

Analysis of potential cost reductions related to falls in hospitalized elderly patients by correcting high-dose prescriptions of sedative hypnotics

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Abstract

Background: Risk factors for falls include older age, diseases, and certain medications. High-dose sedative hypnotics have been shown to increase the risk of falls, necessitating caution when these medications are used. High-dose sedative hypnotics have an increased half-life in elderly patients with reduced hepatic and renal function, which may increase fall risk.

Methods: This retrospective survey evaluated the potential cost reductions associated with fall prevention by changing high-dose prescriptions. For this purpose, the association between falls and high-dose usage of sedative hypnotics was analyzed in hospitalized elderly patients. Study participants were 267 ambulatory patients aged ≥ 65 years who were taking sedative hypnotics and were hospitalized for ≥ 3 days from May 2012 to April 2013 at the Gifu Municipal Hospital, Japan. Patients' age, sex and usage of sedative hypnotics (high-dose vs. non-high-dose) were analyzed, as well as the costs incurred by tests, drugs, and wages for medical personnel for patients on high-dose sedative hypnotics who experienced falls.

Results: Analysis revealed a significantly higher rate of falls in the group using high-dose sedative hypnotics (21.4%; 14/224) compared to the non-high-dose group (6.3%; 9/42, $p=0.004$). Assessment of cost demonstrated potential savings of ¥589 per case if falls could be prevented by correcting high-dose prescriptions.

Conclusions: This study indicates that high-dose prescriptions of sedative hypnotics may be associated with fall risk in the elderly. Correcting high-dose prescriptions for these drugs would be beneficial not only for medical safety, but also the medical economy.

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Introduction

In-patient falls account for the majority of incident reports in hospitals, with report rates as high as 70% [1]. Fall rates vary by facility [2], but almost one-third (30%) of patients sustain physical injury, and 4–6% sustain serious injuries following falls [3, 4]. This increases the economic burden caused by these patients due to the additional medical costs for drugs

and testing fees during the treatment of physical injuries, and the extended length of hospital stay caused by the patient becoming bedridden or needing long-term care [5].

Risk factors for falls are complex and include internal factors such as diseases (e.g., muscle weakness and dementia), certain medications, aging, and external factors (differences in floor levels, beds, footwear, and

lighting) [6]. Sedative hypnotics [7, 8], psychotropic agents [9, 10], anti-hypertensive agents [7, 11], anti-epileptic drugs [12], and anti-Parkinson agents [13, 14] are known risk factors for falls. Among these drugs, sedative hypnotics greatly affect the risk of falling [15, 16] since they cause depressed levels of consciousness, cognitive impairment, and muscle relaxation [17]. High dosages of sedative hypnotics have been shown to be associated with falls in the elderly [18].

Hospital pharmacists must actively participate in providing effective and safe drug therapy in hospitals, and adjust prescriptions if needed. Conducting economic evaluations of pharmacist involvement in ensuring the correct use of drugs is very important and can be used as indicators for novel interventions. During medical economic assessment, estimations of medical expenses are performed using the so-called 'micro-costing method' [19, 20]. This method calculates the measurement and evaluation of the usage of various medical resources. Although there have been several reports indicating that pharmacist involvement to ensure correct medication use can potentially reduce medical expenses [21, 22], the potential cost reductions achieved by targeting sedative hypnotics prescriptions for fall prevention have not been assessed.

Sedative hypnotics include drugs with a lower maximum recommended dose for the elderly compared to that recommended for younger adults in package inserts. The package inserts of some drugs recommend a gradual dosage increase in the elderly. Fall risk might thus be greater when the maximum recommended dose of a sedative hypnotic is exceeded, or when the dosage is not gradually increased in an elderly patient with reduced hepatic and renal function.

In the present study, potential cost reductions associated with fall prevention by correcting high-dose sedative hypnotic prescriptions were estimated. The effects of high-dose prescriptions of sedative hypnotics on falls in elderly in-patients were also elucidated.

Methods

Study participants

Study participants included 267 ambulatory patients aged ≥ 65 years, who were taking sedative hypnotics and were hospitalized for ≥ 3 days from May 2012 to April 2013 at the Gifu Municipal Hospital, Japan. This study was conducted with the approval of the ethics committees of the Gifu Municipal Hospital and Gifu Pharmaceutical University.

Survey items

Medical records were retrospectively investigated for the following data: presence or absence of falls, circumstances of falls, participant age, participant sex, usage of sedative hypnotics, and usage of other medications considered to be risk factors for falls (psychotropic agents, anti-hypertensive agents, non-steroidal anti-inflammatory drugs, cardiac stimulants, anti-epileptic agents, and anti-Parkinson agents). Costs for tests, drugs, and physician/nurse labor needed due to falls were also analyzed. In individuals experiencing falls, the usage of sedative hypnotics was determined on the day prior, and four days prior, to the day of the fall. For individuals who did not experience a fall, sedative hypnotic drug use was determined prior to the mid-day of hospitalization. Prescriptions were classified as high-dose when the maximum recommended dose was exceeded, or when the dosage was not gradually increased as recommended in the package insert.

Calculation of potential cost reductions by correcting high-dose prescriptions

Costs required for tests and treatment in patients who experienced falls were calculated by using the points table for medical treatment covered by health insurance in Japan in 2012, and the 2012 National Health Insurance Drug Price Standard. Expenses for labor performed by health professionals were calculated using the following equation:

Physician/nurse labor cost = hourly wage of physician/nurse \times hours worked by the physician/nurse

Physician and nurse wages per hour were calculated as firm-sized totals (at least ten workers in total) based on cash wages paid for scheduled hours worked, as noted in the “cash wages paid out by profession” section in the 2012 Basic Survey on Wage Structure in Japan. Other special allowances, such as fixed wages and yearly bonuses (calculated by industry) were also taken into account. Consequently, the following wages were in our calculations: physicians, ¥5,428/hour; and nurses, ¥2,055/hour (as of November 13, 2014: €1=¥144, \$1 USD=¥116)

Statistical analysis

The Student *t*-test and the χ^2 test were used to examine the differences between the high-dose and non-high-dose groups. SPSS18.0J (Armonk, New York) software was used for statistical analysis, and statistical significance was set at $p < 0.05$.

Results

Patient characteristics and fall incidents

Of the 267 study participants included in this survey, 43 (16.1%) were in the high-dose group and 224 (83.9%) in the non-high-dose group. Patient characteristics are shown in Table 1. Ten fall incidents occurred in the high-dose group, and 14 in the non-high-dose group. Table 2 provides details of the sedative hypnotic prescriptions, and the circumstances of the falls experienced by patients in the high-dose group. Among the ten incidents, the prescribed dosage of the drug exceeded the maximum recommended dosage in seven cases, and the dosage was not gradually increased as per the package insert recommendations in three cases. Most patients were prescribed with 2mg Flunitrazepam ($n = 6$). Case #10 was excluded from analysis because the timing of the fall and the half-life of the sedative hypnotic seemed to indicate that the medication was not likely to have caused the fall. Thus, 266 participants were included in the final analysis. A significantly higher rate of falls was found in the high-dose group (21.4%; 9/42) compared to the non-high-dose group (6.3%; 14/224, $p = 0.004$) (Fig. 1).

Table 1. Patient characteristics

	High-dose group (n = 43)	Non-high-dose group (n = 224)	<i>p</i>
Age (year) ^a	73.7±7.2	76.2±6.8	0.029*
Male	29	116	0.085
Psychotropic agents	9	27	0.188
Antihypertensive agents	20	123	0.400
NSAIDs ^b	11	66	0.741
Cardiac stimulants	1	5	1.000
Anti-epileptic agents	0	3	1.000
Anti-Parkinson agents	0	2	1.000

Student’s *t*-test was used to assess the difference in age and the χ^2 test for all other characteristics. ^a mean±standard deviation; ^b NSAIDs; Non-Steroidal Anti-Inflammatory Drugs; * $p < 0.05$

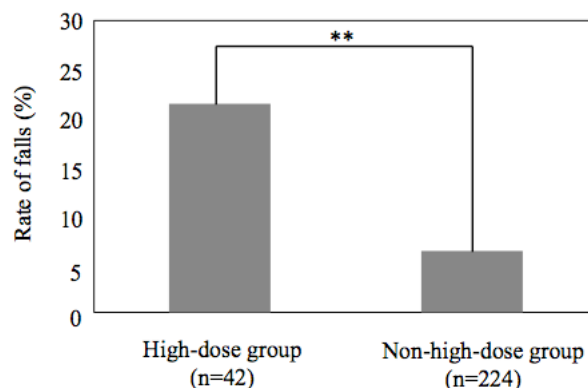


Figure 1. Rate of falls in the high-dose and non-high-dose groups
** $p < 0.01$

Analysis of potential cost reductions

Fall-related additional costs for testing, drugs, and healthcare professionals’ labor were calculated for patients in the high-dose group (Table 3). These costs included drug costs of ¥730, testing fees of ¥2,100, and physician/nurse labor costs of ¥21,916. The total cost was ¥24,746. A potential cost reduction of ¥589 per case was determined for the 42 cases of high-dose prescriptions. These costs could be saved through fall prevention by correcting high-dose prescriptions.

Table 2. Summary of cases of fall incidents in the high-dose group

Sex, Age	Classification of high-dose prescriptions ^a	Sedative hypnotics	Drugs potential to induce falls ^b	Circumstances of the fall (assessed through medical records)
Female, 65	Recommended dosage	Flunitrazepam (2 mg)	Other sedative hypnotics and psychotropic agents	Fell by the bedside. Fell trying to sit on a bedside chair, sustaining impact to the shoulder. Could not get up on her own, returned to bed with assistance. Measured patient's vital signs, reported to attending physician. Patient put under observation.
Female, 65	Recommended dosage	Flunitrazepam (2 mg) and zolpidem (20 mg)	Other sedative hypnotics and psychotropic agents	Stumbled and fell over the sheet on the floor, sustaining impact to the right elbow, but no complaints of pain. Did not hit head. Patient put under observation. Directed to wear shoes and stay away from potentially dangerous slippers.
Male, 67	Recommended dosage	Flunitrazepam (2 mg)	Other sedative hypnotics and psychotropic agents	Patient was sitting beside bed. Measured patient's vital signs. Patient claimed to have fallen when asked if he had sustained any injuries. No external injuries were evident. Patient could not stand by himself. Two nurses helped patient to stand and returned patient to bed. Attending physician was informed during morning rounds. Patient put under observation.
Male, 67	Recommended dosage	Flunitrazepam (2 mg)	Other sedative hypnotics and psychotropic agents	Patient staggered and fell while trying to move from wheelchair to bed. A scrape was evident on the patient's right elbow, and light bleeding was noted. The wound was sterilized and bandaged. The attending physician visited and warned patient and patient's family about falling due to worsening palsy. Measured patient's vital signs. Patient put under observation, but no changes noticed.
Male, 67	Recommended dosage	Flunitrazepam (2 mg)	Other sedative hypnotics and psychotropic agents	Fell on rear while trying to gargle. Measured patient's vital signs. No external injury was evident. Reported to the attending physician. Patient put under observation. Rearranged area around the patient's bed, installing I.V. stand and drain to aid the patient in moving more freely.
Male, 68	Recommended dosage	Flunitrazepam (2 mg)	Other sedative hypnotics and psychotropic agents	Visited patient's room upon hearing cry from room, discovered the patient on his side by the bedside. Checked for tender areas, but patient did not complain of pain. Two nurses helped patient back to bed. Measured the patient's vital signs.
Male, 87	Gradually increasing dosage	Zolpidem (10 mg)	-	Visited patient's room when mat sensor went off, found patient on side, having fallen over. Patient had gotten dizzy and fallen off bed. Patient complained of having struck shoulder. Thus, the patient was returned to bed, and vital signs of patient were measured. Reported to the attending physician in the morning. Patient was instructed to call for a nurse when needing to visit restroom. Patient's bed was changed to a bed with railings on three sides.

Male, 74	Recommended dosage	Zolpidem (20 mg) and triazolam (0.5 mg)	Other sedative hypnotics and NSAIDs ^{c)}	Fell on rear end at bedside. Patient was returned to bed by two nurses, and vital signs of patient were measured. Patient was restrained around waist when he attempted to get up. Patient began to yell and was thus transferred to treatment room. Mitten put on when the patient attempted to gnaw and pull the I.V. out. Reported to the attending physician, patient put under observation.
Male, 81	Recommended dosage	Zolpidem (10 mg)	-	Was found sitting down in room. Vital signs of the patient were measured, but no notable changes found. Patient returned to bed but exhibited tremors that did not subside. Installed mat sensor. Reported to the attending physician.
Male, 70	Recommended dosage	Zolpidem (10 mg)	Anti-hypertensive drugs	Bed-leaving sensor went off frequently. Patient was discovered sitting down, with the chair suppressing the mat sensor. Vital signs of the patient were measured. No external injury evident. Reported to the attending physician, patient put under observation. Patient moved to room near the nursing station.

^a Recommended dosage, prescriptions exceeding the maximum recommended dose for the elderly noted in the package insert; gradually increasing dosage, dosage was not gradually increased in elderly patients as recommended in the package insert; ^b Other sedative hypnotics, doses other than those in high-dose prescriptions among prescribed sedative hypnotics; ^c NSAIDs; Non-Steroidal Anti-Inflammatory Drugs

Table 3. Calculation of costs incurred by falls for each case

Hours worked by nurse (min)	Nurse labor cost (yen)	Hours worked by physician (min)	Physician labor cost (yen)	Testing for the damage	Cost of testing for the damage (yen)	Drugs for treatment of the damage	Cost of drugs for treatment of the damage (yen)	Total cost (yen)
40	1,370	3	271	-	-	-	-	1,641
48	1,644	5	452	-	-	-	-	2,096
34	1,165	5	452	-	-	-	-	1,617
41	1,404	18	1,628	-	-	Loxoprofen tape 50 mg ×7	198	3,231
34	1,165	3	271	-	-	-	-	1,436
41	1,404	5	452	-	-	-	-	1,857
86	2,946	35	3,166	Hip diagnostic radiography	2,100	Acetaminophen tablet 400 mg ×10 and haloperidol injection 5 mg ×1	233	8,445
58	1,987	5	452	-	-	Indomethacin suppository 25 mg × 1	18	2,457
36	1,233	5	452	-	-	Felbinac cataplasm 70 mg ×12	281	1,966

Discussion

A retrospective survey of 267 hospitalized elderly patients was conducted in Japan to assess the association between fall risk and high-dose hypnotic sedative prescriptions, and to calculate the cost reductions that could be achieved through fall prevention by targeting these high-dose prescriptions. Patients in the high-dose group experienced falls at a significantly higher rate than those in the non-high-dose group. Our cost analysis revealed potential annual savings of ¥589 per case.

Sedative hypnotics are often prescribed to the elderly, since they often experience insomnia [23]. Known side effects of sedative hypnotics include disorientation, listlessness, headache, fatigue, amnesia, and muscle relaxation [24]. Many reports have indicated that sedative hypnotics are related to fall rates [8, 12, 18]. The use of high-dose sedative hypnotics in the elderly seems to be associated with an increased fall risk due to a carry-over effect caused by the increased half-life of the drug associated with the patients' poor hepatic and renal function. Sedative hypnotics are included in the National Institute of Public Health (Japan) list of "drugs which should generally be avoided in the elderly, irrespective of disease" [25], based on the Beers Criteria for Potentially Inappropriate Medication Use in Older Adults [26], due to the increased risk of falls and bone fractures. These drugs include short-, long-, and super-long-acting benzodiazepines and flunitrazepam. The omega-1 selective sedative hypnotic zolpidem is considered to be associated with a low risk of falls due to its weak muscle relaxant action, but has also been reported to be associated with a higher fall rate than some other sedative hypnotics [27]. Flunitrazepam (2mg) was the most-often prescribed drug associated with falls in the high-dose group (six cases). Flunitrazepam is an intermediate-acting benzodiazepine; treatment with a dosage of 1mg/day is recommended for the elderly based on the drug's side effects (e.g. disorientation) noted in the package insert. It is also known to have a high rate of carry-over due to its long half-life [28]. Therefore, the falls in this study may have been caused by this carry-over effect-induced sedative and hypnotic and muscle relaxant action. A significantly higher rate of falls was found in the high-dose group, indicating that high-dose prescriptions of sedative hypnotics may have

caused these falls. Thus, gradually increasing the dosage and not exceeding the maximum recommended dose may prevent falls in the elderly.

Regarding fall-induced physical injury, 24% of patients were reported to have developed serious complications, and 4% experienced bone fractures [29]. A fall incident can thus necessitate an extended hospital stay and longer treatment, leading to increased medical costs. The annual additional medical cost caused by falls has been reported as being as high as ¥7 million [30]. From a medical economy standpoint, fall prevention is crucial, given the potential increase in medical costs in Japan. In this study, the micro-costing method was used to estimate the potential cost reductions through fall prevention. Drug costs, testing fees, and labor costs incurred by falls of patients with high-dose prescriptions of sedative hypnotics were analyzed. In our study, the total cost was ¥24,746, which is a cost of ¥589 per case. Kobayashi *et al.* calculated the medical costs for drugs, testing, and additional hospital days associated with falls from 28 incidents of falls in a year of reported cases [31]. They reported a mean cost of ¥9,435 (¥2,040–42,970). In the present study of nine cases, a mean cost of ¥2,750 per person was calculated in fall-related additional costs, which is lower than the figure reported by Kobayashi *et al.* This is probably because in this study, none of the patients experienced serious injuries such as bone fractures; only external injuries such as scrapes were sustained, leading to a lower estimate of fall-based additional costs.

Conclusions

This study indicates the possibility that high-dose prescriptions of sedative hypnotics in elderly in-patients are related to fall risk. Cost analysis revealed potential cost reductions of ¥589 per case through fall prevention by correcting high-dose prescriptions in the elderly in-patients. In conclusion, these data indicate that corrections of high-dose prescriptions of sedative hypnotics by hospital pharmacists would be useful in terms of medical safety and medical economy.

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