

Relationship between the Risk of Falling and Drugs in an Academic Hospital

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The purpose of this study was to investigate the frequency of inpatient falls and to evaluate the risk factors of drugs in an academic hospital. The study population consisted of inpatients at Ehime University Hospital in Japan and the study was conducted from April 1st to October 31st, 2006. Children and teenagers (<18 years old) were excluded. Inpatient falls were registered regularly with incident reports submitted by nurses and other hospital employees discovering the fall. Logistic regression techniques were used to estimate the odds ratios (OR) of the association of falls and drug use. Of the 4084 adult patients, 65 (1.6%) fell. An OR (unadjusted) for risk of falling were observed for various drug classes; hypnotics (OR 2.12; 95% CI, 1.25 to 3.52), anxiolytic (OR 3.35; 95% CI, 1.83 to 5.82), anti-Parkinson's (OR 5.79; 95% CI, 1.71 to 14.80), narcotics (OR 3.08; 95% CI, 1.06 to 7.11), hypotensives, diuretics (OR 2.39; 95% CI, 1.42 to 3.95). A multivariate logistic regression analysis showed that inpatient falls were significantly associated with patients older than 70 years (OR, 2.25; 95% CI, 1.35 to 3.77), with patients taking anxiolytic drugs (OR 2.36; 95% CI, 1.24 to 4.25), and with patients taking anti-Parkinson's medication (OR 5.04; 95% CI, 1.44 to 13.43). In conclusion, this study provides information regarding the relationship between fall-related accidents and drugs. Therefore, pharmacists should provide appropriate drug information related to the risk of falling to both patients and medical staff members.

Key words—fall; risk factor; drug; academic hospital

INTRODUCTION

Falls frequently occur in hospitalized patients. Depending on the hospital type and patient population, the fall rates have been estimated between 1.3% and 20% in Japan.¹⁻⁴⁾ Falls in hospitals leads to negative outcomes such as injuries and prolonged hospitalization. In addition, falling can also result in psychological repercussions and disabilities, including the fear of future falls and a restriction of daily activities, particularly for geriatric patients.^{5,6)} Therefore, the prevention of falls and fall-related injuries are important issues. It has recently been established that fall risk assessment is one of the first important steps of fall prevention, and several simple risk assessment tools have been developed to identify high-risk patients.^{7,8)} In Ehime University Hospital, an academic acute-hospital, nursing assessment has been conducted for fall risks, screening using a fall assessment score sheet including pharmacological, environmental and individual factors. However, fall risk assessment is difficult because falling remains a complex

phenomenon with multifactorial causes.

Numerous studies designed to examine the risk factors of medication have been conducted in various countries and across differential hospital settings. These studies have indicated that medication is a factor contributing to falls^{9,10)} and that some pharmacological drugs such as benzodiazepines (BZD),¹¹⁻¹³⁾ tranquilizers and hypnotics,^{12,14)} antidepressants,¹⁵⁻¹⁸⁾ hypertensives and diuretic,¹⁸⁻²⁰⁾ narcotics,¹³⁾ anti-Parkinson's,²¹⁾ are reported to increase the prevalence or the odds ratios (OR) of falls. However, there are few reports evaluated the risk of medication statistically in Japan.

Medication may be an intrinsic factor associated with falling because it is specific to the individual as well as an extrinsic factor, and prescription of medication could theoretically be modified to decrease the risk. Therefore, it is important to investigate the risk of falls associated with drugs among the Japanese population. Therefore, the present study assessed the frequency of inpatient falls and evaluated the potential medication-associated risk factors in an academic hospital by using routinely collected information.

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METHODS

The study population consisted of inpatients at Ehime University Hospital in Japan and the study was conducted from April 1st to October 31st, 2006. Although children are at higher risk than adults for careless mistakes or for losing their rudimentary physical balance, the risk factors in children have reported to be different from those in elderly patients.²²⁾ Therefore, in the present study, children and teenagers (age of less than 18 years) were excluded. This study collected the data concerning the fall incidents (incident reports and fall assessment score sheet) and the all inpatients data (the patients' characteristics and the medication records) during the examination period.

In this hospital, the nursing assessment has been conducted using an assessment score sheet for all patients at the time of admission (Table 1). The sheet contains 36 clinical factors associated with falling with a simple scoring system. Each risk factor on the instrument is allocated a score depending on the calculated relative risk.^{23,24)} The patient is assessed for the presence or absence of the risk factors, and the score is written in the space provided when a risk factor is present. Items are given a score of 1 to 4 if the risk is present and a score of 0 if it is not. The score is then totaled. Based on the total scores, patients were categorized into having a low (<6), intermediate (6–15), or high (≥ 16) risk of falling.^{8,24)} Nurses plan a basic common nursing care plan for prevention of falling depending on the level of the risk (high, intermediate and low risk of fall).^{8,23,24)}

An inpatient fall is registered regularly with an incident reported submitted by the nurse or other hospital employee discovering the fall. The medical charts were reviewed to obtain the inpatients data, such as age and sex. All drugs prescribed during hospital stay were abstracted from hospital charts electronically. The medications were classified as hypnotic, anxiolytic, analgesics, anti-Parkinson's, narcotics, hypotensives and diuretics, and laxatives.

Student's *t*-test was used for comparisons of age. A chi square analysis was used for comparison of gender. The incidence of falling was calculated as the number of patients who experienced one or more falls during the period of hospitalization divided by the total number of patients. The relationship between drug use and the incidence of falls was estimated by

comparison of the odds of exposure among persons who fell or did not fall during hospitalization. A logistic regression analysis was used to calculate the odds ratios with 95% confidence intervals (CI). The odds ratios (95%CI) were calculated for each of these groups. The analysis has frequencies for the variables used, and logistic regression to estimate the risk of falling in terms of the unadjusted odds ratios. Finally, a multivariate logistic regression analysis was performed to identify the independent risk factors of falling. The adjusted odds ratios were derived from the multivariate logistic regression analyses with the risk factors. The independent variables of the final model were selected by a stepwise procedure. The OR and corresponding 95% CI were calculated through logistic regression with the JMP version 5 (SAS Institute Japan, Tokyo) statistical software program. The level of statistical significance used was a probability value of less than 0.05.

RESULTS

From April through October 2006, 4,084 inpatients at the Ehime University Hospital were examined. Of these patients, 65 (1.6%) fell. Table 2 shows the sex and age among inpatients who fell and those who did not fall. The mean age at admission was 57.7 ± 18.6 years. The age of inpatients who fell (68.1 ± 13.1) was significantly higher ($p < 0.001$) than those who did not fall (57.5 ± 18.7). The proportion of male inpatients who fell (39/65, 60%) was significantly higher ($p < 0.001$) than those who did not fall (1903/4019, 47.4%). All inpatients who fell were evaluated by a nursing assessment using an assessment score sheet, and the mean score of the assessment sheets was 15.6 ± 4.4 (Table 3).

Table 4 shows the OR of risk of falling by the various factors listed. In the univariate analysis, gender and age were significantly associated with the incidence of inpatients falls ($p < 0.05$), the OR were 1.67 (95%CI, 1.02 to 2.77) in males and 2.54 (95%CI, 1.56 to 4.19) in patients > 70 years old. Moreover, the univariate analysis for drugs revealed that the use of hypnotics, anxiolytic, anti-Parkinson's, hypotensives and diuretics were significantly related to falls ($p < 0.01$). In addition, narcotics was significantly associated with falling ($p < 0.05$). However, analgesics and laxatives demonstrated no significant relationship.

The adjusted odds ratios for the potential risk fac-

Table 1. Assessment Score Sheet

	score	/	/	/	/	/
More than 70 years old	2					
History of falls	2					
Visual disorder Auditory disorder	1					
Paralysis Numbness Bone, Joint have abnormality	3					
Muscle weakness Walker, Wheelchair, Canes Transfer assistance Gait deficit Tube (infusion, gastric fistula) Bedridden	3					
Present situation cognition disorder Cognitive impairment Lack of judgment Restless action Failure of memory	4					
Analgesics Narcotics Hypnotics, Anxiolytic Anti-Parkinson's Hypotensives, Diuretics Laxatives	1 1 1 1 1 1					
Urinary incontinence Frequent urination Toilet assist Urethral catheters Toilet/during the night Distance to toilet	2 2 2 2 2 2					
Anemia Hypoxia Orthostatic hypotension Hypoglycemia	1 1 1 1					
Environmental change	2					
total						
Score ≥ 16, high risk Score 6–15, intermediate risk Score 0–5, low risk						

The sheet consists of ten categories, age, history of falling, sense, functional motility disorder, active elements, cognition, medications, excretion and external factors. Each category includes the risk factor of falls.

tors of falls appear in Table 4. A multivariate logistic regression model was constructed with gender-, age- or medication-related risk factors. In the adjusted model, the factors that were significantly associated with an increased risk of inpatient falls included a

patient age of >70 years old (OR, 2.25; 95% CI, 1.35 to 3.77) and the use of anxiolytic (OR, 2.36; 95% CI, 1.24 to 4.28), anti-Parkinson's (OR, 5.04; 95% CI, 1.44 to 13.43) medications.

Table 2. Patient Characteristics

	Total	Non-fallers	Fallers	Significant differences
Inpatient	4084	4019	65	
Age (year)	57.7±18.6	57.5±18.7	68.1±13.1	$p < 0.001$
(range)	(18 to 99)	(18 to 99)	(36 to 89)	(Student's <i>t</i> -test)
Gender				
Male (%)	1942	1903 (47.4%)	39 (60.0%)	$p < 0.001$
Female (%)	2142	2116 (52.6%)	26 (40.0%)	(Chi square analysis)

Age (year) represents the mean ± S.D.

Table 3. Assessment Score and Risk Levels among Fallers

Risk level	Assessment score range	Number of fallers N	Assessment score	
			Mean ± S.D.	Median (range)
Total		65	15.6±4.4	16 (7 to 24)
Low risk	(0 to 5)	0	—	—
Intermediate risk	(6 to 15)	27	11.5±2.8	12 (7 to 15)
High risk	(>15)	38	18.6±2.5	18 (16 to 24)

Table 4. Frequencies and Odds of Association with Falling Based on Selected Variables among Hospitalized Patients

Variables	All N (% of total)	Fallers N (%)	Unadjusted OR (95% CI)	<i>p</i> -value	Adjusted OR (95% CI)	<i>p</i> -value
Total	4084 (100)	65 (1.6)				
Gender						
Male	1942 (47.6)	39 (2.0)	1.67 (1.02–2.77)	0.0450	1.40 (0.85–2.35)	0.1286
Female	2142 (52.4)	26 (1.2)	0.60 (0.36–0.98)			
Age (years)						
<70 years	2730 (66.8)	29 (1.0)	0.39 (0.24–0.64)			
≥70 years	1354 (33.2)	36 (2.7)	2.54 (1.56–4.19)	0.0002	2.25 (1.35–3.77)	0.0019
Drugs classes						
Hypnotics	847 (20.7)	23 (2.7)	2.12 (1.25–3.52)	0.0041	1.66 (0.94–2.87)	0.0727
Anxiolytics	373 (9.1)	16 (4.3)	3.35 (1.83–5.82)	0.0001	2.36 (1.24–4.28)	0.0064
Analgesics	1523 (37.3)	27 (1.8)	1.19 (0.72–1.96)	0.4796	1.17 (0.69–1.95)	0.5481
Anti-Parkinson's	49 (1.2)	4 (8.2)	5.79 (1.71–14.80)	0.0011	5.04 (1.44–13.43)	0.0035
Narcotics	111 (2.7)	5 (4.5)	3.08 (1.06–7.11)	0.0182	2.55 (0.84–6.29)	0.0637
Hypotensives, Diuretics	814 (19.9)	24 (2.9)	2.39 (1.42–3.95)	0.0008	1.55 (0.88–2.68)	0.1191
Laxatives	1715 (42.0)	30 (1.8)	1.19 (0.72–1.94)	0.4938	0.73 (0.42–1.25)	0.2610

DISCUSSION

The present study assessed the frequency of inpatient falls and evaluated the medication use risk factors by using routinely available data. Since the incident reports of falls are regularly submitted by nurses and other hospital employees who discovered the fall in this hospital, all falls that occurred during the study period were examined. This study, using multivariate logistic regression analysis, like previous

studies,^{5,13,21} identified several risk factors associated with falls. The major findings of the present study were that three variables were independently associated with an increased risk of inpatient falls: age >70 years old, the use of anxiolytic and anti-Parkinson's medications.

Several studies have demonstrated that elderly inpatients are an independent risk for inpatient falls.^{5,13,21} The current analysis of patient-related characteristics showed that patients' age >70 years

old has almost a 2.3-fold increase in the risk of falling in comparison to patients age <70 years old. In general, an elderly person frequently has a number of risk factors for falls such as muscle weakness, balance disorders, visual deficits, cognitive impairment and polypharmacy. With the rapid aging of the society, the number of elderly person who are at risk of falling is increasing in Japan. Therefore, sufficient screening for fall risk is necessary for elderly inpatients.

In this study, inpatients receiving anti-Parkinson's drugs showed an almost 5.0-fold increase in the risk of falling compared with the reference categories. Parkinson's disease is movement disorder which characterized by muscle rigidity, tremor, dyskinesias and akinesia.²¹⁾ In addition, the side effects of anti-Parkinson's medication are considered to be the main cause of such falls. For example, dopaminergic agonists have side effects such as hallucination, dyskinesia and depression,²⁵⁾ while anti-cholinergic agents have side effects such as cognitive impairment, derangement and blurred vision.²⁵⁾ Therefore, it is suggested that anti-Parkinson's medication is a significant predictor of falls.

At present, many anxiolytic medications are ben-

zodiazepine receptor agonists. The pharmacological profile of benzodiazepines and structurally unrelated ligands of the benzodiazepine site of γ -aminobutyric acid A (GABA_A) receptors is dominated by hypnotic, anxiolytic, sedative, myorelaxant and anticonvulsant activities. However, despite their therapeutic effectiveness, many benzodiazepine receptor agonists have side effects in regard to movement disorders, including impaired coordination, balance, muscle relaxant action and ataxia.^{25,26)} Another side effect of benzodiazepine receptor agonists are psychological impairments such as short-term memory impairment, hallucinations and delirium symptoms.^{25,27)} These side effects are also thought to be associated with falls.²⁸⁾ In the present study, inpatients receiving anxiolytic medications showed an almost 2.4-fold increase in the risk of falling in comparison to the reference categories. This result is consistent with previous results in several settings.^{5,12,19,20,26,28)} However, for hypnotics, narcotics, hypotensives and diuretics, the OR were statistically significant in the unadjusted models but not in the adjusted model. Since previous studies have pointed out the critical role of some pharmacological drugs, such as psychotropic, cardiac

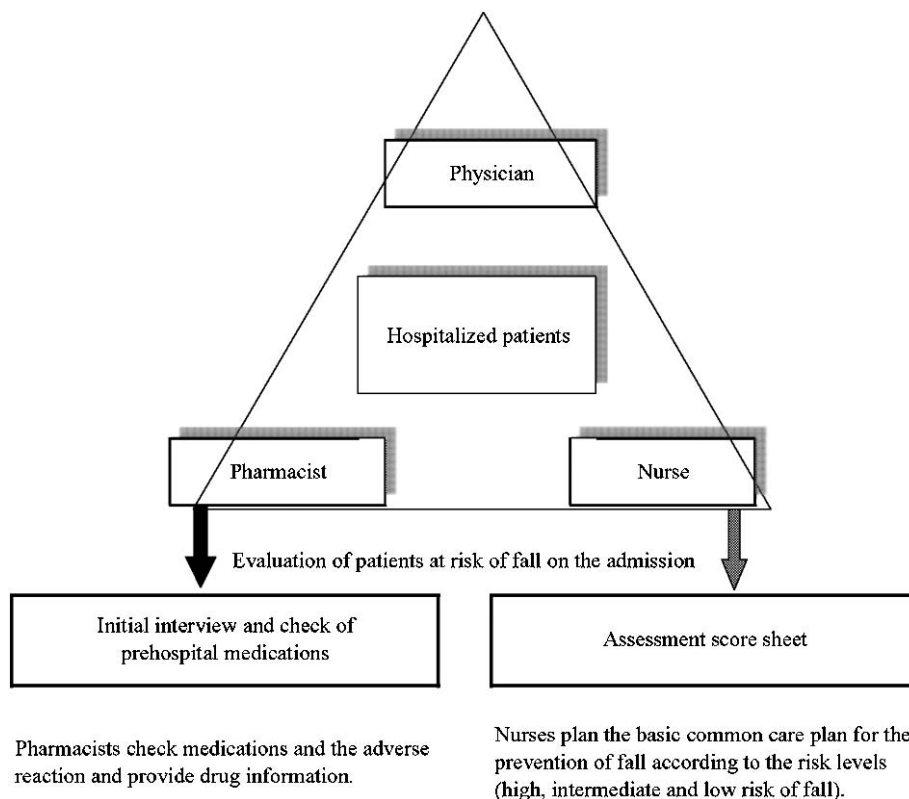


Fig. 1. Fall Prevention Program in Ehime University Hospital

or analgesic drugs, further study is needed to investigate the risk of falls associated with these drugs.

Fall rates are affected by differences in the hospital type, patient population and composition of prevention programs. For patients with psychiatric illness, falls are the most common complication of the hospital stay. In addition, falls also represent a significant problem for elderly patients in long-term care institutions.²⁹⁾ In acute-care hospitals, the fall rates are reported to be between 1.3% and 15%.^{4,30)} The incidence of inpatient falls at this hospital, an academic hospital, was 1.6%. The fall prevention program in this hospital is shown in Fig. 1. When patients are admitted to this hospital, nurses conduct the fall risk screening for all patients using an assessment score sheet (Table 1) and institutes a basic common care plan for the prevention of falling according to the risk levels (high, intermediate and low risk of fall). Pharmacists conduct an initial interview at the time of admission and check the outpatient prescription drugs including high-risk medicines.³¹⁾ In addition, the patient data of the initial interview is recorded in a reporting system to be able to confirm by another medical staff.³¹⁾

In summary, in this study, a multivariate logistic regression analysis clearly demonstrated that an age above 70 years old and the use of anxiolytic and anti-Parkinson's medications are risks for inpatient falls. Although these risk factors are already contained in our assessment score sheet, it is important to regularly re-evaluate the risk factors of falls. Therefore, pharmacists should more actively provide appropriate drug information including any information related to the risk of falls to both the patients and medical staff members.

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