

Predictors of Serious Injury Among Hospitalized Patients Evaluated for Falls

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BACKGROUND: Inpatient falls are common and result in significant patient morbidity.

OBJECTIVE: To identify predictors of serious injury being found on imaging studies of inpatients evaluated after a fall.

DESIGN: Retrospective study.

SETTING: An 1171-bed urban academic medical center.

PATIENTS: All inpatients who fell on thirteen medical and surgical units from January 1 to December 31, 2006.

MEASUREMENTS: Patient characteristics, circumstances surrounding falls, fall-related injuries, and length of stay were collected through review of incident reports and computerized medical records. Primary outcome of fall-related injury was determined by evidence of injury on imaging studies within two weeks of the fall. Univariate and multivariate logistic regression were used to calculate adjusted odds ratios (ORs) for injury after an inpatient fall.

RESULTS: A total of 513 patients had 636 falls during the study time period. Fall incidence rate was 1.97 falls per 1,000 patient days. 95 patients (19%) fell multiple times (range, 2-6 events); 74% of the falls occurred in patients who were previously assessed as being "at risk" by the nursing staff. Multivariate analysis, adjusting for age and sex, found evidence of trauma after a fall (OR = 24.6, $P < 0.001$) and ambulatory status (OR = 7.3, $P < 0.01$) to be independent predictors of injury being found on imaging studies.

CONCLUSIONS: Inpatient falls are common despite high-risk patients being identified. After adjusting for age and sex, evidence of trauma and ambulatory status were independent predictors of an injury being found on imaging studies after an inpatient fall. *Journal of Hospital Medicine* 2010;5:63-68. © 2010 Society of Hospital Medicine.

KEYWORDS: fall prevention, injury, inpatient falls.

An estimated 2% to 15% of all hospitalized patients experience at least one fall.¹ Approximately 30% of such falls result in injury and up to 6% may be serious in nature.^{1,2} These injuries can result in pain, functional impairment, disability, or even death, and can contribute to longer lengths of stay, increased health care costs, and nursing home placement.²⁻⁵ As a result, inpatient falls have become a major priority for hospital quality assurance programs, and hospital risk management departments have begun to target inpatient falls as a source of legal liability.^{1-3,6,7} Recently, the Centers for Medicare and Medicaid Services announced that it will no longer pay for preventable complications of hospitalizations, including falls and fall-related injury.⁸

Much of the literature on falls comes from community and long-term care settings, and only a few studies have investigated falls during acute care hospitalization.^{3,9,10} From these studies, risk factors for inpatient falls have been identified and various models have been developed to pre-

dict an individual patient's risk of falling. However, unlike in the community setting, interventions to prevent falls in the acute care setting have not proven to be beneficial.^{11,12} Commonly used approaches including restraints, alarms, bracelets, or having a volunteer sit with high-risk patients have not been found to be effective.^{13,14} Only 1 study found a multicomponent care plan that targeted specific risk factors in older inpatients to be associated with a reduced relative risk of recorded falls.¹⁵ Given this dearth of consistent evidence for the prevention of falls in hospitalized inpatients, the American Geriatrics Society has identified this as a "gap area" for future research.¹⁶

There are also limited data regarding predictors of injury after inpatient falls. A few small studies have identified potential risk factors for sustaining an injury after a fall in acute care, such as age >75 years, altered mental status, increased comorbidities, visual impairment, falls in the bathroom, and admission to a geriatric psychiatry floor.^{2,5,17} However, to our knowledge, there are no studies that have

identified potential characteristics of inpatients found immediately after a fall that predict an injury. Providers who assess inpatients who have fallen need guidance on how to identify those in need of further evaluation and testing. This study sought to quantify the types and severity of injuries resulting from inpatient falls and to identify predictors of injury after a fall among a cohort of patients who fell at an urban academic medical center.

Patients and Methods

Patient Population

The study population included all inpatients on 13 medical and surgical units who experienced a fall between January 1, 2006 and December 31, 2006, while hospitalized at an 1171-bed urban academic medical center. Telemetry, intensive care, pediatric, psychiatric, rehabilitation, and obstetrics or gynecology units were excluded from this analysis; the patients on these units are special populations that are qualitatively different than other acute care patients and have a different set of risk factor for falls and predictors of fall-related injury. The study was approved by the institutional review board of the Mount Sinai School of Medicine.

Data Collection

Inpatient falls were identified retrospectively by review of hospital incident reports, which are most often completed by the unit nurses. In our institution, all falls generate an incident report. Using a standardized abstraction form, patient characteristics, circumstances surrounding falls, and fall-related injuries were collected from the reports.

Laboratory data for anemia (hemoglobin < 12.0 g/dL), low albumin (<3.5 g/dL), elevated creatinine (>1.5 mg/dL), prolonged partial thromboplastin time (>35 seconds), and elevated international normalized ratio (INR > 1.3), were extracted from the patient's computerized medical record, if available. Number of days from admission to the fall, length of stay to the nearest hundredth of a day, and discharge disposition were also recorded for each patient.

Results of all radiographic studies, including x-ray, ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI), performed within 2 weeks after the fall were obtained. The indication for the imaging study was assessed from the order given to the radiology department and from the patient's medical record. A positive finding on an imaging study was defined as evidence of intracranial hemorrhage, fracture, joint effusion, soft-tissue swelling, or any other injury potentially caused by trauma. Fall-related injury was defined as positive findings on any of these imaging studies that were performed as a result of the fall. Evaluation of fall-related injuries was conducted by a reviewer blinded to the baseline patient characteristics and laboratory data.

Statistical Analyses

Baseline characteristics and risk factors of patients with and without fall-related injuries were compared using the chi

square test or Student *t* test as appropriate. Univariate and multivariate logistic regression were used to calculate adjusted odds ratios (ORs) for injury after an inpatient fall. The multivariate model was developed using a manual forward method. Prior research shows that patients with recurrent falls do so in the same manner and for the same reasons.^{2,3,17} Thus, analyses were performed including only the first fall episode as the outcome of interest. Analyses were performed with SPSS statistical software (SPSS Inc., Chicago, IL) using 2-sided *P* values.

Results

During the study period, 513 inpatients sustained 636 falls at the Mount Sinai Medical Center. There were 54,257 admissions to the hospital with 322,670 total patient days during this time. Therefore the fall incidence rate was 1.97 falls per 1,000 patient days. Characteristics of inpatients who fell are shown in Table 1. Most patients had 1 fall episode; however, 95 patients (19%) fell multiple times (range, 2-6 events). There were no significant differences between recurrent fallers and those who fell once with respect to baseline characteristics, injuries sustained, or discharge disposition.

Fall Circumstances

The majority of patients who fell (74%) had been assessed by the nursing staff as being "at risk for falling" prior to the event. Overall, most falls (73%) occurred on medical rather than surgical units. The units with the most falls were geriatrics, neurology, and general medicine. Details about circumstances surrounding the falls are shown in Table 2. In most instances (71%) patients were found on the floor after the fall while less than 8% of falls were witnessed. Approximately 12% of patients received sedatives within 4 hours of falling (40% opioids, 30% benzodiazepines, 16% zolpidem, and 14% other). Laboratory values at the time of fall revealed that 70% of patients who fell were anemic, 62% had low albumin, and 19% had an elevated creatinine. Almost 20% of the patients had a prolonged partial thromboplastin time (PTT) and 18% had an elevated INR.

The median number of days from patient admission until they fell was 4 days (range, 0-134), with 70% of patients falling within the first week of admission. In general, there was no difference in fall rate by time of day, though slightly more falls (56%) occurred during the night shift (7 PM to 7 AM).

Fall-related Outcomes

Twenty-five patients (5%) had evidence of trauma on physical exam after the fall, including lacerations, swelling, and ecchymoses, as documented by the evaluating nurse. A total of 120 imaging procedures were ordered following the first fall; when all inpatient falls were included, 145 imaging procedures were ordered. Most imaging studies (87%) did not show significant findings. Among studies with positive findings, the most common abnormality was fracture, including 3 hip, 1 humeral, 1 vertebral, 1 nasal, and 1 rib fracture.

TABLE 1. Demographic Characteristics of Patients Who Sustained a Fall

Characteristic	Number of Patients (n = 513) [number (%)]
Age (years)	70 (21-104)
Age >75 years	202 (39)
Male gender	255 (50)
Assessed "at risk of falling"	
Yes	378 (74)
No	2 (5)
Unknown	110 (21)
Number of falls	
1	418 (82)
2	78 (15)
3	10 (2)
4	4 (1)
5	2 (0.4)
6	1 (0.2)
Multiple falls	95 (19)

NOTE: All values are given as number (%) except age, which is median (range).

Other injuries found on imaging studies included 1 subdural hematoma, 1 acute cerebral infarct, 2 soft-tissue hematomas, and 2 knee effusions. The acute cerebral infarct was not considered to be a result of the fall. Additionally, 3 patients had soft-tissue swelling noted on head CT and 1 had Foley catheter-related trauma.

The average length of stay for the 513 inpatients who fell was 20 days (range, 7-444) compared to 6 days for all patients admitted to the hospital during the same period. Among inpatients who fell, there was no statistical difference in length of stay between those who did and those who did not have a fall-related injury found on imaging. More than one-half (53%) of the patients who fell were discharged to home, 21% to rehabilitation facilities, 12% to nursing homes, and 9% died during the hospitalization.

Results of Univariate Analysis

Univariate predictors of injury after a fall are shown in Table 3. Patients having evidence of trauma indicated by the evaluating nurse after a fall had an increased risk for having an abnormal imaging study (OR = 14.7, $P < 0.001$). Having an activity level of "ambulatory" ordered by the provider (OR = 2.5, $P = 0.09$), falling during the night shift (OR = 2.5, $P = 0.11$), having ambulation as the fall-related activity (OR = 2.2, $P = 0.12$), and older age ($P = 0.19$) all showed a trend toward higher rates of injury being found after a fall. There was no significant association between fall-related injury and being an elderly patient (age > 75 years), sedative use, falling in the bathroom, or having an elevated PTT or INR.

Multivariate Predictors of Injury

In multivariate analysis, after adjusting for age and sex, evidence of trauma after a fall (OR = 24.6, $P < 0.001$) and hav-

TABLE 2. Circumstances of First Inpatient Fall

Characteristic	Number of Falls (n = 513) [number (%)]*
Location	
Medical unit	374 (73)
Surgical unit	139 (27)
Time	
Day shift (7:00 AM to 6:59 PM)	225 (44)
Night shift (7:00 PM to 6:59 AM)	282 (56)
Character of fall	
Assisted to floor	15 (3)
Fall alleged	92 (18)
Fall witnessed	39 (8)
Found on Floor	363 (71)
Unknown	4 (<1)
Fall-related activity	
Ambulation	164 (32)
Bathroom	122 (24)
Bed	21 (4)
Chair	19 (4)
Other/unknown	187 (36)
Mental status	
Oriented	274 (53)
Confused	151 (29)
Unknown	88 (17)
Activity level ordered	
Ambulatory	246 (48)
Nonambulatory	135 (26)
Unknown	132 (26)
Siderails	
Complete	15 (3)
Partial	352 (69)
None	15 (3)
Unknown	126 (25)
Environmental obstacle	
None	355 (69)
Wet	20 (4)
Debris	2 (<1)
Unknown	136 (27)
Restraints	
Yes	3 (<1)
No	374 (73)
Unknown	136 (27)
Sedative use	
Total	64 (12)
Opioids	28 (6)
Benzos	21 (4)
Antipsychotics	7 (1)
Other	8 (2)
Evidence of trauma	
Yes	25 (5)
No	285 (56)
Unknown	203 (40)

Abbreviation: benzos, benzodiazepines.

*Percentages were rounded to nearest whole number and may not add exactly to 100%.

ing an activity level of "ambulatory" ordered by the provider (OR = 7.3, $P = 0.01$) were independent predictors of injury being found on imaging studies (Table 4). Analyses limited to the 120 patients who had imaging found that the association between evidence of trauma (OR = 6.22, $P = 0.02$) and

TABLE 3. Univariate Analysis of Predictors of Injury Being Found on Imaging Studies After Inpatient Falls

Variable	Patients		OR	P Value
	without injury (n = 497) [number (%)]	Patients with injury (n = 16) [number (%)]		
Elderly	195 (39)	7 (44)	1.2	0.72
Gender male	245 (49)	10 (63)	1.7	0.30
Location surgical unit	142 (29)	6 (38)	1.5	0.44
“At risk of falling” prior to event	365 (73)	13 (8)	1.6	0.49
Protocol in place	338 (68)	11 (69)	1.0	0.95
Activity level ambulatory	235 (47)	11 (69)	2.5	0.09
Occurrence on night shift	270 (54)	12 (75)	2.5	0.11
Restraint use	3 (1)	0 (0)	–	–
Sedative within 4 hours	61 (12)	3 (19)	1.6	0.44
Fall related to ambulation	156 (31)	8 (50)	2.2	0.12
Evidence of trauma	19 (4)	6 (38)	14.7	<0.001
Prolonged PTT	93 (19)	5 (31)	1.9	0.29
Elevated INR	90 (18)	3 (19)	1.0	0.96
Anemia	351 (71)	9 (56)	0.6	0.32
Elevated creatinine	97 (20)	2 (13)	0.7	0.60
Low albumin	309 (62)	8 (50)	1.6	0.58

Abbreviations: INR, international normalized ratio; OR, odds ratio; PTT, partial thromboplastin time.

having an activity level of “ambulatory” ordered (OR = 5.53, $P = 0.04$) remained statistically significant.

Discussion

Inpatient falls are common and result in significant patient morbidity and increased healthcare costs. Falls in the acute care setting have also proven to be difficult to prevent and as a result have become a priority for patient safety and hospital quality.

Our study confirms that a high percentage of patients with an initial fall will have recurrent falls.¹ Additionally, the majority of patients in this cohort fell despite having been assessed as “at risk for falling” prior to the event. The types of injuries sustained after inpatient falls (eg, subdural hematoma, multiple fractures, joint effusions, other hematomas, and soft-tissue swelling) are similar to those found by other authors.^{2,3,17,18}

In this study, inpatient falls were associated with an almost 2-week increase in length of stay. Though we cannot say that this was directly due to falls, and an increased length of stay may just be a marker of severity of illness, this association warrants further study, perhaps with a matched control group of patients who did not fall, and has implications for healthcare cost containment.

We found that having evidence of trauma after a fall and having an activity level of “ambulatory” ordered by the provider were independent predictors of injury being found after an inpatient fall. It seems intuitive that patients who have physical evidence of trauma, such as lacerations or bruising, would be more likely to have an underlying injury.

TABLE 4. Multivariate Analysis of Predictors of Injury Being Found on Imaging Studies After Inpatient Fall

Variable	All Patients (n = 513)		Patients with Imaging (n = 120)*	
	OR	P Value	OR	P Value
Age	1.03	0.17	1.016	0.52
Gender	3.19	0.11	2.843	0.17
Evidence of trauma	24.63	<0.001	6.22	0.02
Activity level ambulatory	7.33	0.01	5.53	0.04

Abbreviation: OR, odds ratio.

*Since not every patient who fell had imaging, the analysis was repeated only including those patients who did have imaging studies.

Clinically, this confirms that providers should have a high index of suspicion for injury being found on imaging studies in such patients. Similar findings have been noted in the emergency medicine literature that further support the validity of our findings.¹⁹

Less clear are the reasons for the observed association between having an activity level of “ambulatory” ordered and higher risk of injury after an inpatient fall. Prior studies have found that ambulatory inpatients are less likely to use assistive devices that they use at home while hospitalized and are less likely to call for help; these factors may contribute to falls.^{2,3} However, the interpretation of this finding is limited by the fact that 26% of the patients who fell had an unknown activity level ordered.

Altered mental status, comorbidity, age > 75 years, visual impairment, falling in the bathroom, and being on a geriatric psychiatry floor have previously been found to be risk factors for sustaining an injury after an inpatient fall.^{2,5,17} Conversely, this study did not find altered mental status to be a significant predictor of injury. One reason may be that this was subjectively determined by the evaluating nurse and not by a standardized measure of cognitive impairment. Patients who are oriented may also be more likely to report unwitnessed falls and injuries than patients with altered mental status.³

There was also no association between age and fall-related injury in our cohort. On univariate analysis, patients who were older in age were more likely to have an injury found after an inpatient fall but this was not statistically significant. Previous authors have suggested that today’s inpatients are increasingly ill and may have risk factors for falls and injuries that are independent of age, such as multiple comorbid conditions or deconditioning.³

We hypothesized that patients who are anticoagulated and had an elevated INR or PTT would be more likely to sustain an injury. Anemic inpatients have also been found to be at increased risk of falls.²⁰ We found no significant association between fall-related injury being found on imaging studies and anemia, low albumin, elevated creatinine, prolonged PTT, or elevated INR. Not every patient who fell

had these laboratory values available. However, even when only inpatients who fell and had laboratory tests were included in the analysis, there was still no association with fall-related injury.

This study has several limitations. First, a low number of serious injuries was found on imaging studies after inpatient falls in this cohort; this limited the power of the study to identify predictors of fall-related injury.

Second, fall-related injury was defined as a positive finding on imaging studies within 2 weeks of an inpatient fall. Thus, some fall-related injuries may have been missed in patients who did not have imaging. However, any patient who had a serious injury after a fall and remained hospitalized would likely have had symptoms such as pain or altered mental status that would have led to an imaging study. Moreover, the analysis was repeated including only inpatients who fell and had imaging, and the association between having evidence of trauma and having an activity level of "ambulatory" ordered and sustaining a fall-related injury remained significant.

Third, we relied on hospital incident reports to identify inpatient falls. These reports yield a limited amount of information and may be inaccurate or incomplete. A recent study also raised concern that incident reports significantly underreport actual fall incidence.²¹ However, previous studies have found no indication that falls are underreported and suggest that incident reports are an established custom in hospital culture.^{1,22} Medical staff are aware that administrators want to keep track of hospital fall rates for both quality improvement and documentation for risk management.^{1,22} It is unlikely that severe falls or falls leading to serious injury are not reported. A different source of underreporting may actually be failure of patients to tell the medical team about an unwitnessed fall. Older patients may be concerned they will be placed in nursing homes and those with memory loss may forget to report a minor fall. Education of patients and family members could improve reporting of inpatient falls and further our understanding of contributing factors.

Finally, although the evaluation of fall-related injuries was conducted by a blinded reviewer, the potential for bias does exist among even the best-intentioned reviewers. Additionally, there may be some degree of variability within the reviewer's data abstraction.

This study adds valuable information about the epidemiology of inpatient falls at large, urban, tertiary-care academic medical centers, including characteristics of patients who fell, circumstances surrounding falls, injuries sustained, and predictors of fall-related injury found on imaging. Although additional research is essential to identify methods to effectively prevent inpatient falls, this study contributes to the limited data in this area, can guide providers who are evaluating inpatients who have fallen, and may be used to design future investigations. It is imperative that measures are identified to avoid the frequent adverse outcomes that result from inpatient falls. Insurance companies, hospital

administrators, patients, and providers will be demanding that a safe environment be a key component of quality of care measures.

This study draws attention to the scope of the problem at our institution that is common to hospitals across the country. In our study, our academic medical center had a fall rate consistent with published reports, but new efforts have been focused on quality improvement in this area. An interdisciplinary fall prevention committee has been formed that includes physicians, nurses, patient care assistants, physical therapists, pharmacists, and representatives from information technology (IT). Currently, a program of a fall risk-factor assessment with targeted interventions to reduce those risk factors is being developed for all high-risk patients and will be piloted on inpatient units.

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