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PATTERNS AND PREDICTORS OF INPATIENT FALLS AND FALL-RELATED INJURIES IN A LARGE ACADEMIC HOSPITAL

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ABSTRACT

OBJECTIVES: Most research on hospital falls has focused on predictors of falling, whereas less is known about predictors of serious fall-related injury. Our objectives were to characterize inpatients who fall and to determine predictors of serious fall-related injury.

METHODS: We performed a retrospective observational study of 1,082 patients who fell (1,235 falls) during January 2001 to June 2002 at an urban academic hospital. Multivariate analysis of potential risk factors for serious fall-related injury (vs no or minor injury) included in the hospital's adverse event reporting database was conducted with logistic regression to calculate adjusted odds ratios (aORs) with 95% confidence intervals (CI_{95}).

RESULTS: The median age of patients who fell was 62 years (interquartile range, 49–77 years), 50% were women, and 20% were confused. The hospital fall rate was 3.1 falls per 1,000 patient-days, which varied by service from 0.86 (women and infants) to 6.36 (oncology). Some (6.1%) of the falls resulted in serious injury, ranging by service from 3.1% (women and infants) to 10.9% (psychiatry). The most common serious fall-related injuries were bleeding or laceration (53.6%), fracture or dislocation (15.9%), and hematoma or contusion (13%). Patients 75 years or older (aOR, 3.2; CI_{95}, 1.3–8.1) and those on the geriatric psychiatry floor (aOR, 2.8; CI_{95}, 1.3–6.0) were more likely to sustain serious fall-related injuries.

CONCLUSIONS: There is considerable variation in fall rates and fall-related injury percentages by service. More detailed studies should be conducted by floor or service to identify predictors of serious fall-related injury so that targeted interventions can be developed to reduce them (*Infect Control Hosp Epidemiol* 2005;26:822-827).

Falls are known to be one of the most common inpatient adverse events.[1-3] Up to 33% of hospital falls lead to injury.[2,3] Inpatient falls may increase length of stay and cause permanent disabilities and even death. From a risk management and quality of care perspective, it is important to develop interventions to decrease falls and the harm they cause.

Most research on falls has been conducted in elderly populations from the community and long-term–care facilities.[4-6] Less is known about falls among hospital inpatients. Across all study populations (community based, nursing home, and inpatient settings), there has been more emphasis on the identification of fall rates, predictors of falling, and prevention of falls than on the specific assessment of fall-related injury rates and predictors and prevention of serious fall-related injuries.[7,8] Falls that result in injury are costly to patients and healthcare institutions and can lead to nursing home admission and even death. Recent studies have found that multidisciplinary interventions may be able to reduce the incidence of falls in hospitals.[9-11] However, these studies were limited to rehabilitation environments or elderly care wards. Although some interventions demonstrated some benefit in reducing rates of fall-related injury, the reduction was not significant. It is therefore important to conduct more research on falls resulting in injury so that focused interventions and prevention strategies can be developed.[6,12-14]

The development of successful hospital-based interventions to decrease fall rates and fall-related injury requires large, well-designed studies to characterize the nature of inpatient falls and identify predictors of fall-related injury. We have previously conducted studies on falls in a large academic hospital to characterize the circumstances surrounding the falls and to identify risk factors for falling.[15,16] To further our research, we conducted a larger study to describe characteristics of inpatients who fall, to calculate fall and fall injury rates, and to determine

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the predictors of serious injury from falls among hospital inpatients.

METHODS

This study was conducted at Barnes–Jewish Hospital, a 1,300-bed academic teaching hospital within BJC HealthCare and affiliated with Washington University School of Medicine, St. Louis, Missouri. Seven services that spanned 45 floors were included in this study: cardiology (13 floors), oncology (3 floors), medicine (7 floors), surgery (10 floors), neurology and orthopedics (5 floors), women and infants (4 floors), and psychiatry (2 adult psychiatry floors and 1 geriatric psychiatry floor).

A retrospective analysis of 1,235 inpatient falls that occurred from January 2001 to June 2002 was conducted. The falls were reported by nurses and other hospital employees into the hospital's online adverse event reporting database. Physical therapy falls were excluded because they were less likely to result in injury than the rest of the falls as these patients were always assisted to the floor by physical therapists. Neonates falling from their mother's bed were excluded because these falls are qualitatively different from adult inpatient falls.

A patient who fell only once during the study period is referred to as a "one-time faller," and a patient who fell more than once is referred to as a "repeat faller." Only the first fall for each repeat faller was included in the analysis to maintain independence of the observations. It has been documented that repeat fallers are not significantly more likely than one-time fallers to sustain injury[10] and they tend to repeat type and location on successive falls.[1]

A fall was defined as a sudden, unexpected descent from a standing, sitting, or horizontal position (including slipping from a chair to the floor, patients found down on the floor, and assisted falls). The fall-related variables in the online event reporting system included patient gender, mental status prior to the fall, date and time reported, reporting department, fall location, mechanism of the fall or activity at the time of the fall, side rail position prior to the fall, whether the call light was within reach prior to the fall, restraint use prior to the fall, bed position prior to the fall, type of injury, severity of injury, and a narrative describing the fall. For the analysis, an additional variable identifying whether the fall was elimination related was created by reading the narrative for each fall. An elimination-related fall was defined as a fall that occurred during an activity related to elimination needs, such as ambulating to or from the bathroom or bedside commode, reaching for toilet tissue, exiting a soiled bed, or using the toilet or bedside commode. Falls that were definitely elimination related were coded as "yes." Falls that could not be definitely identified as elimination related were coded as "no/unknown."

Severity of injury was classified within the online adverse event reporting system as follows: (1) none: no significant discomfort, no effect on clinical course, and no increased length of stay; (2) minor: minimal impact on patient care, may involve some clinical intervention, and no lasting impact on patient outcome (eg, minor cuts, minor bleeding, swelling, pain, or minor contusions); (3) moderate: moderate impact on patient care, some clinical intervention, lengthened stay or rehospitalization, and some lasting impact on the patient's outcome (eg, excessive bleeding, lacerations requiring sutures, loss of consciousness, or moderate head trauma); (4) major: severe impact on patient care, major clinical intervention, lengthened stay or rehospitalization, and major impact (functional or cosmetic impairment) on patient's outcome (eg, fractures, subdural hematomas, other major head trauma, or cardiac arrest); and (5) death: death related or attributed to the fall. Injury classification was later validated and updated by reviewing x-ray and computed tomography scan results.

This research was reviewed and approved by the institutional review board of the Washington University School of Medicine. Comparisons of proportions for categorical variables were tested with Pearson chi-square and Fisher's exact tests. Tests were two-tailed and a P value of less than .05 was considered significant. Univariate and multivariate logistic regression were used to calculate both crude odds ratios (ORs) and adjusted ORs with 95% confidence intervals (CI_{95}) for risk factors for serious fall-related injury (including moderate to major injury and fall-related death). Cases with missing data for potential risk factors were excluded from multivariate analysis. Outliers and influential cases were identified by the use of regression diagnostics. The multivariate model was constructed using a manual stepwise method to include significant (or borderline significant) predictors and confounders. Adequacy of the multivariate model was assessed using the Hosmer–Lemeshow goodness-of-fit test. All analyses were conducted using SPSS software (version 11.0.1; SPSS, Inc., Chicago, IL).

RESULTS

A total of 1,082 inpatients fell during the study period (representing 1.4% of all patients admitted between January 1, 2001, and June 30, 2002) and met our inclusion criteria. Of this sample, 962 (89%) fell only once. The remaining 120 patients (11%) fell more than once: 101 (84.2%) fell twice, 9 patients fell 3 times, 7 patients fell 4 times, 2 patients fell 5 times, and 1 patient fell 6 times. This represents a total of 1,235 falls that occurred during the study period. Demographics of the inpatients who fell are included in Table 1. One-time fallers were analyzed separately from repeat fallers to determine whether the two groups differed significantly regarding demographics. Repeat fallers were slightly older, on average, than one-time fallers (64.3 vs 61.8 years), but the difference between the two groups was not statistically significant.

Approximately half of the one-time or repeat fallers were described as alert prior to the fall; approximately 20% of the one-time or repeat fallers were assessed as confused. Most one-time fallers (94.0%) and repeat fallers (95.0%) had no or minor fall-related injuries. Elimination-related falls were more likely to occur among one-time fallers (40.0%) than repeat fallers (30.0%; $P = .03$).

TABLE 1
DEMOGRAPHICS OF INPATIENTS WHO FELL DURING JANUARY 2001 TO JUNE 2002

Characteristic	One-Time Fallers* (N = 962)	Repeat Fallers*,† (N = 120)	P
Mean age, y (SD)	61.8 (18.6)	64.3 (15.0)	.16
Gender			
Male	475 (49.4%)	65 (54.2%)	.32
Female	487 (50.6%)	55 (45.8%)	
Mental status prior to fall			
Alert	510 (53.0%)	65 (54.2%)	.99
Confused	192 (20.0%)	22 (18.3%)	
Agitated or combative	36 (3.7%)	5 (4.2%)	
Sedated or unconscious	15 (1.6%)	4 (3.3%)	
Unknown or not documented	209 (21.7%)	24 (20.0%)	
Injury severity			
None	631 (65.6%)	88 (73.3%)	.65
Minor	273 (28.4%)	26 (21.7%)	
Moderate	38 (4.0%)	4 (3.3%)	
Major	20 (2.1%)	2 (1.7%)	
Death‡	0 (0.0%)	0 (0.0%)	
Elimination-related fall			
Yes	385 (40.0%)	36 (30.0%)	.03
No/unknown	577 (60.0%)	84 (70.0%)	

SD = standard deviation.
*A patient who fell once during the study period is referred to as a one-time faller; a patient who fell more than once during the study period is referred to as a repeat faller.
†Only the first fall for each repeat faller was included.
‡Two deaths occurred among the repeat fallers after their second fall.

Elimination-related falls were significantly more likely to occur at night than at any other time of day (48.3% vs 32.7%; $P < .001$); they were also significantly more likely to occur in the patient's bathroom than in any other location (68.0% vs 33.1%; $P < .001$). Patients who were 65 years or older were more likely than younger patients to have an elimination-related fall (55.1% vs 44.9%; $P = .002$).

The hospital fall rate for the study period was 3.10 falls per 1,000 patient-days, with approximately 34% of falls resulting in injury (including minor injuries). Rates by service varied from 0.86 (women and infants) to 6.36 (psychiatry) falls per 1,000 patient-days (Fig. 1), and the percentages of falls resulting in injury varied from 27.1% (neurology and orthopedics) to 42.6% (oncology) (Fig. 2). The geriatric psychiatry floor, which is included in the psychiatry service in Figure 1, had the highest fall rate (13.66%) compared with all other hospital floors.

There was no significant variation in the percentage of injuries during the study period. Six percent of all falls resulted in serious injury. Serious fall injury percentages ranged by service from 3.1% (women and infants) to 10.9% (psychiatry). The most common types of serious injuries from falls were excessive or serious bleeding or laceration (53.6%), fracture or dislocation (15.9%), and hematoma or contusion (13.0%). The remaining 17.5% of serious injuries consisted of a multitude of injury types. There were two fall-related deaths, which represented 0.2% of the inpatients who fell during the study period. Both occurred for repeat fallers following their second fall. No tests were conducted after these patients fell, so it is difficult to determine whether the fall contributed directly to their death. Overall, repeat falls were not significantly more likely than first falls to result in serious injury (7.2% vs 5.9%; chi-square = 0.4; $P = .54$).

Crude ORs for potential risk factors for serious injury from first falls are included in Table 2. Significant predictors were age of 75 years or older (crude OR, 2.6; CI_{95}, 1.2 to 5.6), sedated or unconscious mental status (crude OR, 3.8; CI_{95}, 1.2 to 11.9), and residence on the geriatric psychiatry floor (crude OR, 3.7; CI_{95}, 1.8 to 7.4). Patients aged 50 to 64 years and 65 to 74 years also had an elevated likelihood of serious injury compared with patients younger than 50 years, but this did not reach statistical significance (crude OR, 2.1; CI_{95}, 0.9 to 4.8; and crude OR, 1.9; CI_{95}, 0.8 to 4.7, respectively). Similar results were obtained for the oncology (crude OR, 2.1; CI_{95}, 1.0 to 4.4) and adult psychiatry (crude OR, 2.2; CI_{95}, 0.9 to 5.4) floors. Gender, time of day, confused mental status, and agitated

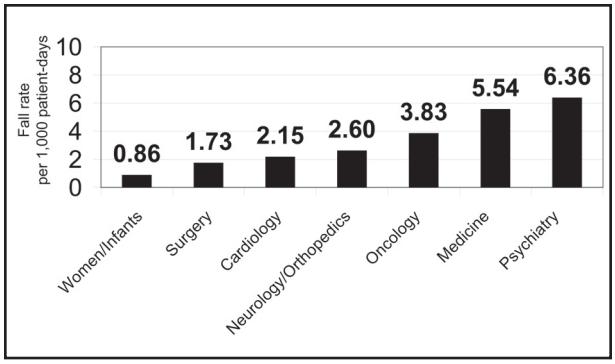

FIGURE 1. Fall rates by hospital service, January 2001 to June 2002.

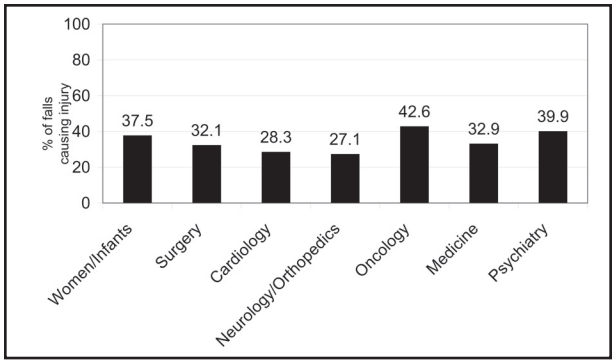

FIGURE 2. Percentages of falls resulting in injury (including minor and serious) by hospital service, January 2001 to June 2002.

TABLE 2
UNIVARIATE PREDICTORS OF MODERATE AND SEVERE INJURY FROM FIRST FALLS

Exposure	No or Minor Injury (N = 1,018)	Moderate or Severe Injury (N = 64)	Crude OR	CI_{95}
Gender				
Male	512 (50.3%)	28 (43.8%)	-	
Female	506 (49.7%)	36 (56.3%)	1.3	0.8–2.2
Time of day				
Day (7:00 am to 2:59 pm)	304 (29.9%)	20 (31.3%)	-	
Evening (3:00 pm to 10:59 pm)	316 (31.0%)	15 (23.4%)	0.7	0.4–1.4
Night (11:00 pm to 6:59 am)	398 (39.1%)	29 (45.3%)	1.1	0.6–2.0
Age, y				
< 50	274 (26.9%)	9 (14.1%)	-	
50 to 64	248 (24.4%)	17 (26.6%)	2.1	0.9–4.8
65 to 74	190 (18.7%)	12 (18.8%)	1.9	0.8–4.7
⩾ 75	306 (30.1%)	26 (40.6%)	2.6	1.2–5.6
Mental status				
Alert	537 (52.8%)	38 (59.4%)	-	
Agitated or combative	40 (3.9%)	1 (1.6%)	0.4	0.1–2.6
Confused	198 (19.4%)	16 (25.0%)	1.1	0.6–2.1
Sedated or unconscious	15 (1.5%)	4 (6.3%)	3.8	1.2–11.9
Unknown	228 (22.4%)	5 (7.8%)		
Floor				
Other services or floors	795 (78.1%)	37 (57.8%)	-	
Oncology	94 (9.2%)	9 (14.1%)	2.1	1.0–4.4
Adult psychiatry	59 (5.8%)	6 (9.4%)	2.2	0.9–5.4
Geriatric psychiatry	70 (6.9%)	12 (18.8%)	3.7	1.8–7.4

OR = odds ratio; CI_{95} = 95% confidence interval.

or combative mental status were not significant predictors of serious injury.

In the multivariate model identifying significant predictors of serious injury (Table 3), age of 75 years or older (adjusted OR, 3.2; CI_{95}, 1.3 to 8.1) and residence on the geriatric psychiatry floor (adjusted OR, 2.8; CI_{95}, 1.3 to 6.0) remained significant predictors of serious injury. When examined as a continuous variable, age was still a statistically significant risk factor (adjusted OR, 1.019; CI_{95}, 1.001 to 1.038). Sedated or unconscious mental status did not re-

TABLE 3
MULTIVARIATE ANALYSIS OF PREDICTORS OF MODERATE AND SEVERE INJURY FROM FIRST FALLS*

Exposure	Adjusted OR	CI_{95}
Age, y		
< 50	-	
50 to 64	2.0	0.8–5.1
65 to 74	2.1	0.8–5.7
⩾ 75	3.2	1.3–8.1
Mental status		
Alert	-	
Agitated or combative	0.4	0.1–3.3
Confused	1.0	0.5–1.9
Sedated or unconscious	3.1	0.9–11.0
Unknown		
Floor		
Other services or floors	-	
Oncology	1.9	0.8–4.5
Adult psychiatry	2.1	0.7–6.7
Geriatric psychiatry	2.8	1.3–6.0

OR = odds ratio; CI_{95} = 95% confidence interval.
*Number of fallers with no or minor injury = 790; number of fallers with moderate or severe injury = 59.

tain statistical significance in the final model (adjusted OR, 3.1; CI_{95}, 0.9 to 11.0). There were no significant interactive effects among the predictor variables. The Hosmer–Lemeshow goodness-of-fit test found the multivariate model to be appropriate (Hosmer–Lemeshow statistic, 12.35; $P = .136$).

DISCUSSION

This study provides important information regarding demographics of inpatient falls, fall and injury rates by service, and predictors of serious injury from a fall. The proportion of falls related to elimination needs in this study (40%) was similar to those of our prior studies (50% and 47%).[15,16] The proportion was slightly lower in this study, most likely because we were limited to adverse event reporting data in this study but we were able to interview nurses and patients and review the nursing electronic charting system in our previous studies. This study also confirmed that patients 65 years or older are more likely to have elimination-related falls and that elimination-related falls are more likely to occur at night, as found in our prior studies.

Few data are available regarding predictors of serious fall-related injury (compared with no or minor injury) for inpatients of all ages in an acute care hospital with a wide range of services. Most studies on falls, regardless of the setting (community, long-term care, or hospital), have focused on predictors of falls and interventions to prevent falls. Studies that have analyzed predictors of fall-related injury have usually been conducted in rehabilitation hospitals, long-term–care institutions, or the community. Many of these studies examined only the elderly and used different injury outcomes, such as investigating only fractures or having any type of injury, including minor injury.[13,17] Results from these studies have documented a wide variety of risk factors for fall-related injury and are not consistent. Only one study has evaluated the predictors of serious fall-related injury among inpatients from all services of an acute care hospital.[14] The comparison group for that study was patients who did not fall instead of patients who fell and did not suffer serious injury. Furthermore, falls from only three services (medicine, surgery, and obstetrics and gynecology) were assessed.[14]

Although confused mental status was not a significant predictor of falls resulting in injury in this study, confusion has been documented as a significant predictor of injurious falls in inpatient, long-term–care, and community settings.[13,14,18] In contrast to some of these studies, which used standardized assessments of confusion (Confusion Assessment Score and Mini-Mental State Examination Score), the mental status of our subjects was assessed subjectively based on the opinion of the staff member recording the fall in the hospital's adverse event database. This lack of standardized assessment may have influenced our results. Information on mental status was also missing for a substantial number of cases, which could have limited the power to detect a significant association. Sedated or unconscious mental status was of borderline significance in our multivariate model, despite a point estimate of 3.8 for the likelihood of having a serious fall-related injury. Failure to achieve significance may reflect the small number of patients with this condition. Failure to achieve statistical significance could also be due to multicollinearity in the model, as more patients in the oncology service than in other parts of the hospital were sedated or unconscious (8.0% vs 1.4%; $P < .001$).

Advanced age (75 years or older) was a significant predictor of serious injury in our study and has been documented as a predictor of fall-related fracture in patients of rehabilitation hospitals.[17] Yet most studies, regardless of the setting, have not reported age as a predictor of fall-related injury. Our study design did not allow us to assess many other variables that could be potential predictors of serious injury from falls (such as osteoporosis, osteopenia, or previous fractures). However, advanced age could serve as a marker for these and other comorbidities that have been significant predictors of falls and fall-related injuries in inpatient and community studies.[14,18]

Residence on the geriatric psychiatry floor was a significant predictor of serious injury in our sample. Given that the geriatric psychiatry floor also had the highest fall rate during the study period, this group may deserve further study to define risk factors and to test fall prevention strategies. There are many health conditions common to geriatric psychiatry patients, including Parkinson's disease, Alzheimer's disease, cardiac arrhythmias, electroconvulsive therapy, and treatment with mood stabilizers,[19]

that should be assessed as potential predictor variables. Although statistical significance was not reached, residence on the oncology and adult psychiatry floors also increased the risk for fall-related injury. These patients also have specific conditions that could increase their risk of injury from a fall.

Caution should be exercised in comparing fall rates across floors, services, or hospitals. It is not known exactly what proportion of falls are actually reported. However, falls have been tracked aggressively throughout this hospital for a decade. There were also limitations to our study inherent to a retrospective study design. As mentioned previously, patients' risk factors were classified based on the opinions of staff members entering the information into the hospital's adverse event system database and could be biased because information was entered after the fall event. Future studies on predictors of injurious falls should include variables that are objectively measured and systematically ascertained. Many of the entries in our hospital's reporting database were not required fields. We were not able to assess all pertinent potential risk factors, including extrinsic factors such as staff levels, because we relied only on the variables included in the adverse event database. Finally, a relatively small number of patients in this study had serious injuries, which could explain why so few correlates of serious injuries were identified.

There is great need to better understand the nature of inpatient falls in acute care hospitals and, in particular, the characteristics of patients and the hospital environment that can lead to serious injury as a consequence of falls. Our results may be used to develop more detailed and methodologically rigorous studies targeting specific floors or services. Prospective studies are needed to validate the risk factors for fall-related injury and should also include patients who did not fall as another comparison group. Information gained from future studies can be used to develop interventions that will minimize the severity of injuries due to falls among high-risk patients in acute care settings.

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