

# Predictors of Injury Severity for Inpatient Falls in Taiwan: A Retrospective Study

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## Research Article

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## ABSTRACT

**Background:** Falls consist of one of the most frequently reported adverse hospital events. Little is known about the risk of severe injury for inpatients due to falls. The purpose of this study was to determine factors associated with fall injury severity.

**Methods:** We performed a retrospective study with subjects from a teaching hospital of central Taiwan and collected relevant data from the Adverse Event (AE) reporting system from 2008 to 2013.

**Results:** A total of 498 patients who had fallen during hospitalization were enrolled in the study. We identified risk factors for severe injuries by logistic multiple regression analysis, medical units ( $P=0.000$ ,  $P<0.05$ ), age ( $P=0.031$ ,  $P<0.05$ ), lacking a companion ( $P=0.023$ ,  $P<0.05$ ), and frequent falls ( $P=0.023$ ,  $P<0.05$ ) were significantly correlated with the severity of the falls. The severity of the fall 4-5 times and the severity of the fall more than 6 times are almost the same. Single and recurrent falls resulted in different degrees of injury with a significant correlation between the frequency of falls and the injury severity.

**Conclusions:** Severe injuries from falls are significantly correlated with ward units, number of falls, and the age. The severity of falls in psychiatric and rehabilitation ward patients was greater than that of patients in acute wards. The injury severity was also correlated with the number of falls. It may be possible to establish a fall prevention model that takes into account specific fall risk factors.

## BACKGROUND

Patient safety is an important issue for the World Health Organization. Falls are amongst the most frequently reported adverse hospital events<sup>[1]</sup>. A fall is operationally defined as "unintentionally coming to lay on the ground, floor or other lower level"<sup>[2,3]</sup>. The Taiwan Joint Commission on Hospital Accreditation monitors the incidence of patient falls reported from the 513 healthcare organizations, found fall incidence ranging from 0.05% to 0.06%. Regarding hospital fall incidents, the severities of fall injury were no injury (48.1%), had an injury (51.0%). This report injury rate was higher than the USA report fall injury rate 20-30%<sup>[4,5]</sup>. The fall-related retrospective studies report, some country patients suffered from moderate to serious injuries, and approximately the population is aged 65 years old or older<sup>[4-6]</sup>. The results of

regression analysis showed that the variables include companions, lower limb weakness, and postural hypotension was all positively associated with fall-related injuries<sup>[7]</sup>.

Fall-related injuries include bruises, lacerating wounds, fractures of upper and lower extremities, hip fractures, and intracranial injuries<sup>[8,9]</sup>. The harm from falls increases the burden of morbidity<sup>[10,11]</sup>, and can result in an added financial burden to patients, families, and the society<sup>[8]</sup>. For medical institutions, inpatient falls may prolong hospital stays, increase medical staff anxiety, and lead to patient's complaints and litigations<sup>[12,13]</sup>. Thus, reducing the number of severe injuries from falls is important.

This study hypothesis the severity of falls with risk factors associated (Eg: companion, the frequency of falls, fall of the situation, medical unit, risk assessment) haven't the correlation. And single fall and recurrent falls with risk factors aren't the correlation. The main purpose of this study was to characterize the situations leading to inpatient falls and to identify predictive factors associated with fall severity. A secondary aim would be to differentiate the risk factors into those associated with single events and those associated with recurrent falls.

## LITERATURE

### Factors Associated with Inpatient Falls

The severity of inpatient falls has been associated with factors such as the fall being unwitnessed (78%), the fall location (47%), the previous patient activity (27%), the presence of a physical impairment/frailty (9.5%) and the presence of cognitive impairment/confusion (9.2%)<sup>[14]</sup>. The risk factors for falls are classified into intrinsic and extrinsic factors and include age, physiological disease, lower-extremity weakness, poor hand-grip strength, balance disorders, visual defects, cognitive impairment, and the use of multiple drugs, lighting, defective assistive devices, slippery floors, race, and certain medications<sup>[11,15]</sup>.

### Injury Severity of Inpatient Falls

Falls can occur either one time or multiple times in one patient and the risk factors associated with them can differ. Recurrent falls are associated with higher mortality<sup>[15,16]</sup> and elderly patients, those who live alone, or those with unstable gait are prone to recurrent falls<sup>[17-19]</sup>. Studies have indicated that patients over the age of 60 have a higher incidence of falls<sup>[20,21]</sup>. A significant correlation has been found between the numbers of falls experienced by a patient and his or her age or the presence/absence of a companion at the time of the fall<sup>[21]</sup>. Most patients' fall-injuries comprise skin tears and bruising<sup>[22]</sup>. In 4–6% of cases falls are severe and include fractures, subdural hematomas, bleeding and even death<sup>[22]</sup>. More than 50% of injury-related hospitalizations occur among people 65 years or older. Additionally, falls cause more than 95% of all hip fractures in the elderly<sup>[23]</sup>. Even though the literature includes studies of factors that lead to patients' falls, the factors associated with the severity of those falls have not yet been identified. With this study, we tried to answer this question in order to provide information necessary for planning strategies to reduce the severity of fall-related injuries.

## METHODS

### Study Design and Setting of the Study

This is a retrospective study conducted in a private teaching hospital in central Taiwan. At the time, the hospital had on average 580–650 inpatients daily from internal medicine, surgery, gynecology and obstetrics, podiatrists, ICUs, rehabilitation and psychiatry wards. The average hospital stay at the time was 5 to 6 days.

### Population and Sample

Subject's histories were collected from the Adverse Event (AE) reporting system from January 1, 2008, to December 31, 2013. We included all inpatients with falls reported by the AE reporting system and excluded outpatients.

### Study Definition and Data Collection

The AE reporting system is an electronic system that allows clinicians, health-care managers to record and manage adverse clinical incidents that occur in a hospital setting. The system on falls includes the basic information for the patient (gender, age, medical record number, bed number) and the information about the fall (high-risk group, health status, medications, environmental factors, location, situation, presence or absence of a companion, severity of the fall, and the medical unit). The severity of falls can be divided into none injuries; minor injuries, for example, minor skin tears, bruising; moderate injuries, for example, soft tissue injuries; major injuries, for example, head injury, fracture; and death.

Minor injuries require little or no treatment, moderate injuries require minor medical or nursing treatment or observation, and major injuries need medical treatment and consultation.

**Statistical Analysis**

Data were manually coded and entered into a database for analysis with the SPSS software version 19 (IBM SPSS Inc., Chicago Illinois). The descriptive statistical analysis is presented as percentages, means and standard deviations. And, the inferential statistical analysis included Pearson’s correlation and Bonferroni correction and Logistic multiple regression analysis. A p-value less than 0.05 was considered statistically significant.

**Ethical Considerations**

This study adhered to all relevant research ethical criteria and the institutional review board of our hospital approved the study (TTMHH104025).

**RESULTS**

**General Condition of Patients with Falls**

The cases of 498 patients who had fallen during hospitalization between 2008-2013 years were used in the study. Patients with companions had more falls than those without one (62.7% vs. 37.3%, respectively). The majority of patients fell only once (94%) and the severity of most falls was minor (38.8% were none injuries and 38.2 % had only minor injuries). Most falls (38% occurred in patients 65 years or older; 32.1% occurred in patients 41-64 years). The acute medical units were the most frequent units with falls in the hospital (82.9%) (Table 1).

**Table 1** Characteristics of patients with falls, N=498.

Item	Category	Number	Percentage
Companion	No	186	37.3
	Yes	312	62.7
Frequency of falls	One time	468	94
	Twice-thrice times	12	2.4
	Four-five times	8	1.6
	Six and more	10	2
Severity of injury	none injuries	193	38.8
	Minor injuries	190	38.2
	Moderate injuries	96	19.3
	Major injuries	19	3.8
Age	0-18 years	79	15.9
	19-40 years	70	14
	41-64 years	160	32.1
	>65 years	189	38
Medical unit			

	Psychiatrists	58	11.6
	Rehabilitation	27	5.4
	Pediatrics	49	9.8
	Obstetrics and Gynecology	14	2.8
	Medical	130	26.1
	Surgical	180	36.2
	Intensive care unit	7	1.4
	Others	33	6.7
Risk assessment			
	Low risk	281	56.4
	High risk	217	43.6

**Predicted Factors Associated with the Severity of Falls**

We identified medical units ( $P=0.000$ ,  $P\leq 0.05$ ) and age ( $P=0.031$ ,  $P\leq 0.05$ ) as independent factors associated with the severity of falls. Also, if children were excluded from the analysis, the presence of a companion was associated with the severity of the fall ( $P=0.023$ ,  $P\leq 0.05$ ). According to our results, the specific medical unit ( $P=0.000$ ) was the most important factor associated with the severity of falls followed by the fall frequency ( $P=0.023$ ,  $P\leq 0.05$ ), the presence of a companion ( $P=0.023$ ,  $P\leq 0.05$ ) and the patient’s age ( $P=0.036$ ,  $P\leq 0.05$ ) (Tables 2 and 3).

**Table 2** Correlation between falls injuries severity and related factors N=498. Note:  $\leq 0.05$ .

Item	Category	Mean	SD	P value
Companion				0.004 *
	No	2.02	0.870	
	Yes	1.80	0.826	
Frequency of falls				0.005 *
	First time	1.86	0.847	
	Twice-thrice times	1.92	0.739	
	Four-five times	2.13	0.835	
	Six and more	2.80	0.422	
Fall of situation				0.069
	Sleeping	2.00	0.707	
	Trips to the toilet	1.75	0.889	
	Walking	2.03	0.770	
	Moved to/from bed	2.00	0.862	
	Bath/wash	1.75	0.676	
	Siting	1.92	0.717	
	Picked up	1.76	0.970	
	Use a walker	2.28	1.018	
	Other factors	1.78	0.796	

Medical unit				0.000*
	Psychiatrists	2.47	0.731	
	Rehabilitation	2.63	0.792	
	Pediatrics	1.69	0.508	
	Obstetrics and Gynecology	1.43	0.514	
	Medical	1.85	0.846	
	Surgical	1.65	0.801	
	Intensive care unit	1.43	0.787	
	Outpatient	2.19	0.981	
Risk assessment				0.075
	Low risk	1.82	0.822	
	High risk	1.96	0.878	

Further analysis revealed that the surgery ward had the highest fall percentage (180/498, 36.1%) of the acute wards. And, that this fall percentage (36.1%) was greater than the fall rate of the medical ward (130/498, 26.1%), the pediatric ward (49/498, 9.8%), the obstetrics and gynecology ward (14/498, 2.8%), and the intensive care unit (7/498, 1.4%) (Table 1). Additionally, even though the acute wards had the higher number of falling inpatients, the psychiatric and rehabilitation wards had the highest percentage of severe falls (both with P=0.000, P≤0.05) (Table 3).

Table 3 Logistic multiple regression analysis of fall severity. Note: ≤0.05.

Items	Coefficient	T value	P value
Medical units	1.613	12.026	0.000
Psychiatrists	0.616	4.500	0.000
Companion	0.036	0.438	0.023
Age	0.003	2.169	0.031
Risk factor of falls	0.052	0.698	0.485
frequency of falls	0.036	0.438	0.023

**Factors Associated with Frequency of Falls**

Our results also showed that recurrent falls caused more major injuries. Four or five times of falls caused the severity of injury similar to six times of falls (Table 4). The correlation between the frequency of falls and the severity of falls was shown significant statistically (P=0.009, P≤0.05). Patients with recurrent fall most had moderate injuries (14/30 patients; 46.7%), while those with a single fall experienced mostly none injuries (187/468 patients, 40.0%) and minor injuries (180/468 patients, 38.5%). Variables such as the presence of a companion (P=0.001, P≤0.05), the severity of injury (P=0.001, P≤0.05), the risk factors of fall (P=0.009, P≤0.05), the medical units (wards) (P=0.000, P≤0.05), and the patients' ages (P=0.001, P≤0.05) had associated with single or recurrent falls. Patients with companions had a higher percentage of single falls (302/468, 64.5%) than those without a companion (166/468, 35.5%). However, patients without a companion had more recurrent falls (10/30, 33.3%) than those with a companion (20/30, 66.7%).

Table 4 Severity and frequency of falls. Note: ≤0.05.

Severity of falls	Frequency of falls	Mean	SD	P value	95% CI	
					Low	High
First time	2-3 times	0.156	0.280	1.000	-0.59	0.90

	4-5 times	-0.303	0.297	1.000	-1.09	0.48
	Above sixth	-0.996*	0.254	0.001	-1.67	-0.32
2-3 times	First time	-0.156	0.280	1.000	-0.90	0.59
	4-5 times	-0.458	0.404	1.000	-1.53	0.61
	Above sixth	-1.152*	0.374	0.013	-2.14	-0.16
4-5 time	First time	0.303	0.297	1.000	-0.48	1.09
	2-3 times	0.458	0.404	1.000	-0.61	1.53
	Above sixth	0.693	0.386	0.440	-1.72	0.33
Above sixth	First time	0.996*	0.254	0.001	0.32	1.67
	2-3 times	1.152*	0.374	0.013	0.16	2.14
	4-5 times	0.693	0.386	0.440	-0.33	1.72

Furthermore, the health condition was the most important factor associated with single or recurrent falls. The surgery ward had the highest percentage of single falls (176/468, 37.6%) and the psychiatric ward had the highest percentage of recurrent falls (21/30, 70.0%). Patients 65 years or older had the highest percentage of single fall events (184/468, 39.3%). And, those with ages ranging from 41 to 64 years had the highest percentage of recurrent falls (15/30, 50.0%). Single falls occurred more frequently while going to the toilet (155/468, 33.1%) whereas recurrent falls were associated with moving to/from the bed (9/30, 30.0%) (Table 5).

Table 5 The analysis of factors associated with frequency of falls, N=498.

Factors		Frequency of falls						P value
		single fall		recurrent falls		Total		
		n	%	n	%	n	%	
Companion	No	166	35.5	20	66.7	186	37.3	0.001 *
	Yes	302	64.5	10	33.3	312	62.7	
Situation	Sleeping	14	3.0	3	10.0	17	3.4	0.063
	Going to the toilet	155	33.1	6	20.0	161	32.3	
	Ambulating	57	12.2	8	26.7	65	13.1	
	Move to/from the bed	105	22.4	9	30.0	114	22.9	
	Bath/wash	23	4.9	1	3.3	24	4.8	
	Siting	24	5.1	0	0.0	24	4.8	
	Take someone	17	3.6	0	0.0	17	3.4	
	Use a walker	18	3.8	0	0.0	18	3.6	
	Others	55	11.8	3	10.0	58	11.6	
Severity of injury	None	187	40.0	6	20.0	193	38.8	0.001 *
	Minor	180	38.5	10	33.3	190	38.2	
	Moderate	82	17.5	14	46.7	96	19.3	
	Major	19	4.1	0	0.0	19	3.8	

Risk factors of fall	Health cond.	255	54.5	20	66.7	275	55.2	0.009*
	Drug reaction	26	5.6	5	16.7	31	6.2	
	Environment	77	16.5	4	13.3	81	16.3	
	Others	110	23.5	1	3.3	111	22.3	
Medical units	OB/GYN	14	3.0	0	0.0	14	2.8	0.000*
	Pediatric	48	10.3	1	3.3	49	9.8	
	Medicine	128	27.4	2	6.7	130	26.1	
	Surgery	176	37.6	4	13.3	180	36.2	
	ICU	7	1.5	0	0.0	7	1.4	
	Psychiatrists	37	7.9	21	70.0	58	11.6	
	Rehabilitation	25	5.3	2	6.7	27	5.4	
	Others	33	7.0	0	0.0	33	6.7	
Age	0-18 yrs	78	16.7	1	3.3	79	15.9	0.001
	19-40 yrs	61	13.0	9	30.0	70	14.0	
	41-64 yrs	145	31.0	15	50.0	160	32.1	
	>65 yrs	184	39.3	5	16.7	189	38.0	

## DISCUSSION

The present study showed that inpatients 65 years and older comprised the majority of those falling. This agrees with previous reports<sup>[12,16,21]</sup>. The most frequent situations associated with hospital falls in this study were going to the toilet, moving to and from the bed, and ambulating. This too is similar to other reports<sup>[14,21]</sup>. Among the acute hospital wards, the surgery ward was the location with most falls. We found that falls in the surgery ward occurred in similar situations (moving to and from a bed, during toilet or bathroom trips) and that most falls occurred during the night and morning. Our results also show that patients with companions suffered more falls than those without one (62.7% vs. 37.3%, respectively). However, the reasons for that included situations in which the companion was not available (companion was asleep, was gone, was careless or unable to help, or the patient had refused help). Other studies have found similar results<sup>[14,21]</sup>.

### Predicted Factors for the Fall Severity

The medical unit was a stronger predictor of the fall severity than the patient's age. For instance, patients from psychiatric or rehabilitation wards experienced the more severe falls injuries. This is likely due to the gait and stance impairments in elderly patients in those wards, due to medication and physical weakness<sup>[24]</sup>. It has been reported that patients with arthritis or psychiatric history are more prone to falls due to their prescribed medications<sup>[15]</sup>. In addition, excluding children, recurrent falls were the main factor associated with the fall severity. Therefore, psychiatric or rehabilitation wards and inpatients above 65 should be targeted by plans to reduce the risk of falls and consequently reduce fall severity.

### Correlation between the Fall Severity and Frequency of Falls

The present results showed that the severity of fall injury was correlated with recurrent falls (P=0.009). Compared with recurrent falls, single falls often caused none injury or minor injury. However, patients with recurrent falls had a moderate degree of injury. In addition, there was a significant correlation between the number of falls and the severity of falling events occurring more than 3 times causing similar higher injury severities (**Table 4**). This is consistent with the findings that mortality is correlated with recurrent falls<sup>[15,16]</sup> and shows why it is important to prevent recurrent fall for the patient safety. We further analyzed factors associated with either single or recurrent falls. We found that patients older than 65 years fell more often than the rest, but those with ages ranging from 41–65 were the ones having most recurrent falls. This was different from other reports showing older patients had the higher recurrent falls percentage<sup>[18]</sup>. The

discrepancy may be due to the different study populations. In our study, patients with recurrent falls were mostly from the psychiatric and rehabilitation wards. These patients have more physical health and drug factors and the prevention of falls tends to one way education, so it is easier to recurrent the fall. Accordingly, patients with unstable gait or under certain medications have been found to be more prone to recurrent falls<sup>[25,26]</sup>. The single fall often occurs in the situation of having a companion. Recurrent falls often occur in the unaccompanied situation, mainly because a single fall is related to the negligence of the companion or lack fall prevention, but the recurrence falls are related of the inadequate of the companion. Presumably, patients with companions get help more often after their single fall and prevent recurrent falls. Single falls occurred more frequently when patients were going to the toilet, whereas recurrent falls were associated with moving to from the bed, and with wheelchair transfers (probably due to improper use of patient aids). We found that patients with dependence on patient aids, those with unstable gait, or without a companion had a higher risk of falls. This is consistent with the finding that patients living alone, with unstable gait, or who use a walker suffer more recurrent falls<sup>[17,18]</sup>. Therefore, the factors associated with single falls and those associated with recurrent falls are quite different. To prevent fall injuries from recurrent falls, attention should be paid to inpatients using patient aids, those with unstable gait, and those without a companion.

### CONCLUSIONS

According to our research, severe injuries from falls are significantly correlated with ward units, number of falls, and the patient's age. The severity of falls in psychiatric and rehabilitation ward patients was greater than that of patients in acute wards. The injury severity was also correlated with the number of falls. Recurrent falls caused more severe injuries, and those suffering more than 3 falls experienced similarly severe injuries. Patients 65 years or older had the highest percentage of single falls, and those between 41 and 64 years had the highest percentage of recurrent falls.

#### Relevance to Clinical Practice

Based on our study we suggest several preventive measurements.

- 1) Targeting specific inpatient populations in fall prevention models (psychiatric and rehabilitation wards patients need an improved fall prevention plan).
- 2) Paying attention to high-risk individual patients such as those older than 65 years, those without a companion, those requiring patient mobility aids, and those with unstable gait.
- 3) Preventing recurrent falls by evaluating the cause of the first fall and educating the patient in fall prevention practices.

It is important to acknowledge the problem of inpatients falling and to assess the repercussions on the functional capacity of the patients. Multicomponent interventions are more effective in preventing falls in clinical practice and include setting up a fall prevention protocol implemented in the institution and using signage or bed/chair alarm systems. Based on our finding that psychiatric patients may have fallen due to sedation and inherent psychomotor changes, we suggest periodic medication effect reviews or increased nursing supervision. Attention should be given to the hospital environment to reduce the risk of falls related to physical structures and furnishings, including in the patient's bedroom and bathroom.

#### Research Limitations

This study was limited that it is a retrospective analysis and from the Adverse Event (AE) reporting system from a single teaching hospital, so the data may be biased and limits its inference potential. In addition, this study not collects detail on the number of medications the subjects are on, the future study could deep explore. A longitudinal study may help better understand predictive factors to help prevent future falls.

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