CE

ORIGINAL RESEARCH

Predicting Injurious Falls in the Hospital Setting: Implications for Practice

This study looked at 10 patient variables—and what it found may surprise you.

Inpatient falls constitute the largest category of reported adverse events in hospitals.[1] According to the Agency for Healthcare Research and Quality, inpatient fall rates range from 1.7 to 25 falls per 1,000 patient days, depending on care area; the overall risk of falling has been estimated at about 1.9% to 3% of all hospitalizations.[1] Given that there are about 37 million hospitalizations in the United States every year, the annual incidence of falls in hospitalized patients could reach over 1 million.[1] Fall-related injuries can range from pain and bruising to more serious outcomes such as fractures, intracranial injuries, and death. Overall, annual fall-related costs have been projected to reach $47 billion by the year 2020.[2]

Patient falls are widely regarded to be a nurse-sensitive indicator of performance. The American Nurses Credentialing Center Magnet Recognition Program includes injurious falls as one of its nurse-sensitive core indicators.[3,4] And in-hospital falls have become a priority for providers and policymakers. As a result of the Deficit Reduction Act of 2005, fall-related injuries were classified as hospital-acquired conditions by the Centers for Medicare and Medicaid Services (CMS); thus, since 2008, the CMS no longer reimburses providers or hospitals for treating such injuries.[5]

Tinetti was one of the first researchers to identify injury as "the morbid outcome of concern" in falls.[6] Yet, in the three decades since, falls research has continued to focus on predicting and preventing falls in general; there has been little focus specifically on injurious falls. Risk factors for falling have been well documented in the literature, and include older age, adverse effects of medication, alterations in certain laboratory values, mobility issues, cognitive issues, incontinence, and behavioral impulsivity.[7] Risk factors can be evaluated using various screening and assessment tools developed to predict a patient's risk of falling. But such tools can't help a clinician assess whether the patient is at risk for fall-related injuries. Nor are there evidence-based guidelines to help clinicians determine which patients need relevant, preventive interventions. The aim of this study was to determine which patient factors are associated with injurious falls in hospitalized adults.

BACKGROUND AND LITERATURE REVIEW

Conceptual framework. The Nelson Data-to-Wisdom Continuum was the conceptual framework guiding the development of this study.[8] Commonly used in nursing informatics, this framework illustrates how data are transformed into information, information into knowledge, and knowledge into wisdom. At the outset, data consist of unique or distinct facts or entities. Through organization and interpretation, data become information. When information is contextualized, it becomes knowledge. When knowledge is synthesized

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ABSTRACT

Background: Despite years of research and increasingly evidence-based practice, falls continue to be the most commonly reported adverse events experienced by hospitalized adults. Yet a majority of the relevant research has focused on predicting and preventing falls in general; there has been little focus on injurious falls.

Purpose: The purpose of this retrospective study was to determine which patient factors are associated with injurious falls in hospitalized adults.

Methods: The study site's adverse event reporting database was used to identify 1,369 patients who fell between January 1, 2006, and October 31, 2013. Of these, 381 (27.8%) subjects suffered injurious falls. Variables of interest included age, sex, fall history, use of diuretics, use of central nervous system medications, cognitive impairment, primary discharge diagnoses, abnormal laboratory values, impaired mobility, and body mass index.

Findings: Bivariate analysis revealed a statistically significant association between injurious falls and having a primary discharge diagnosis of "symptoms, signs, and ill-defined conditions." Having this discharge diagnosis was a significant predictor of injurious falls.

Conclusions: Findings from this study may help hospital clinicians to better identify which patients are most at risk for injurious falls and to create better fall-related injury prevention interventions.

Keywords: falls, fall-related injury, hospital-acquired condition, injurious falls, inpatient

with nursing experience and judgment, it becomes wisdom. For nurses, wisdom can be defined as "knowing when and how to apply knowledge to deal with complex problems or specific human needs."[9] The relationships among these elements are in constant flux as a result of new discoveries and innovations, new evidence, changing policies and regulations, and (in the arena of health care) changing patient preferences.

Literature review. A literature review guided the selection of variables used in this study. The literature search was conducted in July 2014, using the following databases: EBSCO Academic Search Elite, CINAHL, Cochrane Database of Systematic Reviews, and PubMed. No time or language limitations were used. Search terms included *fall injury risk*, *fall injury predictor*, *injury predictor*, *accidental fall* AND *injury*, and *accidental fall* AND *injury in hospitals*. Additional articles were identified by hand-searching bibliographic references. Abstracts for all articles were also reviewed, including two abstracts translated from Japanese to English. Studies that provided data on factors related to injurious falls and that defined such falls as falls resulting in injury or harm were included. Because this study focused on fall injury risk factors in hospitalized adults, studies that examined only fall risk factors in general and studies in pediatric populations were excluded. Full-text articles were retrieved for the 28 studies that met eligibility requirements. All 28 studies examined some factors related to injurious falls and were useful for our purposes, but not all of them found associations or examined the selected variables in the hospital setting.

Seven hospital-based studies that explored the association of injurious falls and various patient factors were identified. These patient factors included age, sex, fall history, use of cardiovascular medications, use of central nervous system (CNS) medications, cognitive impairment, specific medical diagnoses, and abnormal laboratory values.[10-16] See Table 1[10-16] for a synopsis of the findings.

Studies in other settings have also evaluated factors such as impaired mobility and body mass index (BMI). A positive association between mobility deficits and injurious falls was found in seven studies conducted in rehabilitation, long-term care, and community settings.[6, 17-22]

Five studies in long-term care and community settings showed an association between BMI and falls resulting in injury.[20, 21, 23-25] People categorized with low BMI were found to be at higher risk for injurious falls.

METHODS

This retrospective correlational study involved analyzing the data from existing medical records regarding the 10 patient factors identified by the literature review.

Setting and sample. Deidentified data were retrieved from the electronic medical records (EMRs) of patients at an academic medical center in the South Central United States. The medical center provides tertiary care for adults and neonates and serves as the state's only level 1 trauma center. The facility has 450 adult patient beds and records over 25,000 adult discharges a year.

Subjects included all inpatients 18 years of age or older who had sustained a fall while hospitalized during the study period, which was January 1, 2006, through October 31, 2013. This date range was chosen because the study site had implemented a new EMR system in 2006, and later changed its adverse event reporting system on November 1, 2013. Subjects were identified using the study site's Patient Safety Net, an electronic adverse event reporting system that includes falls. Study approval was obtained through the facility's institutional review board.

Neonatal falls were excluded from this study as these falls differ significantly from adult falls.[12] Falls that occurred during physical therapy were also excluded, because although physical therapy increases fall risk, the risk of injury is lower as these patients are usually assisted by staff in reaching the ground.[12, 13] Patients who had experienced multiple falls were also removed from the sample. This approach was consistent with that taken in other studies evaluating risk factors associated with injurious falls in the hospital setting.[12, 13]

Variables. The outcome variable of interest in this study was injurious falls. Falls were defined as an unplanned descent to the floor with or without injury. Falls can result in five recognized levels of injury: none, minor, moderate, major, and death.[26] Definitions for each level of injury are provided in Table 2.[26] For purposes of analysis, falls were stratified into two groups: falls without injury (none) and falls with injury (minor, moderate, major, or death). Potential predictive variables included age, sex, fall history, use of cardiovascular medications, use of CNS medications, cognitive impairment, primary discharge diagnoses, abnormal laboratory values, impaired mobility, and BMI. (See *Patient Factors Examined* for a detailed list.)

Data analysis. To determine whether there were statistically significant associations between the outcome variable and the potential predictive variables, bivariate analyses (χ^2 tests) were used; *t* tests could not be used to examine the continuous variable (age) between patients with and without fall-related injury because the sample was not random—univariate logistic regression was used instead. The categorical variables (sex, fall history, use of diuretics, use of CNS medications, cognitive impairment, primary discharge diagnoses, abnormal laboratory values, impaired mobility, and BMI) were compared using the χ^2 test of association. Analyses were conducted using SPSS statistical software, version 22. Statistical significance was set at $P \leq 0.05$. However, previous studies have considered $P \leq 0.2$ to be sufficiently significant to warrant further analysis using multivariate modeling.[20, 24] Thus, variables meeting this criterion were further explored using multivariate logistic regression.

RESULTS

A total of 1,369 falls in 1,369 patients were included in this study. Of these, 381 falls (27.8%) resulted in some form of injury. The study sample comprised 747 men (54.6%) and 622 women (45.4%). The mean age of all subjects was 55.1 years; the mean age of subjects who experienced injurious falls was 55.5 years. Data for all variables except BMI were available for all subjects; BMI data were available for 1,228 subjects.

Results of the univariate logistic regression and bivariate analyses are presented in Table 3. The primary discharge diagnosis of "symptoms, signs, and ill-defined conditions" was the only factor to have a statistically significant association with injurious falls ($P = 0.019$). Of the 64 subjects with that discharge

Table 1. Prior Research: Patient Factors Associated with Injurious Falls in the Hospital Setting

Source	Age	Sex	Fall History	Medications		CI	Medical Diagnoses	Abnormal Laboratory Values
				CV	CNS			
Nettleman MD, et al., 1993[14]	+							
Bond AJ, et al., 2005[10]	–	+		+				+
Fischer ID, et al., 2005[12]	+	–				+		
Krauss MJ, et al., 2007[13]	–	–				–		
Brand CA, Sundararajan V, 2010[11]	+		–			+	+	
Tzeng HM, 2010[16]						+		
Pierce JA, Jr., et al., 2013[15]				–	+	+		–

CI = cognitive impairment; CNS = central nervous system; CV = cardiovascular.
+ = positive association found; – = no association found.

code, 40.6% were injured. Of the 1,305 subjects with a different primary discharge diagnosis, only 27.2% suffered injury. No statistically significant associations with injurious falls were found between other variables examined.

In this study, six variables had a significance level of $P \leq 0.2$, including abnormal laboratory values; primary discharge diagnoses including injury and poisoning; impaired mobility; the use of CNS medications; primary discharge diagnoses of diseases of the respiratory system; and primary discharge diagnoses including endocrine, nutritional, metabolic, and immunity disorders. These variables were further examined using multivariate logistic regression. To ensure that there was no collinearity between these variables and the variables of age, sex, and fall history, we included all of them in the multivariate analysis. Accordingly, patients with a primary discharge diagnosis of symptoms, signs, and ill-defined conditions had significantly higher odds of experiencing an injurious fall ($P = 0.037$). This association remained significant after adjusting for other predictors in the logistic regression model. See Table 4 for detailed results of the multivariate analyses.

Table 2: Operational Definitions of Fall Injury Levels[26]

Level of Injury	Definition	Considered an Injurious Fall
None	Patient had no injuries (no signs or symptoms) resulting from the fall, or an X-ray, CT scan, or other postfall evaluation resulted in a finding of no injury	No
Minor	Resulted in application of a dressing, ice, cleaning of a wound, limb elevation, topical medication, pain, bruise, or abrasion	Yes
Moderate	Resulted in suturing, application of Steri-Strips or skin glue, splinting, or muscle or joint strain	Yes
Major	Resulted in surgery, casting, traction, or required consultation for neurologic (basilar skull fracture, small subdural hematoma) or internal injury (rib fracture, small liver laceration); patients with coagulopathy who receive blood products as a result of a fall	Yes
Death	Patient died as a result of injuries sustained from the fall (not from physiologic events causing the fall)	Yes

CT = computed tomography.

DISCUSSION

This study examined falls resulting in all levels of injury. Although it seems high, the percentage of patients who sustained injurious falls (27.8%) is consistent with previous estimates indicating that between 6% and 44% of falls in the acute care setting result in injury.[1] This study found that patients with the primary discharge diagnosis of symptoms, signs, and ill-defined conditions were significantly more likely to be injured if they fell. This category includes signs and symptoms that suggest the involvement of more than one disease or system, or that have an unknown etiology.[27] For patients with this primary discharge diagnosis, either a more precise diagnosis could not be made or the patient was admitted for the sole purpose of treating the presenting problem, without treatment or further evaluation of the underlying disease. This diagnostic category can include nausea and vomiting, alterations in consciousness, convulsions, dizziness, fatigue or malaise, sleep disturbances, lack of coordination, paresthesia, abnormal weight loss, urinary incontinence, and abnormal blood chemistries.[28] For example, a patient with cancer who is receiving outpatient chemotherapy might be admitted for nausea and vomiting. Treatment would address the nausea and vomiting, but not the underlying causes (cancer and chemotherapy).

The higher risk of injurious falls in patients with a primary discharge diagnosis of symptoms, signs, and ill-defined conditions might be related to the consequences of such conditions. For instance, patients with urinary incontinence might visit the bathroom more often, where hard surfaces and objects (such as sinks and toilets) are present and likely to be struck during a fall. Patients with poor coordination, paresthesia, or extreme fatigue might have difficulty protecting themselves during a fall. Either scenario could increase the likelihood of injury.

This study was the first to evaluate diuretics use, impaired mobility, and BMI as fall risk factors among hospitalized patients. Although studies conducted in other settings have found associations between diuretics use and injurious falls,[22, 24, 29, 30] this study found no such association. This may be because hospitalized patients are likely to have better access to assistive devices, such as bedside commodes, and to receive toileting assistance from nursing staff. Safety features such as grab bars might also be more available to these patients.

To our knowledge, only one other study has considered a possible association between injurious falls and CNS medications in hospitalized patients. Pierce and colleagues found a statistically significant association between the administration of narcotics and injurious falls,[15] whereas our study did not. The difference in findings may stem from differences in the CNS medications selected: the study by Pierce and colleagues looked at narcotics, benzodiazepines, antihistamines, and zolpidem; our study looked at narcotics, benzodiazepines, barbiturates, neuroleptics, and antidepressants.

Patient Factors Examined

Age
- At time of admission

Sex
- Self-reported in demographic data

Fall history
- Coded data from the medical record

Primary discharge diagnoses
- Infectious and parasitic diseases
- Neoplasms
- Blood and blood-forming organ disorders
- Endocrine, nutritional, metabolic, and immunity disorders
- Mental, behavioral, and neurodevelopmental disorders
- Diseases of the nervous system and sense organs
- Diseases of the circulatory system
- Diseases of the respiratory system
- Diseases of the digestive system
- Diseases of the genitourinary system
- Diseases of the skin
- Diseases of the musculoskeletal system
- Symptoms, signs, and ill-defined conditions
- Injury and poisoning
- Other (V Codes)

CV medications
- Diuretics

CNS medications
- Barbiturates
- Benzodiazepines
- Opiate agonists
- Neuroleptics
- Antidepressants

Impaired mobility
- Movement disorders
- Hemiplegia and hemiparesis
- Cerebral palsy
- Muscular dystrophies
- Gait abnormalities
- Use of a walker, cane, orthotics, or wheelchair support

Cognitive impairment
- Dementia
- Alcohol- or drug-induced mental disorders
- Transient and persistent mental disorders
- Other cerebral degenerations

Abnormal laboratory values
- Low platelet counts (less than 150×10^3 / mm^3)
- Elevated prothrombin time (greater than 14.7 seconds)

BMI

BMI = body mass index; CNS = central nervous system; CV = cardiovascular.

Although our study was similar to two studies that reported an association between cognitive impairment and injurious falls,[12, 15] we did not find such an association. The difference in findings may stem from differences in how cognitive impairment was defined. Fischer and colleagues used variables such as residence on a geriatric psychiatry floor and level of confusion based on subjective observation as indicators,[12] while Pierce and colleagues used prefall confusion.[15] Our study defined cognitive impairment more broadly, using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) coding.[28] In the study by Fischer and colleagues, patients on the geriatric psychiatric floor had the highest fall rate.[12] As a group, they may have been considerably older and have had more comorbidities than the patients with cognitive impairment in our study, making injurious falls more likely.

In the study by Pierce and colleagues, patients with prefall confusion were found to be more likely to suffer an injurious fall than patients without such confusion.[15] Patients who had received narcotics within the 24 hours preceding a fall were also more likely to suffer injury; and of patients who had injurious falls, 79% were under the age of 65 years. Although Pierce and colleagues don't discuss whether administration of narcotics could have caused some of the prefall confusion, this seems possible.

Although two studies in community settings found a significant association between impaired mobility and injurious falls,[18, 21] our study did not. One reason for this difference in findings may be that hospitalized adults with mobility issues have better access to assistive devices and receive more assistance during ambulation than their community-dwelling counterparts. And hospitalized adults with mobility issues are often considered to be at risk for falling. For such patients, active fall prevention efforts by nursing staff may reduce the frequency of falls and therefore the likelihood of fall-related injury.

Abnormal laboratory values indicative of altered coagulation, such as low platelet counts and elevated prothrombin times, warrant particular attention, as intracranial injuries (including intracranial hemorrhage) are more often fatal than other types of fall-related injuries.[31] That said, our study found no association between either abnormal prothrombin times or low platelet counts and injurious falls. This finding is

Table 3. Analysis of Patient Factors Associated with Injurious Falls

Univariate Logistic Regression				
Risk Factor	**Odds Ratio**	**95% CI**		***P***
Age	1.00	0.97–1.01		0.592
Bivariate Analysis, n (%)				
Risk Factor	**Total Sample (N = 1,369)**	**Fallers Without Injury (n = 988)[a]**	**Fallers with Injury (n = 381)[a]**	***P***
Sex				0.404
Male	747 (54.6)	546 (73.1)	201 (26.9)	
Female	622 (45.4)	442 (71.1)	180 (28.9)	
Fall history	334 (24.4)	250 (74.9)	84 (25.1)	0.209
Diuretics	189 (13.8)	138 (73)	51 (27)	0.78
CNS medications	720 (52.6)	532 (73.9)	188 (26.1)	0.135
Cognitive impairment	219 (16)	164 (74.9)	55 (25.1)	0.328
Impaired mobility	148 (10.8)	98 (66.2)	50 (33.8)	0.087
Primary discharge diagnoses				
Infectious and parasitic diseases	63 (4.6)	47 (74.6)	16 (25.4)	0.659
Neoplasms	190 (13.9)	138 (72.6)	52 (27.4)	0.878
Blood and blood-forming organ disorders	24 (1.8)	17 (70.8)	7 (29.2)	0.883
Endocrine, nutritional, metabolic, and immunity disorders	71 (5.2)	46 (64.8)	25 (35.2)	0.154
Mental, behavioral, and neurodevelopmental disorders	56 (4.1)	41 (73.2)	15 (26.8)	0.859
Diseases of the nervous system and sense organs	81 (5.9)	60 (74.1)	21 (25.9)	0.693
Diseases of the circulatory system	177 (12.9)	125 (70.6)	52 (29.4)	0.622
Diseases of the respiratory system	114 (8.3)	89 (78.1)	25 (21.9)	0.142
Diseases of the digestive system	123 (9)	86 (69.9)	37 (30.1)	0.559
Diseases of the genitourinary system	80 (5.8)	59 (73.8)	21 (26.3)	0.745
Diseases of the skin	48 (3.5)	34 (70.8)	14 (29.2)	0.833
Diseases of the musculoskeletal system	46 (3.4)	33 (71.7)	13 (28.3)	0.947
Symptoms, signs, and ill-defined conditions	64 (4.7)	38 (59.4)	26 (40.6)	0.019[b]
Injury and poisoning	186 (13.6)	144 (77.4)	42 (22.6)	0.086
Other (V Codes)	46 (3.4)	31 (67.4)	15 (32.6)	0.462
Abnormal laboratory values	596 (43.5)	445 (74.7)	151 (25.3)	0.071
BMI[c]				0.85
Underweight	967 (78.7)	697 (72.1)	270 (27.9)	
Normal	253 (20.6)	181 (71.5)	72 (28.5)	
Overweight or obese	8 (0.7)	5 (62.5)	3 (37.5)	

BMI = body mass index; CI = confidence interval; CNS = central nervous system.
[a]Percentages are based on the total sample number for each row (category).
[b]Significant finding ($P \leq 0.05$).
[c]n = 1,228.

Table 4. Multivariate Analysis of Patient Factors Predicting Injurious Falls

Variable	OR (95% CI)	*P*
Age	1.00 (0.99–1.01)	0.79
Female sex	1.06 (0.84–1.35)	0.68
Fall history	0.83 (0.62–1.10)	0.19
Impaired mobility	1.34 (0.93–1.94)	0.12
CNS medications	0.88 (0.69–1.12)	0.3
Abnormal laboratory values	0.84 (0.66–1.08)	0.17
Primary discharge diagnoses		
Diseases of the respiratory system	0.73 (0.46–1.18)	0.2
Endocrine, nutritional, metabolic, and immunity disorders	1.40 (0.84–2.34)	0.19
Injury and poisoning	0.79 (0.45–1.16)	0.23
Symptoms, signs, and ill-defined conditions	1.74 (1.03–2.94)	0.037[a]

CI = confidence interval; CNS = central nervous system; OR = odds ratio.
[a]Significant finding ($P \leq 0.05$).

supported by similar findings in the study by Pierce and colleagues, who also reported no such associations.[15] But a study by Bond and colleagues, using international normalized ratio (INR) values, found that abnormal INR values did contribute to the risk of hemorrhagic injury during a fall.[10] The difference in findings may have to do with which laboratory values were examined. And in hospitals that flag abnormal laboratory values as a falls risk factor, nursing staff may be making an extra effort to prevent these patients from falling.

No associations between BMI and injurious falls were found. A large proportion of the sample subjects were underweight (78.7%), while fewer than 1% of patients were overweight or obese. This relative lack of variability may have contributed to the insignificant finding. The large proportion of underweight patients in the sample may reflect the patient populations at the study site. For example, the study site has a large population of oncology patients, for whom weight loss is often a side effect of treatment.

Limitations. This study examined injurious falls occurring at a single institution. Thus, these results may not be generalizable to other settings. Variables reported in the literature as associated with injurious falls were the only variables included in this study. There may be other variables associated with injurious falls. To capture falls for study, we relied solely on the study site's adverse event reporting system, which may not have captured all falls that occurred during the study period. Also, several variables were identified through EMR coding, and EMRs aren't always complete or comprehensive. We did not consider possible environmental factors, such as fall location. Lastly, it's important to note that although some associations were found between certain variables and injurious falls, associations do not infer causation.

IMPLICATIONS AND CONCLUSION

The results of this study have several implications for clinicians. We found a significant association between a primary discharge diagnosis of symptoms, signs, and ill-defined conditions and injurious falls; indeed, 40.6% of patients in this category suffered injurious falls. This suggests that clinicians should pay particular attention to patients admitted primarily for treatment of presenting signs or symptoms without further evaluation, or for whom a more precise diagnosis can't be made. Examples include patients admitted with conditions such as nausea and vomiting, alterations in consciousness, and seizures, or for signs such as electrolyte imbalances (for example, hyponatremia, elevated ammonia levels, and hyperkalemia). Decisions about care and treatment with regard to preventing falls and injury should take these diagnoses into consideration.

It's also important not to dismiss clinically significant findings that may lack statistical significance. As Yet and colleagues have cautioned, relying purely on data-driven approaches to prediction "may not provide either accurate predictions or the insights required for improved decision making."[32] In our study, a large proportion of the total sample (N = 1,369) who took CNS medications, had abnormal laboratory values (elevated prothrombin times or low platelet counts), or were underweight (BMI below 18.5) suffered injurious falls (13.7%, 11%, and 21.9%, respectively), although the associations lacked statistical significance. Hospital fall prevention programs often don't consider these variables. It's imperative that nurses be aware of patients for whom these factors are relevant, so that appropriate interventions can be used.

Patients at risk for injurious falls may benefit from interventions designed to offer protection from hard surfaces during a fall, such as floor mats, low beds, hip protectors, and protective helmets or caps. An awareness of which patient factors are associated with injurious falls will help clinicians provide the most appropriate interventions to the patients who most need them. Given that preventive resources are often limited, it's critical that such resources be used with the right patients at the right time.

Further research. As our study appears to be the first hospital-based study examining impaired mobility and BMI and their relationship to injurious falls, further study of these variables in hospitalized

adults is recommended. Samples showing greater variability in BMI should be studied. Many studies in hospital settings, including this one, rely on retrospective analysis of existing data. Prospective studies examining more diverse variables might yield new information and could reveal additional predictors of injurious falls. Further research should also include patients who experience multiple falls. A better understanding of the characteristics of patients who suffer injurious falls is essential to improving prediction of which patients are at higher risk and to developing interventions that minimize the effects of falls. ▼

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