CME Objectives:
On completion of this article, the reader should be able to (1) describe the circumstances of falls and characteristics of patients who fell during inpatient rehabilitation; (2) identify significant risk factors for falls; and (3) recognize the association between the level of independence and falls.

Level: Advanced.

Accreditation: The Association of Academic Physiatrists is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians. The Association of Academic Physiatrists designates this continuing medical education activity for a maximum of 1.5 credits in Category 1 of the Physician's Recognition Award of the American Medical Association. Each physician should claim only those credits that he or she actually spent in the education activity.

Disclosures: Disclosure statements have been obtained regarding the authors' relationships with financial supporters of this activity. There are no apparent conflicts of interest related to the context of participation of the authors of this article.

0894-9115/08/8705-0341/0
American Journal of Physical Medicine & Rehabilitation

DOI: 10.1097/PHM.0b013e31816ddc01

CME ARTICLE • 2008 SERIES • NUMBER 5

Risk Factors for Falls During Inpatient Rehabilitation

ABSTRACT

Lee JE, Stokic DS: Risk factors for falls during inpatient rehabilitation. Am J Phys Med Rehabil 2008;87:341–353.

Objective: To determine risk factors for falls during inpatient rehabilitation on the basis of admission data, and to assess the predictive value of the FIM instrument.

Design: One thousand four hundred seventy-two patients consecutively admitted to a large tertiary care rehabilitation center during 18 mos were included in this retrospective study. Events surrounding falls were reported by clinical staff. Demographic data, prehospital socioeconomic status, medical condition at admission, and admission FIM scores were analyzed using log-logistic regression model for their association with falls.

Results: One hundred forty (9.5%) patients fell at least once. Most falls occurred during daytime (85%), in a patient room (90%), and were unobserved (74%). About a half of all falls occurred during the first week of rehabilitation stay. Multivariate model revealed that diagnosis of stroke and amputation, age between 41 and 50 yrs, lower cognitive FIM scores, and a large number of medical comorbidities ($\geq$9) were associated with a high risk for fall. The respective prevalence ratios were 1.79, 3.80, 2.01, 0.98, and 1.50.

Conclusions: The rate of falls varies considerably among different diagnostic groups admitted to inpatient rehabilitation. Mid-aged people with stroke and amputation, worse cognitive functions, and greater medical complexity are at a higher risk for falling. Admission FIM score may be of value for predicting falls in rehabilitation setting, which warrants further investigation.

Key Words: Fall, Rehabilitation, Risk, FIM Instrument

Authors:

Jae Eun Lee, DrPH
Dobrivoje S. Stokic, MD, DSc

Affiliations:

From the Center for Neuroscience and Neurological Recovery, Methodist Rehabilitation Center, Jackson, Mississippi.

Correspondence:

All correspondence and requests for reprints should be addressed to Dobrivoje S. Stokic, MD, DSc, Center for Neuroscience and Neurological Recovery, Methodist Rehabilitation Center, East Woodrow Wilson Dr., Jackson, MS, 39216.

Disclosures:

Supported in part by the Wilson Research Foundation, Jackson, Mississippi.

Falls are serious and sometimes harmful events for patients admitted to rehabilitation. Participation in rehabilitation programs regularly encourages mobility, which may create a risky environment compared with general medical wards. The reported rates of falling at least once range from 12.5% in general rehabilitation settings[1] to 20–30% for a general geriatric rehabilitation unit,[2,3] and 39% for a geriatric stroke inpatient rehabilitation unit.[4] This is far greater than the 1.4% fall rate during stays in a general hospital that provides cardiology, oncology, medicine, surgery, orthopedics, neurology, psychiatry, and women's and infants' services,[5] and the 1.9% rate for an acute care specialty hospital without pediatric and obstetrical services.[6]

Falls have been associated with considerable morbidity that may lead to increased length of stay and medical cost. Injuries occur in up to 13% of fallers in a general rehabilitation hospital[1] and in 18% of inpatients admitted to rehabilitation after lower-limb amputation.[7] This is somewhat more than the 10% rate of fall-related injuries reported in a large academic hospital[5] but substantially less than the 33% injury rate in an acute care specialty hospital.[6] Falls may also cause a fear of new falling, possibly leading to further restrictions in mobility,[8] which may negatively impact participation in the rehabilitation program. It therefore seems important to identify and monitor predisposing factors for falls during inpatient rehabilitation as a first step toward developing or modifying the existing fall-prevention programs.

Considerable efforts have been made in the past to determine the risk factors for falls in the rehabilitation setting,[7,9–13] to assess the prediction accuracy of fall-risk indices and models,[14–18] and to evaluate the effectiveness of fall-prevention programs.[4,19] These previous studies, however, have focused on a specific group of patients, mainly stroke,[9,20] amputee,[7,11] and/or geriatric patients.[10,13] Not surprisingly, identified risk factors differ considerably depending on the population studied. Aizen et al.[13] report that risk factors for falls differ between different groups of elderly patients undergoing rehabilitation, thus confirming that the selection of patients affects which combination of risk factors is identified. Although relevant, many previous findings may no longer be as pertinent, because recent policy changes have shifted the composition of patients admitted to inpatient rehabilitation facilities toward more dependent and medically complex cases. Shorter lengths of stay require greater rehabilitation efficiency, which may lead to more aggressive therapeutic approaches and expose patients to a greater risk for fall. These changes, therefore, may influence both intrinsic and extrinsic factors affecting fall risk during inpatient stay. Thus, reevaluation of risk factors for falling is warranted, particularly before implementing new or modifying the existing hospital-wide fall-prevention programs.

Successful hospital-based fall- and injury-prevention programs require large studies to first characterize the nature of falls and identify risk factors. Such studies focusing on a broad sample of rehabilitation inpatients are limited,[1,12,21–23] and the recent ones were conducted in a different geographic and rehabilitation setting compared with the United States. Among those, only a few[12,23] included functional status measures as potential risk factors and demonstrated that functional independence is an important risk factor for falls for specific groups of patients.

The aim of this study is to explore risk factors for falls according to information available soon after admission to a large tertiary care rehabilitation center in the southeast United States. We specifically focused on the potential value of the functional independence measure (FIM) instrument for predicting falls in a large sample of diverse patients. The results are expected to provide useful information that may complement current hospital-wide fall-prevention programs.

METHOD

Participants and Source of Data

The study was conducted at a large tertiary care rehabilitation center that provides statewide comprehensive medical rehabilitation services, located in an urban area of the southeast United States. Information related to falls was extracted from a custom-designed fall database. Information

on sociodemographic status, medical conditions, and FIM scores were obtained from the data submitted to the e-RehabData database. The merged dataset consisted of 1472 patient records admitted between January 1, 2005 and June 31, 2006.

Procedure

A retrospective cohort design was used for the study. Reviews of the fall database and the E-RehabData database were conducted to extract information related to falls and potential risk factors, respectively. Patient-related information included demographics (age, gender, race), prehospital socioeconomic status (marital status, living status, employment), medical condition and severity of impairment at admission (comorbidity, impairment group category, case-mix group), days from onset to admission, and FIM scores at admission. Fall information was extracted from a custom-built hospital database designed for tracking falls. The information included descriptors and circumstances of falls, such as date/time, location, witness account, preceding activity, consequence, and injury details, if any. Although the literature suggests that medication may impact falls,[7,12,24] we did not examine the effect of medication, because such information was not readily available. This study was approved by the hospital's institutional review board for human research.

Measures

Dependent Variable

We adopted the definition of *fall* as proposed in previous studies (sudden, unexpected descent from a standing, sitting, or horizontal position, including slipping from a chair to floor, patients found down on the floor, and assisted falls).[5] The hospital staff recorded all such events that took place during the inpatient stay and reported them on a customized fall-report form. For the purpose of analysis, a patient who fell at least once during the study period is referred to as a *faller*, and a patient who did not fall is referred to as a *nonfaller*.

Independent Variables

We dichotomized independent variables to perform 2 × 2 maximum likelihood estimation and, thereby, determine the difference in prevalence of falls among subgroups of patients divided by major sociodemographic factors and medical condition. For example, even though the age was broken down into eight subgroups, each age group was compared with all others combined. We used a 10-yr cutoff for categorizing age after collapsing patients younger than 20 yrs and older than 80 yrs into a single category, respectively. Our categorization scheme did not seem to impact the statistical power, because only one of the 16 cells (two fall categories by eight age categories) was a sparse cell (i.e., frequency less than five). To verify our findings, we compared the result of maximum likelihood test with that of the forward exact test that is commonly used with sparse cells. Impairment groups were categorized using the primary impairment group codes (IGC) at admission. A relative weight for the case-mix group (CMG) was used as a proxy for the severity of impairment and was controlled for as a continuous variable. The total number of comorbidities (mode = 10, 75% percentile = 9) and comorbidities related to mental disorder, coronary artery disease, and congestive heart failure were identified from the ICD codes. We compared patients with nine or more comorbidities (34% of the sample) with those who had fewer than nine comorbidities. We further compared those with mental disorders (at least one in 48.8%), coronary artery disease (7.4%), or congestive heart failure (10.7%) with those without such a comorbidity. Because 79% of patients were admitted from acute care hospitals, the preadmission setting was not included as a variable in a priori analyses. Custom-developed grading of harm from fall-related injury included three levels for no harm (1 = no harm noted; 2 = possible very slight temporary harm; 3 = need to monitor patient, ultimately no harm) and four levels for harm (4 = temporary harm, need for treatment or intervention; 5 = temporary harm, require new or prolonged hospitalization; 6 = permanent harm; 7 = near-death event; 8 = death).

FIM Scores

The total FIM score (range, 18–126) consists of 13 motor (range, 13–91) and five social–cognitive items (range, 5–35), assessing self-care, sphincter management, transfer, locomotion, communication, social interaction, and cognition. FIM scores were used as a continuous dependent variable in the analysis of variance (ANOVA) models and as a continuous independent variable in the multivariate log-logistic regression model.

Analysis

Statistical analyses were carried out using SAS version 9.1. Descriptive analyses were conducted to describe the sample and the nature of falls. A series of survival analyses were then performed to investigate the effect of demographic and socioeconomic status, medical conditions, and functional independence on time (days) until the first fall. A Wilcoxon test was used to determine significant differences among the subgroups.

The difference in prevalence of falls among subgroups divided by major sociodemographic fac-

tors and medical condition was compared using a 2×2 maximum likelihood estimation. Crude prevalence ratio (PR), 95% confidence interval, and *P* value were reported. Severity-adjusted PR was also estimated.

A series of ANOVA analyses were performed to determine whether the admission FIM scores differed between fallers and nonfallers. In addition to the uncontrolled tests, we conducted the conditional ANOVA after controlling for sociodemographic variables and medical conditions.

We then conducted multivariate log-binomial logistic models, including demographic variables and fall risk factors significant in univariate analyses, to determine which variables best predict falls. Although not significant in univariate analyses, some demographic variables were included in the multivariate model because of their potential covariance with some outcome variables and/or major independent variables. The variables found to lessen the risk of falls in univariate analyses were initially excluded but later included in the multivariate model.

We used a copy method approach for fitting the log-binomial logistic regression models[25] to derive approximate maximum likelihood estimates for PR model regardless of the number of independent variables. The PR instead of odds ratio was reported because the former is often more interpretable.[26]

RESULTS

The average age of subjects was 59.9 ± 20.9 yrs, gender was equally distributed between male and female, and 66% of patients were white. They had 6.9 ± 2.5 comorbidities on admission, and the average length of stay was 17.3 ± 12.0 days. The majority was admitted for stroke (30%), with 18% for orthopedic disorder (knee or hip replacement or fracture), 17% for brain dysfunction (28% nontrauma, 71% closed trauma, and 1% open trauma), and 10% for traumatic spinal cord dysfunction. Other diagnoses represented less than 10% each.

We recorded 171 falls in 140 patients among 1472 admissions from January 1, 2005 to June 30, 2006 (Table 1). This translates into 6.7 falls per 1000 patient-hospital days and 9.5 fallers per 100 admissions. About one in five (19.6%) fallers experienced multiple falls. Most falls (85%) occurred during the first (7 a.m. to 3 p.m.) and second (3 to 11 p.m.) shifts, in patient rooms (90%), and were unobserved (74%). The majority of falls resulted in no harm (grade 3 or less). Fall-related injuries occurred in 10 people (6% of falls). Among them, eight sustained grade 4 injuries (six contusions, six abrasions, and three lacerations, for a total of 15 injuries). The remaining two sustained one fracture each (grade 5).

TABLE 1 Characteristics of 171 falls in 140 patients among 1472 admissions

Variable	Level	*n*	%
Number of falls	1	113	80.7
	2	24	17.1
	3	2	1.4
	4	1	0.7
Event shift	7 a.m. to 3 p.m.	71	41.8
	3 p.m. to 11 p.m.	73	42.9
	11 p.m. to 7 a.m.	26	15.3
Fall from	Bed	47	27.6
	Chair/wheelchair	68	40.0
	Commode	21	12.4
	Other	34	20.0
Fall type	Assisted	30	17.6
	Observed/not assisted	15	8.8
	Unobserved	112	65.9
	Unobserved/reported	13	7.6
Fall location	Patient's room	153	90.0
	Therapy area	7	4.1
	Other	10	5.9
Fall outcome	No harm	158	94.0
	Harm	10	6.0

In 46% of cases, the initial fall occurred within a week of admission. The survival analyses revealed that patients 70 yrs or older fell significantly earlier than those younger than 70 (Wilcoxon $\chi^2 = 10.95$, $P < 0.001$). Figure 1 shows that about a half of the older patients (≥70 yrs) fell within 5 days of admission in contrast to only a quarter of the younger patients (<70 yrs), for whom it took another 5 days to reach a 50% fall rate. Furthermore, falls occurred significantly earlier in the patients with admission motor FIM scores greater than 25 compared with those who scored 25 or less (Wilcoxon $\chi^2 = 5.26$, $P = 0.022$) (Fig. 2).

Table 2 shows that the prevalence of falls differs among subgroups according to sociodemographic status and medical condition. As indicated in bold, a significantly higher prevalence of falls was found in the age group 41–50 yrs, among first rehabilitation admissions, and in stroke and amputation patients. Conversely, a significantly lower prevalence was observed in the age groups 31–40 yrs and 80 yrs or older, those with fewer than nine comorbidities and no mental comorbidity, and patients with traumatic spinal cord dysfunction and orthopedic disorders. The identical results were obtained even after controlling for the severity of impairment (a relative weight for CMG), with the exception that PR for those 80 yrs or older was no longer significantly different from the other age groups. The overall results were not substantially different when PRs were calculated on the basis of the forward exact test.

Table 3 represents the results of a generalized linear model used to determine whether the admis-

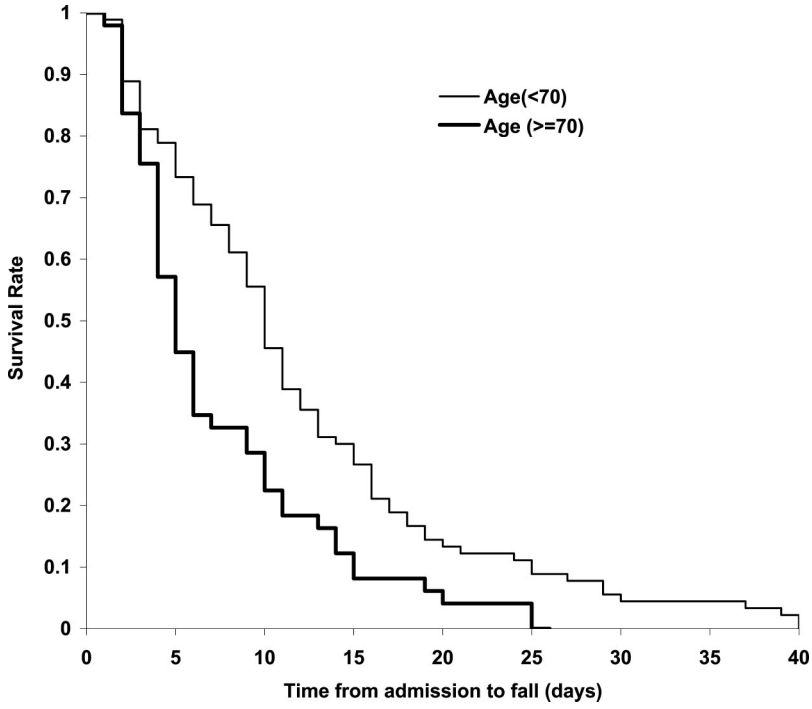

FIGURE 1 *Fall probabilities according to age groups. Note that the proportion of patients 70 yrs or older (~50%) who fell within 5 days is twice as high as those who were younger than 70 yrs (~25%).*

sion FIM scores differed between fallers and nonfallers. We initially found significantly lower total FIM scores in fallers. All other FIM subdomains were also significantly different, except for transfer and locomotion FIM scores. The relationship remained after controlling for demographic variables. After adding the impairment group (IGC) and the severity of impairment (CMG) to the model, however, only mobility FIM score remained significantly lower in fallers than in nonfallers.

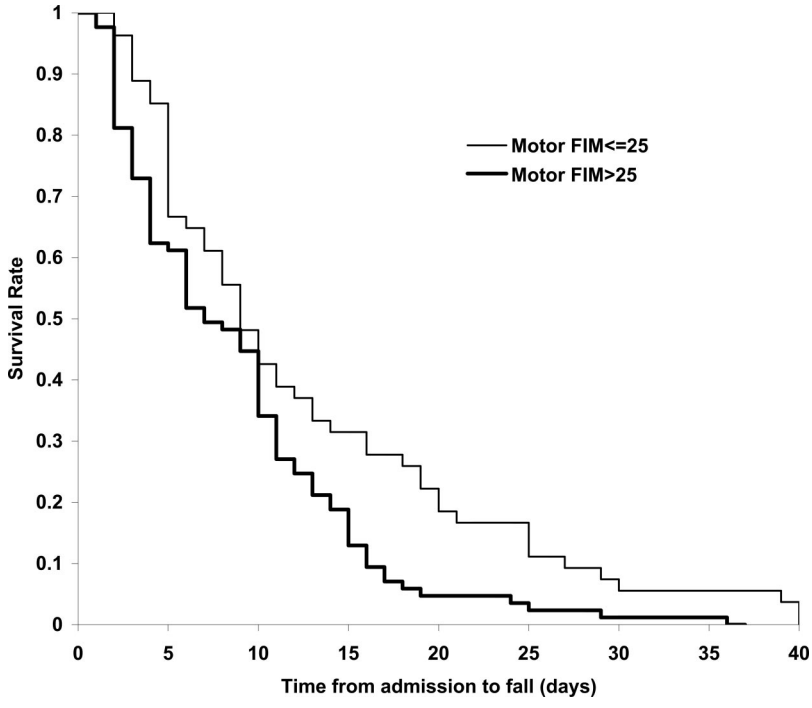

FIGURE 2 *Fall probabilities according to FIM motor score. Note that a larger proportion of patients more independent on admission (motor FIM score >25) fell significantly earlier.*

TABLE 2 Prevalence ratios for fallers by sociodemographic status and medical condition

Variables	*n*	% Fall	Crude PR		Adjusted PR*	
			Ratio (95% CI)	*P* Value	Ratio (95% CI)	*P* Value
Total	1472	9.5				
Race						
Nonwhite	505	10.5	1.2 (0.8–1.6)	0.352	1.2 (0.9–1.7)	0.303
White	967	9.0				
Age groups						
<20	91	5.5	0.6 (0.2–1.3)	0.193	0.6 (0.3–1.5)	0.281
21–30	120	7.5	0.7 (0.4–1.3)	0.268	0.8 (0.4–1.5)	0.414
31–40	78	2.6	0.2 (0.1–0.9)	**0.038**	0.1 (0.0–1.0)	0.049
41–50	133	18.1	1.8 (1.2–2.7)	**0.003**	2.1 (1.4–3.1)	**0.001**
51–60	217	10.6	1.0 (0.7–1.5)	0.977	1.1 (0.8–1.7)	0.540
61–70	275	10.9	1.0 (0.7–1.5)	0.827	1.1 (0.9–1.7)	0.499
71–80	331	9.7	0.9 (0.6–1.3)	0.558	1.0 (0.7–1.5)	0.833
80+	227	6.6	0.6 (0.4–1.0)†	**0.004**	0.7 (0.4–1.2)	0.162
Comorbidities						
<9	970	7.9	0.6 (0.5–0.9)	**0.004**	0.7 (0.5–0.9)	**0.011**
≥9	504	12.6				
Mental comorbidities						
None	753	8.1	0.7 (0.5–1.0)	0.059	(0.7 (0.5–1.0)	0.060
One or more	718	11.0				
Gender						
Female	749	8.1	0.8 (0.5–1.0)	0.070	0.8 (0.6–1.1)	0.113
Male	723	10.9				
Admission class						
Initial admission	1168	10.4	1.7(1.1–2.8)	**0.029**	1.7 (1.1–2.8)	**0.031**
Readmission	284	6.0				
Impairment group categories						
Stroke	431	14.2	1.9 (1.4–2.6)	**0.001**	1.8 (1.3–2.4)	**0.001**
Brain dysfunction	246	7.7	0.8 (0.5–1.2)	0.300	0.8 (0.5–1.24	0.261
Neurologic condition	61	9.8	1.0 (0.5–2.3)	0.923	1.1 (0.5–2.3)	0.869
Spinal cord dysfunction						
Nontraumatic	119	12.6	1.4 (0.8–2.3)	0.225	1.4 (0.8–2.3)	0.296
Traumatic	151	3.3	0.3 (0.1–0.8)	**0.012**	0.3 (0.1–0.7)	**0.004**
Amputation	69	20.3	2.3 (1.4–3.7)	**0.001**	2.4 (1.5–4.0)	**0.001**
Orthopedic disorders	265	3.0	0.3 (0.1–0.6)	**0.001**	0.3 (0.1–0.6)	**0.001**
Major multiple trauma	37	10.8	1.1 (0.5–2.9)	0.784	1.0 (0.4–2.5)	0.980
Debility	82	9.8	1.0 (0.5–2.0)	0.938	1.1 (0.5–2.2)	0.804

* Controlled for the severity of impairment. PR, prevalence ratio; CI, confidence interval.
† PR (95% CI) = 0.59 (0.35–0.98).

Table 4 presents the results of multivariate log-logistic regression analysis applied to identify the potential predictors of falls. A higher risk of falls was found among stroke (PR = 1.79) and amputation (PR = 3.80) patients, in the 41–50 age group (PR = 2.01), among those with nine or more comorbidities (PR = 1.50), and among those with lower cognitive FIM score on admission (PR = 0.98). These results also persisted after adding each variable that lessened the risk of fall (age 31–40, age 80+, traumatic SCI, orthopedic disorder). With traumatic SCI and orthopedic disorder included, cognitive FIM score was no longer significant. A full model, which included all four lessening variables, revealed a significantly lower risk in patients with orthopedic disorders (PR = 0.59; P = 0.039) and, similar to the above, a significantly higher risk for stroke and amputation patients, the 41–50 age group, and those with nine or more comorbidities.

DISCUSSION

The results of this study indicate that about 10% of patients admitted to inpatient rehabilitation experienced falls, and, of those, 20% fell more than once. Falls most often occurred during the daytime, in the patient's room, and were unobserved. Only a small portion of total falls resulted in some injury, and these were mainly inconsequential. Univariate analyses identified that mid-age patients, those admitted for stroke or amputation, and those with a considerable number of medical comorbidities (≥9) were at a high risk of falls. Conversely, those admitted for traumatic spinal cord injury and orthopedic conditions are less likely to fall. On the basis of FIM score, less-inde-

TABLE 3 The difference in functional independence measure (FIM) scores between fallers and nonfallers (significant difference shown in bold)

	Nonfallers (n = 1332)		Fallers (n = 140)		Unconditional ANOVA		Controlled ANOVA*		Controlled ANOVA†	
	Avg	SD	Avg	SD	*F* Value	*P* Value	*F* Value	*P* Value	*F* Value	*P* Value
Total FIM score	59.7	21.6	52.0	20.1	16.0	**<0.001**	15.6	**<0.001**	44.5	**<0.001**
Motor	35.1	15.4	31.4	13.4	7.4	**0.007**	7.3	**0.007**	23.7	**<0.001**
Activities of daily living	24.4	11.2	21.6	9.7	8.0	**0.005**	7.7	**0.006**	24.0	**<0.001**
Self-care	18.5	8.4	16.9	7.6	5.0	**0.026**	4.4	**0.036**	13.1	**0.001**
Sphincter control	5.8	3.6	4.7	3.0	12.9	**<0.001**	13.7	**<0.001**	25.5	**<0.001**
Mobility	10.7	5.1	9.8	4.5	4.1	**0.044**	4.2	**0.041**	10.7	**0.001**
Transfers	7.6	3.9	7.0	3.4	3.3	0.070	3.4	0.065	8.0	**0.005**
Locomotion	3.1	1.8	2.8	1.7	3.1	0.080	3.1	0.081	5.4	**0.020**
Cognitive	24.6	10.0	20.7	9.7	20.0	**<0.001**	19.0	**<0.001**	35.8	**<0.001**
Comprehension	10.2	3.9	8.9	3.9	13.1	**<0.001**	12.3	**0.005**	21.7	**<0.001**
Social cognition	14.4	6.2	11.7	6.1	23.8	**<0.001**	22.7	**<0.001**	42.5	**<0.001**

* Controlled for demographics (race, age, gender, marital status, employment, and living status); † controlled for demographics, impairment group code, and severity of impairment.

pendent patients were more likely to fall, and this association persisted even after controlling for sociodemographic and medical condition variables. Among the fallers, however, the first fall occurred earlier in older and more-motor-independent patients. Subsequent multivariate models revealed that lower cognitive functions, age between 41 and 50 yrs, diagnosis of stroke or amputation, and a considerable number of medical comorbidities (≥9) were associated with a high risk for falls.

TABLE 4 Results of multiple log-logistic regression analysis after controlling for the severity of impairment (significant variables in bold)

Parameter	Ratio (95% CI)	*P* Value
Admit ADL FIM score	1.01 (0.98–1.04)	0.660
Admit mobility FIM score	0.96 (0.91–1.02)	0.206
Admit cognitive FIM score	0.98 (0.96–1.00)	**0.019**
Nonwhite	1.00 (0.72–1.40)	0.998
Age 41–50	2.01 (1.31–3.07)	**0.001**
Male	1.35 (0.95–1.95)	0.091
Married	1.03 (0.71–1.49)	0.864
Unemployed	1.35 (0.93–1.96)	0.112
Living alone	0.96 (0.62–1.49)	0.852
Stroke	1.79 (1.22–2.63)	**0.003**
Amputation	3.80(2.20–6.57)	**0.000**
Any comorbidity related to mental disorder	1.34 (0.98–1.85)	0.069
9 or more comorbidities	1.50 (1.09–2.07)	**0.014**
Initial admission	1.27 (0.77–2.10)	0.343

ADL, activities of daily living; FIM, functional independence measure.

Our results indicate that nearly a half of all falls occurred during the first week of rehabilitation, and another quarter occurred during the second week of stay. These time periods roughly correspond to a first and second quintile of the total length of stay of our patients, respectively. We also found that "early" fallers (<5 days from admission to fall) are older than 70 yrs and with admission motor FIM score greater than 25 compared with "late" fallers (>5 days). This indicates that patients who are partially able to perform motor activities on admission are more likely to fall early. The reason may be that greater ambulatory level and active participation in rehabilitation puts them at risk of falling. Alternatively, the likelihood of falling may be artificially reduced in less-motor-independent patients who are not exposed to or are exposing themselves to risks. In other words, nonfallers may be not falling early because they have fewer opportunities to fall, not because they do not possess the intrinsic risks for fall or extrinsic risks are tamed. The proportion of fallers within the first 2 wks (75%) was somewhat higher in our study than the 64% rate reported by Vassallo et al.[3] The latter study included only elderly rehabilitation patients, whereas our sample was composed of younger subjects who evidently had a high fall rate.

The fallers in our study had an admission motor FIM score of 31 ± 13. Assuming a linear FIM score gain over the length of stay, the mean projected motor FIM score at the time of falling is 42 ± 16 in our sample. This implies that falls in general may be

more frequent among patients who require moderate assistance with motor activities—that is, who perform between 50% and 75% on their own, on average. In other words, the risk for falls among more dependent patients seems to increase with gaining motor abilities during the rehabilitation stay. This may be explained by the routine activity theory commonly applied to crime victimization, stating that going out more frequently increases one's risk of victimization.[27] In the context of patients falling more often while gaining independence, the higher rate of falls may result from a desire, propensity, or encouragement to perform various activities on their own, thereby increasing their probability of falling. This is supported by the findings that most falls were unobserved and happened in the patients' rooms. The follow-up interview revealed that these falls were often related to the need to use the bathroom.

The question remains what level of motor ability is above the fall threshold rendering patients less likely to fall. Suzuki et al.[20] explored the relationship between incidence of falls and six motor FIM score categories in stroke inpatients. They report the highest rate of falls for the group with admission motor FIM scores between 26 and 38. Their study also demonstrates a nonlinear relationship between falls and mobility; however, no statistical model was provided. Thus, further study that will develop and validate a nonparametric statistical model is warranted. This approach may prove of practical value for determining the risk of falls on the basis of FIM score and other information available at admission.

The rates of single and multiple falls in this study are lower than those previously reported for an inpatient rehabilitation sample.[1] This is likely attributable to a relative difference in sample composition. Another reason may be a difference in hospital-specific factors, such as physical environment and implementation of the prevention programs. Therefore, simple cross-comparison of falls between different studies may only be meaningful after careful consideration of the sample and unique hospital factors. It could be argued that a high rate of unobservable falls led to inclusion of some cases that presumably did not meet the criteria of "true" falls (false-positive cases). The same assumption may be invoked to explain the relatively small number and low severity of fall-associated injuries. However, most unobservable falls (75% of total) included instances where a staff member found a patient on the floor (66%), whereas far fewer falls were reported to staff (i.e., unobservable/reported, 9%). The fact that in the majority of cases a staff member witnessed a patient on the floor suggests a high reliability of the reported falls, as defined here. Furthermore, the overall lower rate of falls in our study compared with the literature further speaks against the inclusion of questionable instances of falls.

Our data support the notion that sample composition is critical when interpreting falls during inpatient rehabilitation, because the tendency to fall differed among the various diagnostic groups. We found that falls were most frequent in stroke and amputation patients, who represented 53% of all fallers and experienced 50% of all falls while accounting for only 34% of our study sample. This is consistent with the previous study,[1] which also reports the highest prevalence of falls in amputees (19%) and stroke patients (17%). In our study, people with lower-limb amputation and stroke were at a 2.2-fold higher risk of falls compared with other diagnostic groups after controlling for sociodemographic variables and severity of impairment. Multiple falls were also more frequent in stroke patients (67%). This finding emerged even though the overall rate of multiple falls in our study (20%) was lower than previously reported (31%).[1]

Whereas our findings closely approximate previously observed rates of falls among amputees,[1,7] the 14% fall rate among our stroke patients is comparably lower than the 17–38% range reported elsewhere.[1,9] This may be attributed to a relatively low fall rate (12%) among our stroke patients older than 60 yrs, who accounted for 73% of the stroke sample. Conversely, the greatest rate of falling (27%) was seen in the 40- to 60-yr group, which comprised only 23% of total stroke patients. After excluding 4% of those with no falls and younger than 40 yrs, the fall rate in the stroke group was negatively associated with decades of age.

The overall greater rate of falls among the 41- to 50-yr-olds became apparent only after categorizing age into several subgroups. In fact, linear regression did not detect a significant relationship between the prevalence of falling and age, which supports the finding that age as a continuous variable is not associated with falls.[12] Rather, negative quadratic function identified the highest risk in the 40- to 50-yr group, which was further confirmed in multivariate analyses. Although this age group made up only a small proportion of the study sample (9%), they accounted for 17% of total fallers and 50% of stroke patients who fell. These results perhaps reflect a greater attention to fall prevention among older patients compared with younger patients who remain at a high risk for falling.

We also report that the fallers in rehabilitation settings are characterized by medical complexity, because people with many comorbidities ($\geq$9) were more likely to fall. This is similar to a recent study in amputees that found a significant association

between four or more comorbidities and falls.[7] The same authors also report that the amputees with coronary artery disease or congestive heart failure were at a higher risk of falling. Our additional analysis based on the ICD codes, however, showed that coronary artery disease and congestive heart failure were not associated with falls in our broader rehabilitation sample. Rather, our data show a marginally significant trend toward increased risk of falls in those with comorbidities related to mental disorders, both in univariate and multivariate analyses, which warrants further investigations.

Although it is generally accepted that a previous fall becomes a risk factor for future falls,[3,28] the impact of premorbid falls on fall rate during first inpatient rehabilitation after acute neurological events is less clear. The retrospective nature of our study, however, precluded a retrieval of fall history and studying its associated impact. However, we found no significant difference between single and multiple fallers during the first rehabilitation stay regarding race, age, gender, diagnosis, or total FIM score. This also implies that the reported results would not significantly differ if only single fallers were compared with nonfallers.

Our study suggests that admission FIM score may have a value for predicting falls during rehabilitation stays. This is in agreement with the findings of Saverino et al.,[12] who report that total FIM scores were significantly associated with falls in a multivariate model. We specifically found that lower cognitive FIM score is a significant predictor of falls in the multivariate model that also included other predisposing risk factors. Activities of daily living and mobility FIM scores, however, were significant in the univariate but not in multivariate analyses. It seems, therefore, that among patients with comparable motor abilities, falls occur more often in those with worse cognitive functions.

As is customary in most hospitals, our center has an ongoing fall-prevention program and has empirically developed a simple score sheet to identify those at risk according to diagnosis, age, mental status, mobility, toileting needs, and medication use. The ongoing fall-prevention program includes a variety of safety precautions, such as keeping the bed in low position, use of side rails, activation of an alarm on getting out of bed, closer staff supervision, safety instructions, calling for assistance, locking wheelchairs, sitter supervision, family/caregiver education, and regular bathroom schedules. Although the purpose of this study was not to evaluate such measures but, instead, to independently determine current risk factors, the ongoing program was a confounder that possibly contributed to a comparably lower rate of falls and a shift in fallers to a lower age group. Despite considerable overlap between the empirically derived risk factors and those reported here, the fall risk assessment score ascribed to patients during the time of this study proved insensitive. This is likely attributable to the relatively simplistic scoring criteria used, which further emphasizes the need for developing a more comprehensive assessment based on information available at admission. Thus, our results provide the basis for future research aimed at better discriminating fallers from nonfallers during the inpatient rehabilitation stay.

CONCLUSIONS

This study found a comparably lower rate of falls during inpatient rehabilitation than previously reported. Falls were most frequent in mid-aged, medically complicated stroke and amputation patients with impaired cognitive functions. Several domains of the FIM instrument showed a good prognostic value in predicting falls in the rehabilitation setting. The overall results suggest that patients at a higher risk for falls during inpatient rehabilitation can be identified according to information available at admission. Lastly, our results demonstrate that falls represent a "moving target" that requires frequent, comprehensive evaluations and adjustments in ongoing fall-prevention programs.

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Vol. 87, No. 5 • May 2008

This is an adult learning experience and there is no requirement for obtaining a certain score. The objective is to have each participant learn from the total experience of studying the article, taking the exam, and being able to immediately receive feedback with the correct answers. For complete information, please see "Instructions for Obtaining Continuing Medical Education Credit" at the front of this issue.

Every question must be completed on the exam answering sheet to be eligible for CME credit. Leaving any item unanswered will make void the participant's response. This CME activity must be completed and postmarked by December 31, 2009. The documentation received will be compiled throughout the calendar year, and once a year in January, participants will receive a certificate indicating CME credits earned for the prior year of work. This CME activity was planned and produced in accordance with the ACCME Essentials.

CME Self Assessment Exam Questions

CME Article Number 5: *J.E. Lee, et al.*

1. According to this study, where and when do the majority of falls occur?
   A. In the therapy gym, during daytime
   B. In the patient's room, during daytime
   C. In a recreational area, during daytime
   D. In the patient's room, during nighttime

2. This study indicates that nearly a half of all falls occurred during the first week of rehabilitation. Who are the early fallers?
   A. Younger than 70 yrs and with better motor FIM score on admission
   B. Younger than 70 yrs and with worse motor FIM score on admission
   C. Older than 70 yrs and with better motor FIM score on admission
   D. Older than 70 yrs and with worse motor FIM score on admission

3. The study suggests that the risk for falls may be predicted on the basis of information available at admission to a tertiary rehabilitation hospital. Which is *not* found to be a risk factor for falls?
   A. Large number of comorbidities
   B. Age 60 or older
   C. Diagnosis of stroke
   D. Diagnosis of amputation

4. What *best* explains the finding that the risk for falls increases with gaining motor abilities?
   A. Greater challenge during therapy
   B. Less supervision
   C. Unfamiliar environment
   D. More opportunities to fall with increased activity

5. The majority of falls occurred in patients admitted for their first rehabilitation after an acute event. According to the literature, which variable *not examined* in this study may be an additional risk factor for falls in this setting?
   A. Level of activity before acute event
   B. Fall history
   C. Medication use during rehabilitation stay
   D. Use of assistive devices during rehabilitation stay

The answers to any essay questions must be typed or computer printed on a separate piece of paper and attached to this page.

After finishing this exam:

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