score other than 4 was coded as having altered mental status. Nurses classified patients as either independent or dependent for each of the 7 ADLs (feeding, bathing, dressing, grooming, toileting, transferring, and walking).<sup>18</sup> Admission bed mobility was assessed by nurse rating on a 4-point scale, from 1 = immobile to 4 = fully mobile.

### In-Hospital Outcome Assessment

Throughout the hospitalization, the primary nurse of each patient was interviewed weekly about whether the patient was expected to remain limited to a bed or chair for at least the next week. Whether patients had regained mobility was determined on the basis of the nurses' reports. Patients were defined as ambulatory if their activity was no longer confined to a bed or chair. Patients who died were included in the analysis, as the purpose of this study was to determine characteristics at *admission* that would predict who would likely regain ambulatory ability.

### Statistical Analysis

Appropriate descriptive statistics, including means, standard deviations, and proportions, were used to describe the characteristics of those in the study group. For each variable of interest, logistic regression with dummy coding was used to examine unadjusted relationships with recovery of ambulatory ability. The independent contribution of each of the predictor variables to recovery of ambulatory ability was then tested in a series of multivariate logistic regression models that sequentially adjusted for factors considered important covariables. This was done by adding groups of similar covariates into the model in separate stages. These covariate groups were length of stay, demographics, global health measures and specific medical problems, hospital-related factors, and admission bed mobility. All statistical analyses were performed using the Statistical Analyses System (SAS Institute, Cary, NC), and  $P < .05$  was considered statistically significant.

## RESULTS

For this study, 286 participants met all eligibility criteria, with 119 (42%) regaining ambulatory ability during hospitalization. Mean age of study participants was  $73 \pm 9$  years, with 12% of participants more than 85 years old. On admission, 214 patients (75%) were dependent in all 7 ADLs. Mean length of stay ( $\pm$  SD) was  $12.3 \pm 6.5$  days, with a range of 1-31 days. Table 1 presents the cohort characteristics and the unadjusted effects of each variable for predicting those who did and did not recover ambulatory ability by characteristic. The  $P$  value of a variable in Table 1 indicates how significant that variable was, as determined with a simple logistic regression analysis. The unadjusted odds ratio of each variable is presented in Table 2 in order to facilitate comparisons with the adjusted odds ratios from the multivariate models. Analysis of the effects of the unadjusted single variables showed that age was a significant predictor, with older patients less likely to regain ambulatory ability. Several global health measures and hospital-related factors were also significantly different between those who recovered and those who did not recover ambulatory ability, as summarized in Table 1. Importantly, length of stay was not significantly associated with recovery.

Table 2 shows the effects of adjusting the model for important covariables in a sequential fashion. Model 1 shows that longer length of stay and older age are associated with reduced odds of regaining ambulatory ability after adjusting for other demographic variables. However, age and length of stay were no longer significant after adjusting for global health measures and specific medical problems (Model 2). As demonstrated by the full model (Model 4), the participants who regained ambulatory ability were more likely to be unmarried, have a longer physician-rated life expectancy, not have a diagnosis of deep vein thrombosis, not have physical restraints or a urinary catheter in use, and have greater bed mobility at admission.

Predictors that remained significant in the final multivariate model (Model 4) were summed in order to determine the proportion of patients who had one predictor versus those who had more than one predictor. Figure 1 shows the percentage of those who recovered ambulatory ability according to number of predictors, ranging from one to all 6 predictors. The results demonstrate a graded relationship, with number of predictors positively cor-

**TABLE 1**  
**Bivariate Analysis of Baseline Participant Characteristics Comparing Those Who Recovered and Those Who Did Not Recover Ambulatory Ability**

Characteristic	No. of Subjects	Regained ambulatory ability		P value <sup>a</sup>	
		Yes N (%)	No N(%)		
<i>Demographics</i>					
Age	55-64 years	46	19 (41)	27 (59)	.009
	65-74 years	118	63 (53)	55 (47)	
	75-84 years	88	29 (33)	59 (67)	
	≥85 years	34	8 (24)	26 (76)	
Sex	Female	163	72 (44)	91 (56)	.31
	Male	123	47 (38)	76 (62)	
Race	White	168	72 (43)	96 (57)	.61
	Black/other	118	47 (40)	71 (60)	
Married		164	64 (39)	55 (45)	.30
Not married		122	55 (61)	67 (55)	
<i>Global health measures/specific medical problems</i>					
Life expectancy	<6 months	28	3 (11)	25 (89)	< .0001
	6 months-1 year	43	11 (26)	32 (74)	
	1-5 years	127	47 (37)	80 (63)	
	>5 years	88	58 (66)	30 (34)	
Acute Physiology Score	0-6	71	35 (49)	36 (51)	< .0001
	7-10	83	46 (55)	37 (45)	
	11-13	62	19 (31)	43 (69)	
	14+	61	13 (21)	48 (79)	
Comorbidity Index	0-1.0	89	48 (54)	41 (46)	.01
	1.1-2.5	65	24 (37)	41 (63)	
	2.6-4.0	55	23 (42)	32 (58)	
	4+	63	20 (32)	43 (68)	
Hip fracture present	Yes	30	14 (47)	16 (53)	.55
	No	256	105 (41)	151 (59)	
Neurological disease present	Yes	152	49 (32)	103 (68)	.0007
	No	134	70 (52)	64 (48)	
Hypotension present	Yes	35	18 (51)	17 (49)	.21
	No	251	101 (40)	150 (60)	
Deep vein thrombosis present	Yes	9	1 (11)	8 (89)	.10
	No	277	118 (43)	159 (57)	
Had major surgery	Yes	73	47 (64)	26 (36)	< .0001
	No	213	72 (34)	141 (66)	
Level of consciousness	Altered mental status	123	30 (24)	93 (76)	< .0001
	No altered mental status	163	89 (55)	74 (45)	
<i>Hospital-related factors</i>					
Urinary catheter	Yes	172	66 (38)	106 (62)	.17
	No	114	53 (46)	61 (54)	
Restraints in use	Yes	93	21 (23)	72 (77)	< .0001
	No	193	98 (51)	95 (49)	
Initial bed mobility	Immobile	25	5 (20)	20 (80)	< .0001
	Very limited	100	26 (26)	74 (74)	
	Slightly limited	131	73 (56)	58 (44)	
	Fully mobile	30	15 (50)	15 (50)	

<sup>a</sup>P values were obtained using logistic regression.

The odds ratios associated with these P values are reported in Table 2 in order to facilitate comparisons with the adjusted odds ratios.

related with percentage of those who recovered ambulatory ability ( $P < .0001$ ).

Patients who died prior to discharge were more likely to be male and have altered mental status, a

urinary catheter, restraints, a shorter physician-rated life expectancy, lower admission bed mobility, and increased severity of illness compared to those who survived. When the 34 patients who died

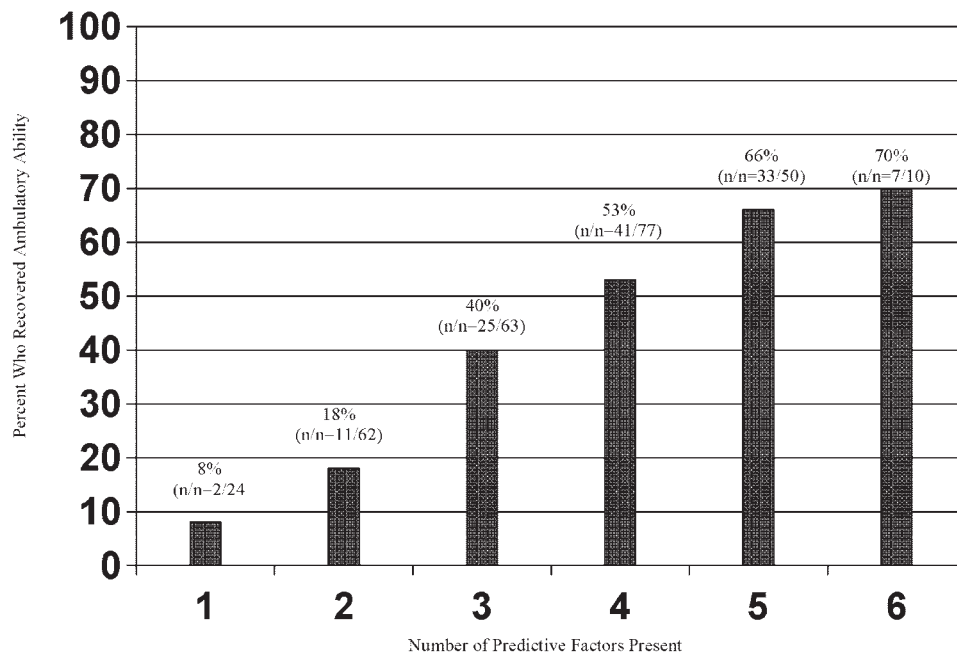
**TABLE 2**  
**Multiple Logistic Regression Models for Factors Associated with Recovery of Ambulatory Ability Prior to Discharge**

Variables	Model 1 Demographics OR <sup>a</sup> (95% CI)	Model 2 Global health/specific diseases OR (95% CI)	Model 3 Hospital factors OR (95% CI)	Model 4 Mobility OR (95% CI)	Unadjusted Results OR (95% CI)
Length of stay	0.9 (0.9-0.99) <sup>b</sup>	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)
Age	0.6 (0.4-0.8) <sup>b</sup>	0.8 (0.5-1.1)	0.7 (0.5-1.1)	0.7 (0.5-1.1)	0.7 (0.5-0.9) <sup>b</sup>
Sex—female	1.1 (0.7-1.9)	0.9 (0.5-1.7)	0.8 (0.4-1.6)	0.9 (0.4-1.6)	1.3 (0.8-2.1)
Race—white	1.3 (0.8-2.2)	1.3 (0.7-2.5)	1.3 (0.7-2.4)	1.2 (0.6-2.2)	1.1 (0.7-1.8)
Not married	1.7 (1.0-2.9)	2.5 (1.3-5.0) <sup>b</sup>	2.7 (1.3-5.5) <sup>b</sup>	3.0 (1.4-6.2) <sup>b</sup>	1.3 (0.8-2.1)
APS quartiles <sup>c</sup>		0.7 (0.5-1.0) <sup>b</sup>	0.8 (0.5-1.0)	0.8 (0.6-1.1)	0.6 (0.5-0.8) <sup>b</sup>
MD-rated life expectancy <sup>c</sup>		1.9 (1.3-2.8) <sup>b</sup>	1.9 (1.3-2.9) <sup>b</sup>	1.9 (1.3-2.8) <sup>b</sup>	2.5 (1.8-3.5) <sup>b</sup>
Comorbidity quartiles <sup>c</sup>		1.0 (0.7-1.3)	1.0 (0.7-1.3)	1.0 (0.7-1.3)	0.8 (0.6-0.9) <sup>b</sup>
No deep vein thrombosis		14.8 (1.6-138.1) <sup>b</sup>	13.1 (1.4-121.1) <sup>b</sup>	11.4 (1.2-105.1) <sup>b</sup>	5.9 (0.7-48.1)
No hip fracture		2.1 (0.8-5.6)	2.1 (0.8-6.0)	2.2 (0.8-6.3)	0.8 (0.4-1.7)
No neurological diseases <sup>c</sup>		1.7 (0.9-3.3)	1.7 (0.9-3.3)	1.7 (0.9-3.4)	2.3 (1.4-3.7) <sup>b</sup>
No hypotension		0.8 (0.3-2.1)	0.8 (0.3-2.2)	0.8 (0.3-2.3)	0.6 (0.3-1.3)
Having major surgery		1.7 (0.8-3.6)	1.8 (0.8-3.9)	1.9 (0.9-4.0)	3.5 (2.0-6.2) <sup>b</sup>
Having normal mental status <sup>c</sup>		2.1 (1.1-4.0) <sup>b</sup>	2.0 (0.8-4.0)	1.6 (0.8-3.3)	3.7 (2.2-6.2) <sup>b</sup>
No urinary catheter			2.1 (1.0-4.2) <sup>b</sup>	2.2 (1.2-5.5) <sup>b</sup>	1.4 (0.9-2.3)
Not in restraints			2.2 (1.0-4.6) <sup>b</sup>	2.5 (1.2-5.5) <sup>b</sup>	3.5 (2.0-6.2) <sup>b</sup>
Bed mobility on admission <sup>c</sup>				1.7 (1.1-2.6) <sup>b</sup>	2.0 (1.5-2.8) <sup>b</sup>

<sup>a</sup>OR = odds ratio; CI = confidence interval.

<sup>b</sup> $P \leq .05$

<sup>c</sup>See Methods section for detailed definitions.



**FIGURE 1.** Graded relationship between number of predictive factors and recovery of ambulatory ability. For each number of predictive factors present, the dark bar corresponds to the percentage of patients who had recovered ambulatory ability when discharged from hospital ( $P < .0001$ ).



were excluded from the multivariate analysis, the factors predicting ambulatory recovery were unchanged from those reported in Model 4 of Table 2.

## DISCUSSION

In this study of older hospitalized patients, approximately 40% were able to regain their ambulatory ability despite being limited to the bed or chair on admission, having significant severity of illness, high level of use of restraints, and functional dependence on admission. Predictors of regaining ambulatory ability were identifiable at hospital admission. These predictors also were correlated with recovery of ambulatory ability in a graded fashion, lending support for the direct relationship between these predictors and recovery.

Physician-rated life expectancy, a simple assessment that combines a physician's medical knowledge and clinical acumen, was demonstrated in our study to be a better predictor of recovery of ambulatory ability than more elaborate measures like the APACHE II<sup>17</sup> and Charlson Comorbidity Index.<sup>16</sup> This assessment can easily be done at the bedside and may help to guide discharge planning for the hospitalist physician. Nurse-rated bed mobility at time of admission, which may reflect aspects of illness severity and cognitive status, was also able to predict recovery.

Of the 6 factors found to be independent predictors of recovery of ambulatory ability, 4 were related to mobility: lack of a DVT diagnosis, absence of a urinary catheter, absence of restraints, and nurse-rated bed mobility at admission. In the group of patients initially expected to be confined to a bed or chair, those with additional mobility-reducing factors, such as catheters and restraints, were less likely to recover, even after controlling for illness severity and comorbidity.

Marital status was not found to predict recovery of ambulatory ability in the simple unadjusted bivariate analysis, but after adjusting for other demographic, global health, and disease-related variables, those who were unmarried were more likely to recover ambulatory ability. These interesting covariate-adjusted effects for marital status have not been previously reported in the literature. One large study of the impact of marital status on hospital outcomes demonstrated those who were unmarried were more likely to require discharge to a nursing home and had slightly higher hospital costs and longer length of stay.<sup>19</sup> Our findings may be related to such patients lacking support other than from

themselves, with the possibility of being discharged to a nursing home an incentive to get up and walk.

Although age, race, and previous ADL status were found to be significant predictors in a previous study,<sup>12</sup> we did not find this in our sample. This may be because, unlike in other studies, most of our patients had significant functional impairment on admission. The importance of age in our cohort disappeared when illness severity and comorbidities were added to the model.

The strengths of this study include having comprehensive patient-related data on demographic, illness severity, comorbidity, and hospital-related factors available, which enabled detailed analyses of predictors for regaining ambulatory ability. In particular, the ability to examine such factors as bed rest and hospital-related treatments like restraint and catheter use, enabled this study to add significantly to the available knowledge of predictors of ambulatory recovery. The use of nurse interviews to obtain patient-related data has been demonstrated in previous studies to be a preferred method of collecting data when compared to patient self-report.<sup>20,21</sup> Examination of these factors in a cohort of patients who would be expected to be at very high risk for remaining bed- or chair bound, given their admission activity limitations and functional dependence, is also noteworthy.

Several important limitations deserve comment. Since the data were collected, average length of hospital stay generally has decreased. However, the patient population we studied continue to experience longer hospital stays than functionally intact patients. One recent study demonstrated that the length of hospital stay of patients who were dependent in one or more ADLs on admission was 35% longer than that of those not ADL dependent at admission.<sup>22</sup> Seventy-five percent of those in the present study cohort were dependent in all 7 ADLs and had a mean length of stay of 12.3 days. Despite the longer mean length of stay, 70% of those in the study cohort were discharged within 2 weeks of admission. In the university hospital where this research was conducted, mean length of stay ( $\pm$  SD) in 2004 was  $6 \pm 8.6$  days, but 10% of patients 55 years of age and older remained in the hospital for more than 2 weeks.<sup>23</sup> This suggests there continue to be long-stay patients in the current hospital environment, to which these findings may apply.

Standards of practice, such as for use of restraints, have also changed. In 1992, between 7.4% and 17% of all hospitalized medical patients were

restrained, according to a literature review.<sup>24</sup> A 1998 survey of 3 hospitals found the prevalence of restraints still ranged from 3.9% to 8.2% and noted that among the most common reasons reported for using restraints were to prevent patient disruption of therapy, to confine confused patients, and to reduce the number of falls.<sup>25</sup> Thus, our study cohort would be more likely to be restrained, even in the current hospital environment, given that 43% of the cohort had altered mental status and that most were at risk for falls because of their poor functional status.<sup>26</sup>

Nevertheless, even though the use of restraints has declined since the data were collected for this study, this should affect neither the internal validity of the results nor the ability to address the question of what factors predict recovery of ambulatory ability. Indeed, the inclusion of patients on whom restraints are frequently used emphasizes the need for continued diligence in creating a restraint-free environment in our hospitals. Data about the use of physical therapy services were not available in the study. Therefore, it is unknown to what extent the use of these services encouraged ambulation.

In this observational study, we found 6 factors associated with regaining ambulatory ability among hospitalized patients who had significant activity limitations and functional dependence on admission. These findings suggest predictors easily assessed by the hospitalist physician can help to identify those patients most likely to recover ambulatory ability prior to discharge. It also demonstrates the importance of mobility in maintaining function, given that many of the predictors are factors that either impede mobility such as restraints and urinary catheters or measure mobility such as admission bed mobility. Last, recognizing physician-rated life expectancy as a strong independent predictor of recovery of ambulatory ability should encourage hospitalist physicians to continue to use their greatest tool, their clinical judgment, to determine who will recover ambulatory ability.

As most of these predictors can be identified on admission or shortly thereafter, these factors may be useful in helping physicians and other health care providers to predict the potential patients have to recover ambulatory ability. This information may help physicians identify patients who might benefit from early mobility programs, placement on hospital units where mobility will be enhanced, or the early initiation of discharge planning for those patients identified as unlikely to regain ambulation

ability. In addition, addressing factors that are potentially modifiable, such as low bed mobility and the use of urinary catheters and restraints may not only improve the chance of recovering ambulatory ability but would also improve the quality of care provided to older patients.

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Received 17 November 2005; revision received 27 April 2006; accepted 2 May 2006.

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