Risk Factors and Injury Associated With Falls in Elderly Hospitalized Patients in a Community Hospital

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Objective: Hospitalized patient falls are a major cause of disability, functional impairment, and even death. The objective of this prospective study was to assess the frequency and contributing factors of falls in hospitalized patients.

Methods: Between December 2004 and November 2005, data related to falls in hospitalized patients were recorded: patient demographics, the patient's functionality, mental status, surrounding circumstances, and the level of injury. Outcome measures were overall rates of patient falls as a function of ward, shift, month, age, and incidence rate ratios (IRRs).

Results: Falls were recorded in 611 patients. The overall patient fall rate was 4.36 (95% confidence interval, 4.02 to 4.72) per 1000 patient-days. The fall rate was significantly above the mean for the neurosurgical (IRR = 2.32; $P < 0.001$) and short-stay wards (IRR = 1.69; $P = 0.013$). Patients aged 56 to 70 years or older than 70 years fell 1.45 and 1.78 times more frequently, respectively, versus patients aged 55 years or younger ($P < 0.001$). The odds that a fall resulted in injury were multiplied by 1.19 for each additional decade of age ($P = 0.018$), and the age-adjusted injury rate for the oncology ward (46.4%) was significantly higher than the overall average ($P = 0.001$).

Conclusions: Age and the patient condition before and during hospitalization resulted as the most important determinants of falls in hospitalized patients.

Key Words: patient safety, elderly, inpatient falls, hospitalized patient falls

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Falls in hospitalized patients are a major cause of disability, functional impairment, and even death, especially among the elderly.[1–3] This represents a worldwide concern as indicated by reports published from Australia,[3,4] Denmark,[5] Hong Kong,[6] Israel,[7,8] Italy,[9,10] the Netherlands,[11] Sweden,[10] and Taiwan.[12] Despite recent improvements in health care and early attempts to reduce patient falls,[13–15] data from the Pennsylvania Health Care Cost Containment Council indicated that the estimated annual fall rates per 1000 patients increased from 5 to 7.2 in Pennsylvania hospitals from 1994 to 1997.[16] A cross-sectional analysis of hospital inpatient discharge records for patients aged 65 years or older from the Wisconsin Bureau of Health Information reported an unintentional fall rate of 6.9%; similar data have also been reported in Massachusetts.[17] Recently, the Joint Council on Accreditation of Healthcare Organizations stressed the importance of reducing the frequency of falls and the risk of injury resulting from falls in hospitalized patients[18] and requested to implement a "fall reduction program."[19]

Several studies have investigated the risk factors[8,17,20–24] and drugs[24] associated with falls among hospitalized patients. However, most fall-related articles have been based on retrospective analyses and/or analyses of a small sample of patients and have provided a limited understanding of this important issue. The few observational prospective studies that have been conducted were not carried out in the United States, where health care system resources are not comparable to most other countries, and the length of hospital stays are generally longer.[25] Establishing the risk factors for falls among U.S. patients is critical for determining the resources and/or appropriate prevention programs necessary for reducing their prevalence and identifying the patients on whom intervention efforts should be concentrated. This prospective study was designed to assess the frequency of patient falls and to identify the contributing factors to patient falls and injuries in an American community hospital.

METHODS

Between December 1, 2004, and November 30, 2005, each hospitalized patient fall at the University of Pittsburgh Medical Center Presbyterian–Shadyside Hospital in Pittsburgh, PA, was recorded using the RiskMaster software program (Northamptonshire, United Kingdom).

Falls took place in one of the following 15 hospital wards: thoracic-cardiac surgery (thor-card surg), surgical oncology (surg oncology), medicine, pulmonary medicine (pulmonary), oncology–stem cell, orthopedic ward (orthopedics), neurosurgical (neurosurg), oncology, cardiology–post catheterization (cardiology–post cath), short stay, family practice (fam pract), medical cardiology telemetric (cardiology-telemetry), cardiothoracic intensive care unit (ICU), surgical/neurosurgical ICU (S/NS ICU), and medical and cardiac ICU (MICU/CCU). For each patient, an independent observer recorded patient demographics, the hospital ward in which the fall took place, the date and time of the fall, the type of surgery performed (when applicable), the patient's functionality at home and in the hospital (i.e., use of a cane, walker, or crutches), any alteration of mental status before the fall, and contributing medications according to the Pennsylvania Department of Health "Patient Safety Reporting

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System" (benzodiazepines, pain medication/opiates, anticoagulants, laxatives, diuretics, cardiac medications, and seizure medications). The degree of injury associated with each fall was also recorded using a 5-level scale: level 1, no injury; level 2, minor injury such as scrapes, bruises, abrasions, and lacerations that did not require sutures; level 3, moderate injury such as fracture, laceration with sutures, head injury, and injury requiring medication and/or surgery; level 4, serious injury that resulted in permanent disability; and level 5, injury associated with death. Altered mental status, history of restraint before or after the fall, whether the patient was a candidate for restraint, and the circumstances of each fall were also recorded. Patient-days by categorical age (<55, 55 to 70, and >70 years) were available for each month for each ward.

STATISTICAL ANALYSES

Rate of Falls

The fall rates per 1000 patient-days of hospitalization were calculated for each month of the study period. In initial descriptive statistics, we present means and 95% exact Poisson confidence intervals (CIs). Model 1 predicted the rate of falls per patient-day from wards (treated categorically) and months (treated categorically) with negative binomial regression, a less restrictive generalization of Poisson regression,[26] because Pearson goodness-of-fit tests were not consistent with a Poisson distribution ($P = 0.002$). In this model, patient-days were the measure of exposure. A Wald test of the overall significance of each independent variable (e.g., month and ward) was conducted, with nonsignificant variables ($P > 0.05$) removed from subsequent models. This resulted in model 2 with ward as the only predictor. Model 3 added age (≤55 years/reference, 56 to 70 years, >70 years) as a predictor. Model 4 added hospital shift (7 A.M. to 3 P.M./reference, 3 P.M. to 11 P.M., 11 P.M. to 7 A.M.) as a predictor, and model 5 added shift-by-ward interactions to model 4. Because patient volume was not available by shift, models 4 and 5 required the assumption that patient volume did not vary by shift within a given ward. Model 3 allows adjustment of ward fall rates for patient mix with respect to age. Models 4 and 5 reveal differences in fall rates by shift after considering age and ward but do not further adjust ward estimates because of the necessary assumptions.

For both Poisson and negative binomial regressions, coefficients were reported as incidence rate ratios (IRRs), the factor by which the rate is multiplied for a 1-unit change in the predictor variable. For ease of interpretation of models 2 and 3, a series of bivariate negative binomial regressions (using 1 ward at a time as a predictor) compared the fall rate for each ward with the overall hospital mean.

Injuries From Falls

Fall severity was recorded for 598 (98%) of 611 falls. Because of the rarity of severe falls, severity was dichotomized as any injury (levels 2 to 5) versus no injury (level 1). Model A predicted the presence of injuries among falls from ward, month, and (continuous) age in years using logistic regression. A Wald test of the overall significance of each independent variable (i.e., month, ward, and age) was conducted, with nonsignificant variables ($P > 0.05$) removed from subsequent models. This resulted in model B with ward and age as the only predictors.

Circumstances of Falls

We also provide descriptive analyses regarding circumstances of falls, including patient characteristics not available for those who did not fall. Because it is not known what proportion of the time patients spend in a given mobility state, and because the patient characteristics of altered mental status and restraint status are unmeasured among the full patient population, these analyses do not directly indicate risk but may be suggestive of future research that records these characteristics among all patients. Among those who fell, the proportion of ward and monthly falls with given circumstances and patient characteristics were calculated, as were corresponding 95% exact binomial CIs. Multinomial logistic regressions were used to model the variation in 5 patient mobility categories by ward and month: general ambulation, moving from the bed, moving in the bedroom, moving from a chair, and other. Logistic regression was used to model the proportion of falls with given circumstances and patient characteristics as a function of month and ward.

Two-sided P values less than 0.05 were considered statistically significant. All analyses were conducted using STATA software version 9 (College Station, TX).[27]

RESULTS

Rate of Falls

Between December 1, 2004, and November 30, 2005, approximately 33,328 patients were hospitalized for 140,231 total patient-days (average length of stay, 4.2 days). During the study period, 611 falls occurred in 563 patients [4.36 (95% CI, 4.02 to 4.72) falls per 1000 patient-days of hospitalization]. A negative binomial regression (model 1) found significant variation in rates of falls by ward ($P = 0.0042$) but not month ($P = 0.7992$); model 2 eliminated month. The average number of patient falls per 1000 patient-days by ward and the corresponding unadjusted (model 2) IRR versus the overall mean of other wards appear in Table 1, along with a 95% CI for the IRR. Ward IRRs relative to the overall group mean ranged from 0.19 to 2.32 (Fig. 1). Two of the 15 wards had fall rates significantly above the overall mean rate: neurosurgery (IRR = 2.32; $P < 0.001$) and short stay (IRR = 1.69; $P = 0.013$); the IRR for neurosurgery indicates that falls occur at more than twice the rate in the neurosurgical ward than in the average of other wards. Four wards had fall rates significantly lower than the overall mean (cardio thoracic ICU, S/NS ICU, MICU/CCU, and cardiology–post catheterization; $P < 0.05$).

Almost half of hospitalized patients were older than 70 years (46.3%); 27.3% were aged 55 to 70 years, and 26.4% were 55 years or younger. Model 3 found that the rate of falls increased significantly with patient age; patients aged 56 to 70 years or older than 70 years fell 1.45 and 1.78 times more frequently, respectively, compared with patients aged

TABLE 1. Falls per 1000 Patient-Days and IRRs Unadjusted and Age-Adjusted, by Ward

		Negative Binomial, Unadjusted (Model 2)		Negative Binomial, Age-Adjusted (Model 3)	
Name of Ward	Falls per 1000 Patient-Days	IRR Compared With Overall Mean	IRR 95% CI	IRR Compared With Overall Mean	IRR 95% CI
Neurosurg	8.83	2.32***	1.70–3.16	2.4***	1.78–3.24
Short stay	7.04	1.69*	1.10–2.60	1.69*	1.11–2.58
Orthopedics	5.79	1.38	0.97–1.96	1.36	0.96–1.93
Pulmonary	5.67	1.35	0.97–1.89	1.36	0.98–1.89
Medicine	5.58	1.19	0.84–1.68	1.13	0.80–1.60
Fam Pract	4.71	1.17	0.78–1.76	1.17	0.78–1.76
Oncology	4.54	1.08	0.73–1.61	1.17	0.79–1.72
Card-thor surg	4.38	1.02	0.71–1.46	1.00	0.70–1.43
Cardiology-telemetry	4.36	1.03	0.68–1.56	1.01	0.67–1.53
Surg oncology	3.61	0.86	0.59–1.25	0.86	0.59–1.24
Oncology–stem cell	2.96	0.69	0.44–1.09	0.76	0.49–1.18
S/NS ICU	1.96	0.36**	0.19–0.69	0.35***	0.18–0.67
Cardiology–post cath	1.60	0.36***	0.21–0.64	0.35***	0.20–0.61
CT-ICU	1.07	0.25**	0.11–0.55	0.24***	0.11–0.52
MICU/CCU	0.84	0.19***	0.08–0.44	0.18***	0.08–0.43

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

55 years or younger ($P < 0.001$). Table 2 also shows age-adjusted IRRs by ward, which are very similar to unadjusted ward IRRs because age distributions vary relatively by ward.

Model 4 found that there was a significant effect of shift on the rate of falls after controlling for ward and age ($P < 0.01$). The adjusted rate of falls was 26% lower during the 11 P.M. to 7 A.M. shift compared with both the 7 A.M. to 3 P.M. and the 3 P.M. to 11 P.M. shifts ($P < 0.01$ for both). Interactions in model 5 found no evidence that the shift effect varied by ward ($P > 0.10$).

Injuries From Falls

In most cases, patient falls were associated with no injury (76.8%). Fewer than one quarter of falls (21.7%) were associated with mild injury (bruise, laceration, and hematoma), and 1.5% of falls resulted in moderate or serious injury.

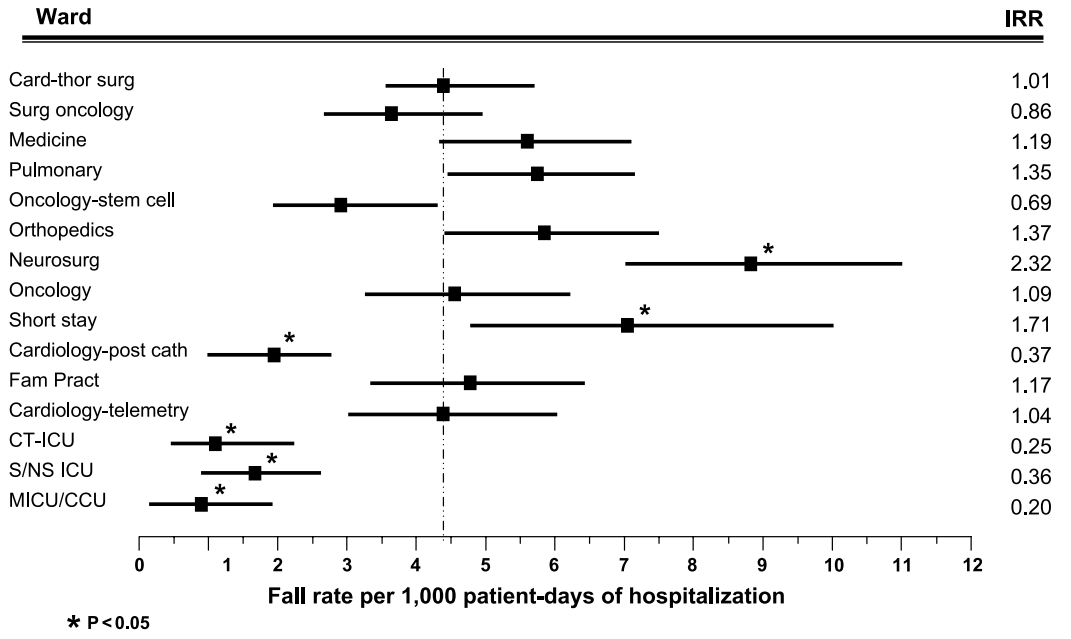

FIGURE 1. Hospitalization patient-fall rate by ward. Of 15 different hospital wards, 2 had fall rates per 1000 patient-days that were higher than the overall mean (4.36; dashed line), and 4 had fall rates per 1000 patient-days that were lower than the overall mean. Error bars represent 95% CIs. *$P < 0.05$.

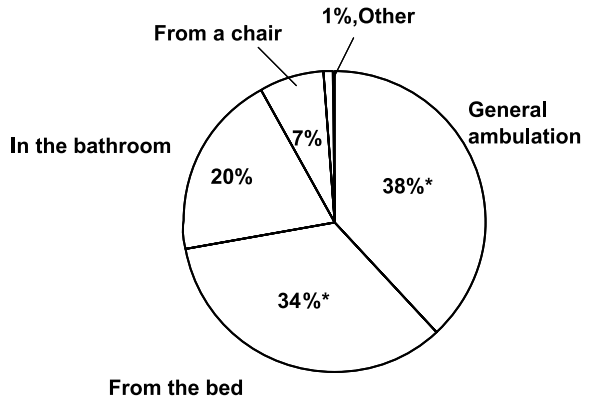

FIGURE 2. Hospitalized patient-fall frequency by movement. A higher proportion of falls of hospitalized patients occurred during general ambulation or while moving from the bed than occurred while moving in the bathroom, moving from a chair, or in other movements. *$P < 0.01$.

Patient falls led to 8 fractures (6 in patients aged 79 years or older). One thumb and 1 wrist fracture were recorded in younger patients; more serious fractures were recorded in older patients (5 femur fractures and 1 humerus fracture). One stroke as a result of a fall was recorded in a 79-year-old patient. There were no reported deaths as a result of a fall.

Logistic regression model A (results not shown) found that the odds that a fall resulted in injury increased with age ($P = 0.011$) and varied by ward ($P = 0.0094$) but not month ($P = 0.1456$). Model B (without month, results not shown) found that the odds of a fall resulting in injury were multiplied by 1.19 for each additional decade of age ($P = 0.018$) and that the age-adjusted injury rate for the oncology ward [46.4% (13 of 28 falls)] was significantly higher than the overall average ($P = 0.001$).

TABLE 3. Proportion of Patient Falls With Given Patient Characteristics

Patient Characteristic	% of Falls	95% CI
Contributing medications	94	92–96
Altered mental status	43	39–47
Cane/walker/crutches in home	21	18–25
Cane/walker/crutches in hospital	17	14–20
Repeat fall	8	6–10

CI indicates confidence interval.

Circumstances of Falls

Patients fell more frequently during general ambulation (38%) and while moving from the bed (34%) compared with falling while moving in the bathroom (20%), moving from a chair (7%), or other (1%; $P < 0.01$; Fig. 2). A multinomial logistic regression indicated that the circumstances of the fall varied significantly by both ward ($P < 0.001$) and month ($P < 0.001$). Falls while ambulating constituted a higher proportion of falls in the surgical oncology ward (57%) than in the cardiology–post catheterization ward (22%) or the cardiothoracic CT–ICU ward (0%; $P = 0.002$ and $P = 0.005$, respectively; Table 2).

Most falls occurred among unassisted patients (93%) and in medicated patients (94%). Alteration of mental status was evident in 43% of patient falls (Table 3). Approximately 1 in 5 falls involved a patient who used a cane, walker, or crutches in the home, and 1 in 6 falls involved a patient who used such aids in the hospital. The proportion of falls

TABLE 2. Frequency of Patient Falls by Ward and Patient Movement

		Patient Movement									
		Ambulatory		From the Bed		BR/Commode		Chair		Other	
Ward	Mean Falls per 1000 Patient-days	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Neurosurg	8.83	40	30–52	30	21–42	20	12–30	9	4–17	1	0–9
Short stay	7.04	27	12–46	30	15–49	33	17–53	3	00–17	7	0–10
Orthopedics	5.79	41	29–55	31	20–45	21	11–33	5	1–14	2	0–5
Pulmonary	5.67	49	37–60	33	23–45	13	6–23	5	1–13	0	0–5
Medicine	5.58	32	21–44	42	30–55	22	13–33	4	1–12	0	0–13
Fam pract	4.71	43	27–61	27	14–44	24	12–41	5	1–18	0	0–9
Oncology	4.54	30	17–47	33	19–49	25	13–41	10	3–24	3	0–7
Thor-card surg	4.38	43	30–57	33	21–46	12	5–23	10	4–21	2	0–13
Cardiology–telemetry	4.36	37	16–62	47	24–71	5	00–26	11	1–33	0	1–22
Surg oncology	3.61	57	42–72	21	11–36	15	6–28	8	2–22	0	0–15
Oncology–stem cell	2.96	26	11–46	37	19–58	33	17–54	4	0–19	0	0–9
S/NS ICU	1.96	29	8–58	50	23–77	7	0–34	14	2–43	0	0–18
Cardiology–post cath	1.60	22	10–39	31	16–48	42	26–59	3	0–15	3	0–41
Cardiothoracic CT–ICU	1.07	0	0–41	57	18–90	14	0–58	29	4–71	0	0–23
MICzU/CCU	0.84	17	0–64	83	36–100	0	0–50	0	0–50	0	0–50

BR indicates bathroom; CI, confidence interval.

involving patients using walking aids varied by ward for the patients who used them at home ($P = 0.005$) and in the hospital ($P = 0.0131$), results not shown.

For example, in the orthopedics ward, 36% of patients who fell used walking aids in the home and 40% in the hospital. In contrast, no patients in the cardiothoracic CT–ICU, S/NS ICU, and MICU/CCU used such aids, and 10% or fewer of patients used such aids in surgical oncology and cardiothoracic surgery wards.

DISCUSSION

Falls among hospitalized patients is an important concern that has recently attracted regulatory attention.[18,19] Previous data suggested that there are multiple clinical and functional risks for hospitalized patient falls, including age,[6,7] previous history of falls[10] or stroke,[11] active neoplasm, stroke, lower postural hypotension, the use of a walking aid and psychoactive drugs,[22] cardiac failure and digoxin,[22] opioids and anti-inflammatory drugs,[24] dementia, disorientation, and low abbreviated mental status scores, as well as lower extremity weakness,[6,7,24] and incontinence, sleepiness, and general weakness.[21]

There is already substantial literature showing that screening patients with risk assessment tools provides no clear benefit, and other interventions also have shown no clear benefit.[28,29] This prospective study provides an original contribution to the growing literature of falls in hospitalized patients. This study examines a large sample size of hospitalized patient falls and attempts to determine the contributing factors, using a complex statistical analysis to evaluate the results. The value of many previously published studies has been limited by small sample size and the fact that most studies were retrospective. This prospective study serves as a necessary foundation to design an adequate program to limit the frequency of falls in hospitalized patients. Our goal is to provide literature, which presents the frequency of falls and factors determining falls of a large population size, to enable the design of factor-related intervention. However, the limitations of this study include the following: (1) the fact that falls in the outpatient population were not included; (2) although the role of medication as a factor of falls was included in the analysis, this study did not account for the role played by each medication group (opioids, anti-inflammatories, anxiolytics, etc.); (3) in this study, the benefit of intervention programs was not assessed.

Recently, Joint Council on Accreditation of Healthcare Organizations has stressed the importance of implementing fall prevention programs for hospitalized patients, including better identification of at-risk patients. The data concerning the effectiveness of such programs are either inconclusive[12] or were collected in the early 1990s, a period not representative of the present patient-fall epidemic. Data indicated that the trends in fall rates in hospitalized patients decreased between the late 1980s and early 1990s,[13–15] only to experience resurgence in the late 1990s to the present.[16] Thus, as the rates in falls continue to rise, it is clear that proper intervention to minimize falls has limited value. Advances in fall prevention require a new way of thinking to determine a solution.

Patients are regularly reminded of the risk of falling when moving while unsupervised and to call for help before ambulating. However, many patients ambulate without supervision. In the absence of continuous monitoring, patient and family education must play an important role. The fact that 43% of falls in the present data occur in patients with altered mental status suggests some limitations on patient education. Although it is difficult to identify effective programs for preventing patient falls, consideration should be given to programs that limit patient movement without assistance and educate patients and their families about the risks of ambulating without assistance. Given limited resources, educational interventions, allocations of staff for supervision, and programs to limit patient mobility may be most effectively applied to those patients at greatest risk of injury-producing falls. The present study suggests areas for this emphasis.

The present study found higher rates of falls in neurosurgery and short-stay wards, suggesting that these wards may most benefit from intervention and supervision. Cardiothoracic CT–ICU, S/NS ICU, MICU/CCU, and cardiology–post catheterization wards, which generally have less mobile patients, had very low rates of falls. Thirty-eight percent of all falls occurred during general ambulation, which is probably less common in these 4 wards. Falls were 26% less frequent between 11 P.M. and 7 A.M., which probably corresponds to less patient activity during that shift, but which may actually represent higher risk among active patients if transitions and ambulation are in fact more than 26% lower during this shift. These results are similar to results published by Kerzman et al[8] (2004), who reported most frequent falls during the 7 A.M. to 3 P.M. shift. On the other hand, there is very little evidence that fall rates or injury rates vary seasonally.

Aging has also been demonstrated to be a risk factor for falls outside the hospital.[30] In an increasingly older population, it is most likely that concerns associated with falls in and out of the hospital will increase. In the present study, older patients were at significantly increased risk of falling, even controlling for ward, and were at greater risk of injury when they did fall. Taken together, older patients are at greatly increased risk for injury falls. For example, an 80-year-old patient has 3 times the odds of an injury fall than a 50-year-old patient in the same ward ($1.78 \times 1.19^3 = 3.00$), suggesting that hospitals should prioritize supervision of patients aged 70 years and older, especially within high-risk wards. Even accounting for age, falls in oncology were more likely to result in injury, suggesting that this ward may merit extra attention, although it has a typical overall rate of falls.. Fortunately, in this 1-year monitoring study, most falls were not serious. However, others have reported fracture rates as high as 4% after patient falls.[5]

Joint Council on Accreditation of Healthcare Organizations has clearly recognized falls as a priority. Even if the risk of serious injuries is limited, hospitals should still make every effort to prevent falls from occurring, as patients should not be exposed to such complications during hospitalizations. Another established risk factor for patient falls is lower-limb weakness.[6] In our data, a large proportion of patients who fell used a cane or walker before or during hospitalization. Although the present study cannot directly assess the risk

associated with such use, such patients may merit special emphasis.

Forty-one percent of all falls occurred during transitions from beds or chairs, and an additional 20% occurred in bathrooms, which is consistent with previous findings.[4,31] Given that only 7% of all falls occurred in the presence of assistance, supervision during transitions in bathroom use may be especially important. For example, Unruh[16] (2002) previously reported that 50% of patient falls were related to nursing staff quantity.

Programs designed to educate patients, their families, and caretakers about these risk factors should be implemented to help reduce the incidence and severity of hospitalized patient falls.

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