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In-Hospital Sequelae of Injurious Falls in 24 Medical-Surgical Units in Four Hospitals in the United States

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Abstract

Background: Up to 50% of patient falls in hospital result in injury. This study was conducted to determine whether injurious falls were associated with increased hospital length of stay (LOS), discharge to a place other than home, and in-hospital mortality.

Methods: A secondary data analysis from a prospective case-control study was conducted in 24 medical-surgical units in four hospitals in the United States. Patients who fell and sustained an injury were matched with at least one control patient who was on the same unit, at the same time, for a similar number of days on the unit at the time of the fall. Data were collected by viewing patients' electronic health records, as well as the hospitals' incident reporting systems. Logistic regression and Cox regression analyses were conducted.

Results: The 1,033 patients (mean age, 63.7 years; 510 males (49.4%)] who sustained an injurious fall were matched with 1,206 controls [mean age 61.6 years; 486 males (40.3%). Fallers

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were significantly more likely than controls to stay longer than 10 days in hospital (Odds Ratio [OR] 1.59, 95% confidence interval [CI] 1.46–1.74) and to be discharged to a place other than home ([OR 1.52, 95% CI 1.21–1.91).

Conclusions: Compared to controls, hospital patients who sustained an injurious fall had longer LOS and were more likely discharged to a place other than home. These associations remained when controlling for patient-level confounders, suggesting that the fall altered trajectory was sustained towards these outcomes. Injurious falls were not significantly associated with increased risk of mortality.

Falls are the most frequent adverse event reported in hospitals in the United Kingdom, and nearly one million patients fall in hospitals in the United States each year.[1, 2] Fall rates vary widely—ranging from 3.4 to more than 11 falls/1,000 patient days, partly on the basis of ward (unit) and hospital population studied.[3–6] Injurious fall rates in acute care settings range from 0.9 to 1.6 injurious falls/1,000 patient days, meaning that 26% to 60% of all in-hospital falls cause physical injury to patients.[7, 8] A large study that compared the prevalence of injurious falls in hospitals before and after the implementation in 2008 of the Centers for Medicare and Medicaid Services (CMS) nonpayment for injurious falls as a "never event,"[9] found that these injurious falls did not decrease over time.[10]

Understanding more about the outcomes of injurious falls in hospital is important, as injurious falls could negatively affect the health and recovery of patients. Earlier small studies that examined outcomes associated with falls did not specifically examine injurious falls, were retrospective. and were conducted during a short period.[11,12] One prospective study conducted in Australia found that injurious falls on medical/surgical units were predictive of increased length of stay (LOS), but it was conducted as part of a larger randomized trial whose primary outcome was to evaluate a multifactorial falls prevention intervention. Hence, conditions where the falls occurred differed according to whether hospitals were in the control or intervention group, and no matching for ward was completed.[13]

Few studies have examined whether injurious falls in hospital are also associated with other adverse outcomes, including mortality, admission to nursing home, or functional decline. Two retrospective cohort studies that investigated the consequences of falls resulting in hip fracture in hospital found that patients who fell and fractured their hip had poorer outcomes, than community-dwelling persons who fell and fractured their hip.[14,15] Conducting longitudinal studies about falls in hospital settings to examine the consequences of injurious falls over time can be problematic because of difficulties in collecting accurate hospital falls data[16,17] and hospital, health system, and ward heterogeneity. It is critical to understand the extent and scope of these adverse events to raise awareness of staff, patients, and the broader health care system about the serious consequences of injurious falls and thus prioritize attention and resources towards further efforts to reduce falls in hospitals.

The aim of this secondary analysis was to describe the characteristics associated with injurious falls in a large case-control study[18,] of patients in a broad hospital medical and surgical population and to determine whether injurious falls, as an adverse outcome, were independently associated with further adverse outcomes in this population.

Methods

Study Design and Ethics

This study entailed secondary analysis of de-identified data from a prospective case-control study examining characteristics of patient fallers sustaining injury to matched controls. The data collection was approved by the Institutional Review Board of the University of Tennessee Health Science Center. The secondary analysis was approved by the University of Florida Institutional Review Board.

Setting and Sample

The original study took place from 2005 to 2010 at four hospitals within the Methodist Healthcare System, Memphis, Tennessee. The goal of that study was to examine the effect of the CMS nonpayment for injurious falls as a never event on patient-level approaches fall prevention among fallers with injury and non-fallers.[18] The hospitals consisted of a university teaching hospital (Methodist University Hospital, with 15 medical, surgical, or medical/surgical units) and three community hospitals (Methodist South, Methodist North, Methodist Germantown, with 9 medical, surgical, or medical/surgical units), all providing adult inpatient medical/surgical services. The health care system uses the same electronic health record (EHR) format, adverse incident event reporting system, and fall prevention protocol.

The sample consisted of adult patients who fell and sustained any level of injury (cases). *Fall injury* was classified as minor (resulting in pain, bruise, abrasion, laceration), moderate (resulting in muscle/joint strain, dislocation) or severe (resulting in open or closed head injury, internal injury or fracture). Patients whose falls caused no injury or whose falls resulted from catastrophic clinical events (for example, seizure, stroke, or arrhythmia) were excluded. Falls from any area of the hospitals other than the participating medical-surgical units were not considered for inclusion. Cases were ascertained prospectively through use of the adverse incident event reporting system; the fall reporting system, as described elsewhere[17]; and ongoing reviews of EHRs. A finding of a fall injury was validated using the medical record.

Up to two controls (nonfallers) were matched to cases (fallers) on the basis of potential environmental confounders. Controls were patients who were on the same unit, at the same time, for a similar number of days on the unit at the time of the case fall. Our intent was to have two controls whenever possible. If there were more than two potential controls for a given case, controls were chosen using a random assignment. An index time was created for each control to indicate the date and time that the corresponding matched case fell.

Medicare Record Review Procedure

Medical record reviews were undertaken in consecutive order of patients who were admitted to a unit, fell at least once, and sustained an injurious fall (“fallers”). On notification of the injurious fall event, the trained research assistant [A.M.C.] reviewed the medical record to confirm that there had been an injury and to gather information to classify the type and level of injury and to collect patient demographic data. The research assistant, who was

experienced in inpatient and hospital data collection, was additionally provided with training from the research team and subsequently collected data for all fallers (including the location, time, and day of the injurious fall) and controls. She then identified up to two patients who met the criteria, all of which were measured with use of the hospital's EHR system, as controls (same length of stay on the ward, on the same ward at the time and day of the injurious fall, but had not fallen), and their EHRs were also reviewed and their demographic data collected.

Variables

Primary Outcome Variables.—The primary outcome variables, all of which were measured with use of the hospital's EHR system and the adverse incident reporting system, were as follows:

- Hospital LOS, as measured as the date of patient admission until discharge
- Discharge from hospital to a facility other than home, such as a skilled nursing facility or nursing home
- In-hospital mortality

Covariates.—The covariates were as follows:

- Demographic and medical history, including patient age, gender, number of medications taken at the time of the injurious fall
- Risk for falling at the time of the injurious fall (defined using the Morse falls score)[19]
- Whether the patient was a readmission to hospital (within 30 days of discharge)
- Comorbidities of Parkinson's disease, dementia, hypertension, congestive heart failure (CHF), diabetes mellitus and stroke (each defined as a positive history in the medical record)
- Receiving anesthesia within 24 hours of the injurious fall
- Documented change in mental state in the 24 hours prior to the injurious fall.

Data and Statistical Analysis

A de-identified database was made accessible to the primary author [A.M.H.] through a secured web site. The database was screened for any instances of patients who had incurred multiple injurious falls, and these patients were excluded from the analysis, as sustaining a fall is a risk factor for further falls,[20] confounding comparison with controls. Patient demographics and characteristics were recoded into categorical variables when appropriate. This included medications, which were categorized according to whether patients took four or more or fewer than four medications. Taking four or more medications is a known risk factor for falls in the community, and polypharmacy is a surrogate marker of multimorbidity, also a known risk factor for falls.[21–23] Because age is a known predictor of in-hospital falls,[4,7] all models were adjusted using age as a continuous variable. Outcome variables were hospital LOS, discharge destination, and mortality. Continuous data were summarized using

means, standard deviations and ranges or medians, interquartile ranges and ranges, according to normality. Categorical data were summarized using frequency distributions. Group comparisons were performed using χ^2 and Fisher's exact tests, as appropriate, for categorical comparisons and Mann-Whitney U and t tests, as appropriate, for continuous outcomes.

Median hospital LOS by patient demographics and characteristics was estimated using Kaplan-Meier survival probabilities. Survival distributions between groups were compared using Log-Rank tests and Kaplan-Meier curves. Effect of covariates on LOS were examined using univariate Cox proportional hazards regression models, adjusting for age. The following covariates were considered: comorbidities, discharge destination, readmission, mortality, number of medications, anesthesia, and mental state change. All characteristics with p-values < 0.15 in the univariate Cox regression models were considered as candidate predictors for the multivariate Cox regression model. Covariate effects were summarized using hazard ratios (HRs) and 95% confidence intervals (CIs).

Covariates associated with outcomes of discharge destination and mortality were evaluated using logistic regression analysis, adjusting for age. The following covariates were considered: patient demographics, LOS, readmission, comorbidities, number of medications, anesthesia, and mental state change. All characteristics with p values < 0.15 in the univariate logistic regression models were considered as candidate predictors for, and entered into, multivariate regression analysis. Covariate effects were summarized using odds ratios (ORs) and 95% CIs. Statistical analysis was conducted using Stata 15 (StataCorp LP, College Station, Texas) and IBM SPSS version 24.0 (Armonk, NY). All hypothesis tests were two-sided, and p values <.05 were considered statistically significant.

Sample Size

For the present analyses, a post hoc calculation indicated that a study with 1,033 fallers and 1,206 controls has 99.9% power (alpha = 0.05, two-tailed) to show survival curve inequalities between fallers and controls, with corresponding median LOS of 6 and 10, and relative risk (HR)=1.6. (PowerSampleSize version 3.0, Dupont and Plummer, Vanderbilt University).[24]

Results

Characteristics of Fallers and Controls

Of the 1,081 patients who were classified as fallers during the study period, the 48 patients who sustained more than one injurious fall and their controls were excluded from the analysis. The characteristics of the remaining 1,033 fallers and the controls are presented in Table 1. There were significant differences between the two groups, including age (fallers were older than controls) and gender (9% more males in the fallers' group). Fallers were also significantly more likely to be diagnosed with a stroke or hypertension. Medications taken by patients in both groups included antiarrhythmics, antibacterials, anticoagulants, antidepressant, antihypertensives, antipsychotics, antiretrovirals, corticosteroids, diuretics, diabetes medications including insulin, non-steroidal anti-inflammatory agents and opiates.

Outcomes for Fallers and Controls

Injurious fallers had significantly longer hospital LOS compared to controls, with a median LOS of 10 and 6 days, respectively (Figure 1). The final multivariable model (Table 2) demonstrated that injurious fallers were 59% more likely to have a longer hospital LOS than controls, even when adjusting for patient mortality, discharge destination, diagnosis, mental state change during admission, and number of medications (Appendix 1).

Compared to controls, fewer injurious fallers were discharged to home. The final multivariable model for discharge destination (Table 2) demonstrated that injurious fallers were 52% more likely to be discharged to a facility other than home compared to controls (95% confidence interval [CI] 21%- 91%).

Of the injurious fallers, 62 (6.0%) died in hospital compared to 47 (3.9%) controls. Overall, injurious fallers did not have a significantly higher risk of mortality in hospital than controls (odds ratio (OR) 1.04, 95% CI [0.68, 1.60]). Male patients who sustained an injurious fall (OR 1.83, 95% CI [1.21, 2.78] and patients diagnosed with a mental state change in hospital who sustained an injurious fall (OR 2.61, 95% CI [1.69, 3]) were significantly more likely to die in hospital (Appendix 1).

Discussion

This secondary analysis of a large prospective case-control study demonstrates that sustaining an injurious fall in hospital is independently associated with a longer LOS and discharge to a facility other than home. Of all injurious fallers, male patients and those with a documented mental state change in hospital were significantly more likely to die in hospital.

Discharge to facilities rather than directly home indicates that injurious falls may slow a patient's functional recovery, with injurious fallers significantly more likely to require ongoing rehabilitation by admission to a skilled nursing facility. Functional decline is already known to be a significant problem for older patients after hospital discharge,[25–27] and therefore it is important that injurious falls do not further affect a patient's functional recovery, thereby preventing him or her from returning directly home. Admissions to other settings for further rehabilitation also increases health care costs.[28]

Control patients were from a similar population who were on the same ward and, up to the time of the fall, had a comparable LOS compared to the injurious fallers. Therefore, our fallers had similar exposure to risk, in matched conditions, to the controls. Injurious fallers' LOS was more than four days (60%) longer, which strongly suggests that these patients' trajectory through their episode of care was adversely affected by the injurious fall. Other studies have also found that falls, whether injurious or noninjurious, are associated with an increased LOS and costs to providers,[11–13] but those studies either used smaller, retrospective populations or did not control for pre-LOS fall time and hospital and ward environment and care provided. In addition, although increasing patient age is associated with an increased prevalence of falls,[4,7,20] 60% of our cohort were younger than 70 years of age, and our modelling adjusted for age throughout. The high number of falls occurring in

patients younger than 70 years may indicate that falls have an adverse effect on recovery in hospital for a broad population age range and that hospital falls are not a “geriatric problem.”

Although this study demonstrated that injurious falls are associated with longer LOS and delayed recovery, we caution against hospitals focusing attention on trying to prevent injurious falls alone. Studies demonstrate that it is difficult to predict risk factors and subsequently accurately identify which patients are at risk of sustaining an injurious fall.[29,30] Because approximately one in three hospital falls cause injury,[6–8] systematically addressing factors that reduce the overall risk of falls is likely to have a positive impact. Sustaining a fall is also known to be strongly predictive of future falls,[19] confirming that addressing falls risk for all patients at admission is important in preventing falls. In addition, these injury data do not include the psychological consequences of a noninjurious fall, such as developing fear of falling,[19] which could further hinder patients’ recovery.

Systematic reviews suggest that falls can be reduced with multifactorial strategies (for example, medication review, environment modification, and surveillance), but the type, amount, and fidelity of the interventions delivered varies widely, making it difficult to prescribe the optimum clinical intervention.[3,32] It is well known that more than 80% of all falls occur unassisted (when patients move without staff in attendance),[5,16] suggesting that strategies that focus on these falls, such as directly educating patients, are important. A study conducted in acute care medical units in the United States found that tailored education for patients reduced falls, although it did not reduce injury.[4] A large randomized trial conducted in Australia found that injurious falls were reduced by 35% when older patients were provided with tailored education in hospital rehabilitation wards, but these units had a mean LOS of 10 days, which may be longer than that of acute short-stay medical or surgical wards.[33] Further studies are needed in acute care settings to find effective ways to reduce falls and subsequent falls injury.

Strengths and Limitations

This was a secondary data analysis of a large case control study,[18] in which data were collected by viewing patients’ EHRs, as well as the hospital data system, which adds to the robust nature of these findings.[16,17] Final classification of falls injuries was completed only by the research assistant [A.M.C.]. However, she was experienced in collecting falls data from Methodist Healthcare medical records, having done so for a previous study.[34] Therefore, we are confident that the consistency of the data collection method, along with the straightforward nature of the data, resulted in a high-quality data set. Falls, when evaluated across hospitals and between wards, have a number of potential confounders: they occur more often in older people and on rehabilitation and medical units, which admit more older and confused patients.[8,20] In the current study, control patients were matched by nursing unit and length of stay on the unit and time of fall, which controlled for factors such as nursing familiarity with the patient, types of patients nursing unit and staffing at the time of the fall. Other patient-level variables, such as age and diagnoses, were controlled for in the multivariate models.

These data were obtained from one region of the United States and may not be generalizable nationally, although we broadened our sample by collecting data from both a large teaching hospital and three community-based hospitals. A significant limitation was that our data collection was based on EHRs, and we were not able to collect all potential covariates known to be associated with the outcomes of interest, such as patient levels of functional ability, mobility limitations, requirement for assistance with activities of daily living, and multimorbidity prior to admission.[26,35] However, we did control for patients' Morse falls risk score, which is based on a falls algorithm consisting of patient history of falls, mobility levels, and confusion.[19] We also included the number of medications in our models, which reflects the patients' levels of multimorbidity.[22,23] Male patients in our cohort were also significantly more likely to fall, which is supported by a large observational data set in the United States of more than 160,000 falls.[5] Our data are observational, so that we cannot be certain of the cause and effect; however, two large studies have found that injurious falls are associated with an increased cost to hospitals,[13,36] suggesting that it is plausible that injurious falls would reduce overall rate of recovery during an episode of care in hospital. We suggest that hospital quality improvement programs that evaluate predictors for LOS or discharge to skilled nursing facilities and nursing homes should also measure the incidence of injurious falls in their cohorts.

Conclusions

Injurious falls independently predict serious adverse outcomes for older patients admitted to hospital. Patients who sustain an injurious fall have a significantly longer hospital LOS and are significantly less likely discharged directly to home. Injurious falls were not significantly associated with increased risk of mortality. Hospitals should continue to evaluate multifactorial falls prevention programs, including educating both staff and patients about the burden of injurious falls and alerting them to the need to take action regarding falls prevention. More research is recommended to examine how to reduce the incidence of falls in hospitals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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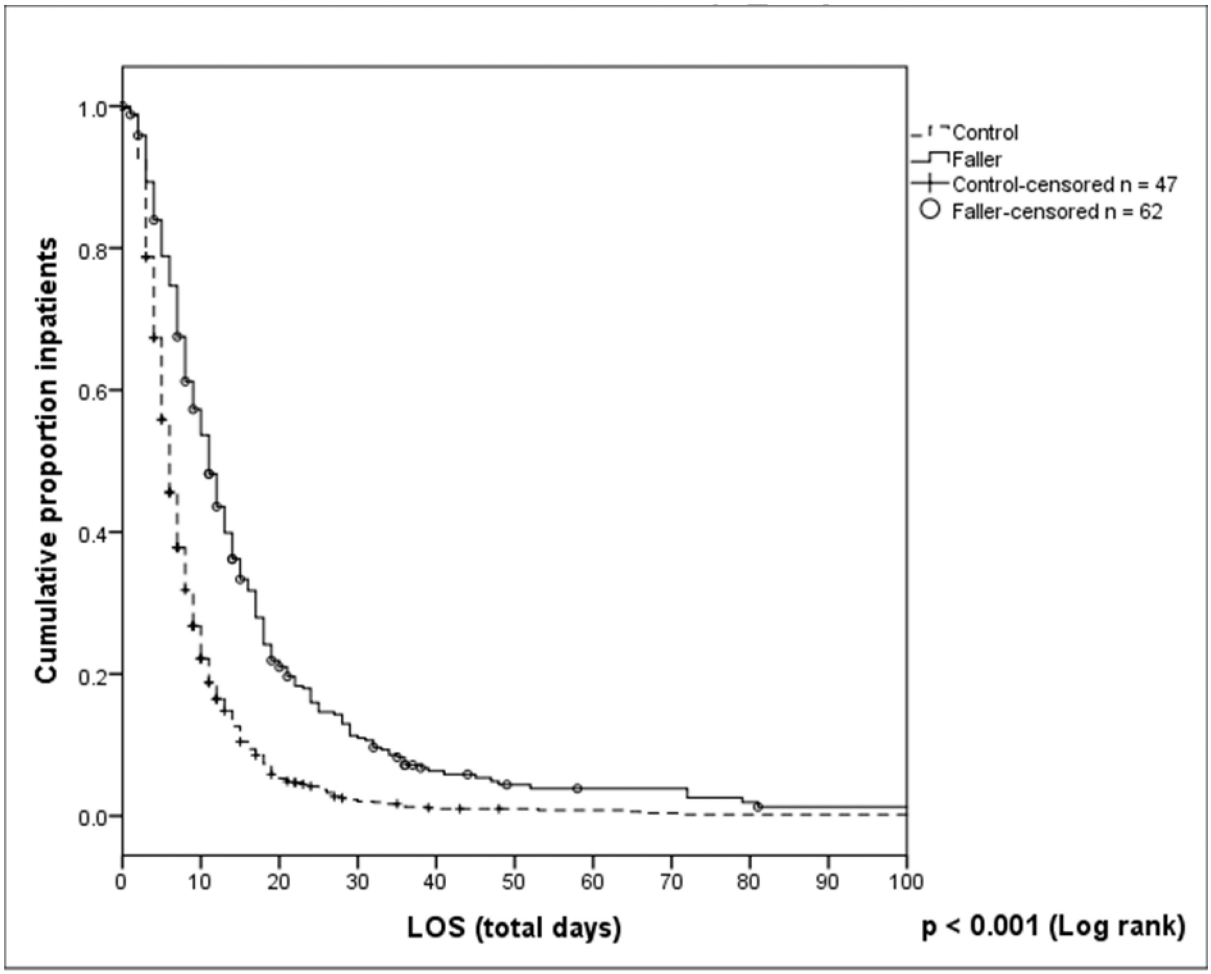

Figure 1.

Injurious fallers had a median length of stay (LOS) of 10 days, which multivariable Cox regression demonstrated was significantly longer ($p < .001$) than controls' median LOS of 6 days (Figure 1).

Kaplan Meier Curve Length of Stay: Fallers versusu Controls

Table 1.

Characteristics of Fallers with Injury and Controls

Characteristic*	**Controls *n* = 1,206 (100%)†**	**Fallers *n* = 1,033 (100%)†**	***P*-Value**
Gender, male	486 (40.3)	510 (49.4)	<0.001
Age, yrs, *mean (SD) [Min-Max]*	61.6 (17.7) [18 – 90]	63.7 (16.0) [18 – 90]	0.003
Age, < 70 yrs	755 (62.6)	633 (61.3)	0.27
Race, non-Caucasian	660 (54.7)	458 (44.4)	<0.001
Re-admission within 30 days of discharge	247 (20.6)	317 (31.0)	<0.001
Admitted through ER	865 (72.1)	734 (71.1)	0.32
LOS (days) *median (IQR) [Min-Max]*	6.0 (4.0, 10.0) [0 – 129]	10.0 (5.0, 16.0) [0 – 192]	<0.001
Number of medications *middle">mean (SD) [Min-Max]*	8.8 (4.2) [0 – 28]	7.7 (4.1) [0 – 22]	<0.001
Four or more medications	1105 (91.6)	891 (86.2)	<0.001
Comorbidities			
Parkinson’s Disease	12 (1.0)	12 (1.2)	0.43
Dementia	143 (11.9)	151 (14.6)	0.03
Hypertension	826 (68.5)	761 (73.6)	0.005
Congestive heart failure	255 (21.1)	244 (23.6)	0.09
Diabetes Mellitus	402 (33.3)	375 (36.3)	0.08
Stroke	147 (12.2)	155 (15.0)	0.03
High risk for falling†	425 (35.8)	564 (55.5)	<0.001
Anesthesia within 24h	268 (22.3)	106 (10.3)	<0.001
Mental state change within 24h‡	228 (19.0)	281 (27.4)	<0.001
Injury severity	Minor	770 (76.3)	
	Moderate	214 (21.2)	
	Major	25 (2.5)	

*all data n (%) unless otherwise stated

†classified as high risk using Morse Falls Score[17]

‡documented change in mental state in the medical record within 24 hours of the fall

Table 2.

Logistic Regression for all Outcomes

Outcome[a]	**Controls *n* = 1,206**	**Fallers *n* = 1,033**	**Adjusted Univariate**			**Adjusted Multivariable**		
	n (%)	**n (%)**	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Length of Stay[b##]								
</= 10 days	939 (77.9)	552 (53.5)						
>10 days	267 (22.1)	480 (46.5)	1.69	1.55–1.84	***	1.59	1.46–1.74	***
Discharge destination								
Nursing home[c]	86 (7.2)	106 (10.7)	1.54	1.14–2.08	**	1.41	0.99–2.01	#
Skilled nursing facility[d]	149 (12.5)	201 (20.2)	1.72	1.36–2.17	***	1.46	1.13–1.89	**
Nursing home or /Skilled nursing facility[e]	235 (19.7)	307 (30.9)	1.80	1.47–2.22	***	1.48	1.17–1.87	**
Not to home[f]	246 (21.2)	347 (35.9)	2.04	1.66–2.50	***	1.52	1.21–1.91	***
Death	47 (3.9)	62 (6.0)	1.53	1.04–2.26	*	1.04	0.68–1.60	#
Death (*excluding minor injuries*)	0	19 (7.9)	2.13	1.23–3.70	*	1.42	0.77–2.63	#

[a] all models adjusted for age;

[##] Hazard ratio;

[*] $p < 0.05$;

[**] $p < 0.01$;

[***] $p < 0.001$;

[#] $p > 0.05$

[b] adjusted for re-admission within 30 days, death during admission, discharge to nursing home or skilled nursing facility, diagnosis of Parkinsons disease, congestive heart failure, diabetes, taking four or more medications, having anesthesia in previous 24 hours, mental state change in 24 hours prior to fall

[c] adjusted for LOS, admitted through ER, diagnosis of dementia or stroke, mental state change in 24 hours prior to fall

[d] adjusted for gender, LOS, admitted through ER, high risk for falling, diagnosis of dementia, hypertension or stroke, having anesthesia in previous 24 hours

[e] adjusted for gender, LOS, high risk for falling, taking four or more medications, diagnosis of dementia or stroke, mental state change in 24 hours prior to fall

[f] adjusted for LOS, high risk for falling, taking four or more medications, diagnosis of dementia or stroke, mental state change in 24 hours prior to fall