Japanese Journal of Comprehensive Rehabilitation Science (2017)

Original Article

Investigation of factors involved in patient falls during the early stage of hospitalization in a *Kaifukuki* rehabilitation ward

Toshio Teranishi, RPT, PhD,[1] Izumi Kondo, MD, PhD,[2] Yuko Okuyama, RPT,[3] Genichi Tanino, RPT, PhD,[3,4] Hiroyuki Miyasaka, OTR, PhD, [1,3] Shigeru Sonoda, MD, PhD [3,4,5]

[1]School of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan
[2]National Hospital for Geriatric Medicine, Obu, Aichi, Japan
[3]Fujita Health University Nanakuri Memorial Hospital, Tsu, Mie, Japan
[4]Fujita Memorial Nanakuri Institute, Fujita Health University, Tsu, Mie, Japan
[5]Department of Rehabilitation Medicine Ⅱ, School of Medicine, Fujita Health University, Toyoake, Aichi, Japan

ABSTRACT
Teranishi T, Kondo I, Okuyama Y, Tanino G, Miyasaka H, Sonoda S. Investigation of factors involved in patient falls during the early stage of hospitalization in a *Kaifukuki* rehabilitation ward. Jpn J Compr Rehabil Sci 2017; 8: 10−15.
Objective: To investigate factors affecting the occurrence of falls during the early stage of hospitalization in a *Kaifukuki* (convalescence) rehabilitation ward.
Methods: The subjects were 545 hospitalized patients, divided into a fall group (having experienced a fall within 14 days following admission) and a non-fall group. Differences between the two groups in terms of the Standing Test for Imbalance and Disequilibrium (SIDE) level and in the subscales of the Functional Independence Measure (FIM) were investigated. Logistic regression was carried out on items for which there were significant differences between the groups as dependent variables and the occurrence of falls as the objective variable, and the odds ratios were computed.
Results: The fall group comprised 36 subjects. Significant differences between groups were found in the SIDE level, lower body dressing, bath transfer, stairs, social interaction, problem solving, and memory. Logistic regression only identified problem solving as associated with the occurrence of falls (odds ratio, 0.288; p=0.035). For the SIDE level, complete separation of non-fall subjects was seen at levels of 2b or higher.
Conclusion: Falls in the early stage following admission do not occur among individuals with good balance, and problem solving according to the FIM is involved in falls.
Key words: *Kaifukuki* rehabilitation ward, fall, determinant

Correspondence:Toshio Teranishi, RPT, PhD
School of Health Sciences, Fujita Health University, 1−98, Dengakugakubo, Kutsukake-cho, Toyoake, Aichi 470−1192, Japan. E-mail:teranisi@fujita-hu.ac.jp
Accepted: December 29, 2016.
COI:The authors have no conflicts of interest to declare.

Introduction

The *Kaifukuki* (convalescence) rehabilitation ward is a hospital ward in which a comprehensive team of specialist healthcare professionals provides intensive rehabilitation [1]. Less variation is present in the environment of the *Kaifukuki* rehabilitation ward than in the living environment of the individual, and patients are able to expand the range of everyday activities as functional disorders or reduced abilities improve through rehabilitation in a suitable environment.

The increase in the range of everyday activities resulting from improved abilities often conflicts with ensuring safety, specifically with avoiding falls. Thus, some variation exists, and falls can occur more readily in the *Kaifukuki* rehabilitation ward than in general hospital wards [2, 3]. During the early stage following admission to the *Kaifukuki* rehabilitation ward, appropriate measures to prevent falls that correspond to the disability status of the patient can be difficult to put in place while a detailed evaluation from the rehabilitation team remains incomplete. In addition, this is a period in which falls have a greater frequency of occurrence because the patient is not used to the new environment or their physical disability [4, 5]. The frequency of falls is reportedly significantly greater during the first 15 days of hospitalization than during any other period, even when adjustments are made for the number of patients hospitalized [5].

The occurrence of falls can lead to post-fall syndrome in patients [6], and the resulting fear of falling again [7] and anxiety can hinder increases in

doi.org/10.11336/jjcrs.8.10

the range of everyday activities [8], thus delaying the progress of rehabilitation. It is therefore important to be able to reasonably estimate the risk of falling in the early stage following admission to a *Kaifukuki* rehabilitation ward, and at the same time propose methods for managing this risk [5, 9].

To date, numerous attempts have been made to estimate the risk of falls in hospital wards[10–13]. In many of these studies, the factors involved in falls are given a numerical weighting, the risk is scored by adding the factors, and a cutoff value is determined. However, the predictive accuracy of such tools depends on the environment in which they are applied, and at least one study has reported that they are currently no better than the clinical decisions made by the nursing staff [14]. Such tools thus do not always give adequate results. Another problem is that these tools add together fall-related factors that vary in nature, so while individuals may have the same numerical risk score, the combinations of factors involved in falls may differ. Linking these tools directly to countermeasures is thus difficult.

The objective of the present study was to investigate the factors necessary for evaluating the risk of falling by clarifying the main factors influencing the occurrence of falls within the first 14 days following admission to a *Kaifukuki* rehabilitation ward. For this, the odds ratios were determined through logistic regression analysis using the explanatory variables of the subscales of the Functional Independence Measure (FIM) [15], an evaluation of the degree of independence in activities of everyday life, and the Standing Test for Imbalance and Disequilibrium (SIDE) [9], which is a simple evaluation of balance, at the time of admission to the *Kaifukuki* rehabilitation ward.

Methods

The subjects were 545 individuals (mean age, 66.7±15.3 years), comprising 301 men (mean age, 64.4±14.3 years) and 244 women (mean age, 69.5±16.1 years) out of the total of 547 patients admitted to the 108-bed *Kaifukuki* rehabilitation ward during the period between July 1, 2011 and June 30, 2012. Two patients were excluded due to missing FIM data.

The items surveyed were diagnosis, gender, age on admission, FIM at the time of admission, SIDE level at the time of admission, and whether the patient had fallen within 14 days after admission. The period for surveying the incidence of falls was set at 14 days (2 weeks) because the results in the literature show that the incidence of falls is significantly greater in the 15 days following admission [5], and also taking into account specificity for certain days of the week. The definition of a fall for the present survey was "a situation where part of the body other than the soles of the feet makes contact with the floor or the ground when this is not intended" [16].

The FIM is an evaluation of the degree of independence in activities of daily living, comprising a motor subscale of 13 items and a cognition subscale of 5 items. The score has 7 steps: 7 indicates complete independence; 6 indicates modified independence with concern for time and safety, requiring devices and time; 5 indicates supervision (patient can carry out more than 90% of the cognitive items alone); 4 indicates that the patient can carry out over 75% of the items alone (75–90% of the cognitive items carried out alone); 3 indicates that the patient can carry out 50–74% of the items alone; 2 indicates that the patient can carry out 25–49% of the items alone; and 1 indicates a need for total assistance, in which the patient can carry out fewer than 25% of the items alone.

The SIDE is a simple balance evaluation that can be administered at the bedside. A flow chart for determining the patient's level is shown in Figure 1.

The breakdown of diagnoses for the 545 subjects is as follows: cerebral stroke in 396 (cerebral infarction, n=195; cerebral hemorrhage, n=171; subarachnoid hemorrhage, n=30); traumatic brain injury in 17; spinal cord disorder in 45; lower limb fracture in 44; and other in 43. Mean scores at the time of hospitalization were 49.2±24.7 for the total of FIM motor subscales and 23.0±9.5 for the total of FIM cognitive subscales. Subjects were divided into a fall group, who had fallen within 14 days of admission, and a non-fall group, who had not fallen.

Next, to determine the dependent variables for logistic regression with the occurrence of a fall as the objective variable, differences in SIDE level between the fall and non-fall groups were investigated using Fisher's exact test, and differences in FIM subscale items were investigated using the Mann-Whitney U-test.

Cutoff values for variables with a significant difference between the fall and non-fall groups were determined using the Youden index.

To eliminate the problem of multicollinearity, the Kendall rank correlation coefficient between each variable was investigated. Where the coefficient was 0.7 or greater, the item having a higher correlation with the occurrence of falls was selected as a dependent variable.

In addition, where there was a complete separation of subjects who fell, the variable was eliminated from the dependent variables to avoid distorting the logistic regression results in the same way as the multicollinearity problem [17].

Odds ratios were computed by logistic regression using the selected dependent variables. Statistical analysis was performed using SPSS Statistics Version 23, and the significance level was set at 0.05.

The present study was approved by the Ethics Committee of Fujita Health University Nanakuri Sanatorium (Nanakuri Ethics No. 88).

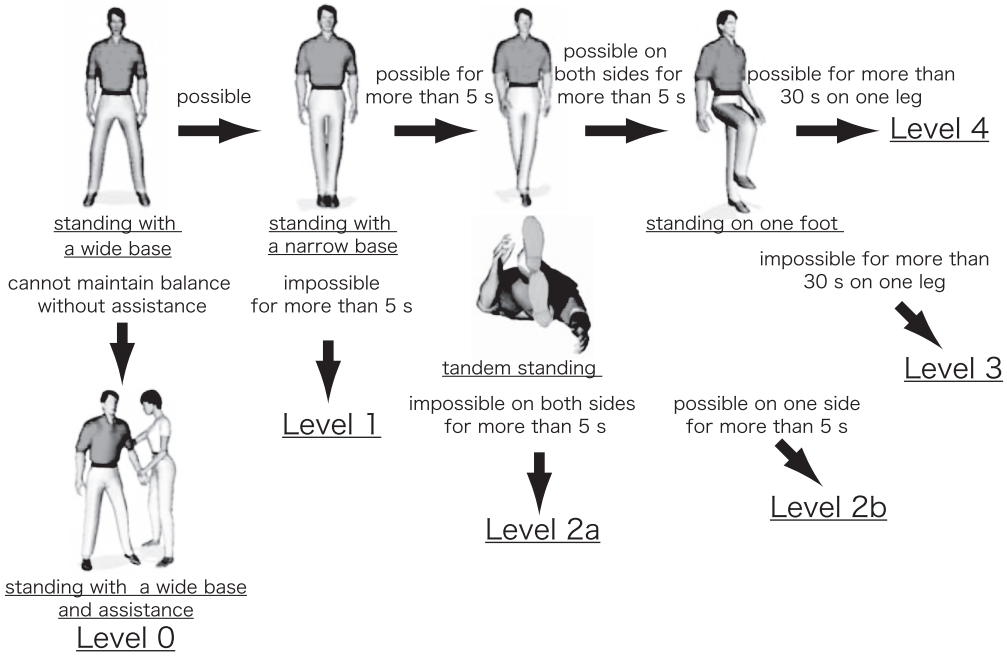

Figure 1. Flowchart to determine the level of SIDE.
The levels are arranged in order of difficulty; more levels should not be included once a subject loses balance at a certain level and requires assistance. As the level of difficulty in the test increases, the risk of falling increases.
Level 0: A standing position with a wide base cannot be maintained without assistance. Support provided by grasping something or being assisted by a caregiver is always required to maintain a standing position.
Level 1: A standing position with a wide base can be maintained without assistance, but standing with a narrow base cannot be maintained for more than 5 s. Balance is lost in a standing position with a narrow base: bringing the legs close together such that the feet are in contact with each other medially at both the heel and forefoot.
Level 2a: A standing position with a narrow base can be maintained for more than 5 s, but a tandem standing position cannot be maintained for more than 5 s with either leg position. The tandem standing position involves standing with the heel of one foot placed at the toe of the other foot, in a straight line (either foot may be in front).
Level 2b: A tandem standing position can be maintained for more than 5 s with one but not the other leg in the leading position.
Level 3: A tandem standing position can be maintained for more than 5 s with either leg in front, but standing on one leg is difficult to maintain for more than 30 s with either leg.
Level 4: A position of standing on one leg can be maintained for more than 30 s with either leg.

Results

Of the 545 subjects, 36 subjects experienced a fall within the first 14 days following admission (fall group). The non-fall group thus comprised 509 subjects, and the rate of fall occurrence was 36/545× 14 (4.72 ‰).

The differences between the two groups in SIDE level and FIM subscale items are shown in Table 1. Significant differences were found in the SIDE level (p=0.021) and in the following FIM subscale items: lower body dressing (p=0.018), bath transfer (p= 0.010), stairs (p=0.012), social interaction (p=0.018), problem solving (p=0.01), and memory (p=0.07).

Cutoff values for the 7 items showing significant differences between groups were determined using the Youden index. For the SIDE level, the cutoff was between 2a and 2b. For the FIM subscale items, the cutoff values were: lower body dressing, between 5 and 6; bath transfer, between 4 and 5; stairs, between 3 and 4; social interaction, between 4 and 5; problem solving, between 3 and 4; and memory, between 5 and 6.

To eliminate the problem of multicollinearity in the logistic regression, the correlation between the 7 items with significant differences between groups and the occurrence of falls was investigated using the Kendall rank correlation coefficient. The results are shown in Table 2.

The only items with a correlation coefficient of ≥0.7 were lower body dressing/bath transfer (0.715). The

Table 1. Comparison of SIDE level and subsale items of FIM between Fall group and Non-Fall group.

		SIDE level	Eating	Grooming	Bathing	Upper body dressing	Lower body dressing	Toileting	Bladder management	Bowel management	Bed trunsfer
Fall group (n=36)	median (interquartile range)	0 (1)	5 (2)	5 (6)	2 (2)	3 (4)	2 (3)	2 (3)	3 (4)	3 (5)	3 (1)
	mean (standard deviation)	—	4.8 (1.8)	4.1 (1.9)	2.3 (1.6)	3.0 (1.7)	2.5 (1.7)	2.6 (1.7)	3.5 (2.3)	3.6 (2.4)	3.6 (1.1)
Non-Fall group (n=509)	median (interquartile range)	1 (3)	5 (4)	5 (4)	2 (4)	4 (6)	3 (6)	3 (4)	5 (6)	5 (6)	4 (3)
	mean (standard deviation)	—	4.8 (2.2)	4.3 (2.2)	2.9 (2.1)	3.7 (2.2)	3.5 (2.3)	3.4 (2.3)	4.2 (2.7)	4.3 (2.6)	3.9 (2.0)
p-Value	—	0.01	0.35	0.44	0.12	0.05	0.02	0.05	0.17	0.12	0.13

		Toilet transfer	Bath trunsfer	Ambulatory	Stairs	Cognitive comrehension	Expression	Social interaction	Problem solving	Memory
Fall group (n=36)	median (interquartile range)	3 (1)	1 (2)	3 (1)	1 (1)	5 (3)	4 (2)	4 (6)	2 (1)	3 (3)
	mean (standard deviation)	3.4 (1.3)	2.0 (1.3)	2.9 (1.1)	1.7 (1.1)	4.5 (1.8)	4.4 (1.8)	4.4 (2.0)	2.8 (1.7)	3.3 (1.8)
Non-Fall group (n=509)	median (interquartile range)	4 (4)	2 (4)	3 (4)	1 (3)	5 (4)	5 (4)	5 (4)	4 (4)	5 (6)
	mean (standard deviation)	3.8 (2.1)	2.8 (1.9)	3.5 (2.0)	2.6 (1.9)	5.0 (1.9)	4.8 (2.0)	5.0 (2.2)	4.0 (2.3)	4.2 (2.2)
p-Value	—	0.11	0.01	0.15	0.01	0.06	0.10	0.02	0.00	0.01

variable showing a higher correlation with the occurrence of falls was bath transfer, which was therefore selected for use as a dependent variable.

With the SIDE level, complete separation of non-fall subjects was seen at level 2b and higher (Figure 2). As a result, SIDE level was excluded from the dependent variables.

Logistic regression was carried out with the 5 FIM items of bath transfer, stairs, social interaction, problem solving, and memory binarized by the cutoff value as dependent variables and occurrence of falls as the objective variable. The results are shown in Table 3. Of the 5 variables, only problem solving statistically affected the occurrence of falls (odds ratio=0.292; p= 0.038).

Discussion

A large proportion of stroke patients were in the hospital ward in the present study, comprising 398 of the 545 subjects (73%). With regard to efforts to prevent falls, the need to determine permitted actions and the need for monitoring, sensors, or restraints is discussed and decided by a team of specialists.The rate of fall occurrence within 14 days of hospitalization was 4.72% in the present study, lower than the 13.9% rate of fall occurrence in *Kaifukuki* rehabilitation wards reported by Tsuchida [18].

SIDE and FIM, which were used as explanatory variables in the present study, are methods of testing with clear criteria. The reliability and validity of these tools have been verified. SIDE is a method devised for discriminative evaluation of the ability to maintain balance in a static standing position that allows simple assessment of a patient immediately after admission to a ward [9]. On the other hand, FIM was developed as an evaluation of the ability to carry out activities of daily living, and the assessment requires a grasp of the status of everyday activities. The assessment of cognitive items in particular included a period of observation, and took several days following admission.

FIM motor subscales with significant differences between the fall and non-fall groups were lower body dressing, bath transfer, and stairs. These items have a high degree of difficulty, and are also items for which the score is affected by the ability to maintain balance. In the FIM cognition subscales, social interaction, problem solving, and memory showed significant differences between the two groups. Falls likely involved the metacognitive ability to “understand the influence of your own words,” which is included in the social interaction subscale; “How do you deal with your needs?” which is included in problem solving; and “Do you remember the agreement on limits to behavior?” which is included in the memory subscale. In addition, a significant difference in SIDE level was found between the fall and non-fall groups. Although there was one case with missing values, none of the

Table 2. Correlation between Variables (Kendall rank correlation coefficient).

	Fall or Non-Fall	SIDE level	Lower body dressing	Bath trunsfer	Stairs	Scial interaction	Provlem solving	Memory
Fall or Non-Fall	1.000	−0.148**	−0.132**	−0.131**	−0.131**	−0.130**	−0.201**	−0.136**
SIDE level		1.000	0.583**	0.592**	0.661**	0.229**	0.349**	0.290**
Lower body dressing			1.000	0.715**	0.620**	0.303**	0.445**	0.414**
Bath trunsfer				1.000	0.614**	0.281**	0.389**	0.365**
Stairs					1.000	0.277**	0.353**	0.316**
Social interaction						1.000	0.664**	0.644**
Problem solving							1.000	0.603**
Memory								1.000

**p<0.01, *p<0.05.

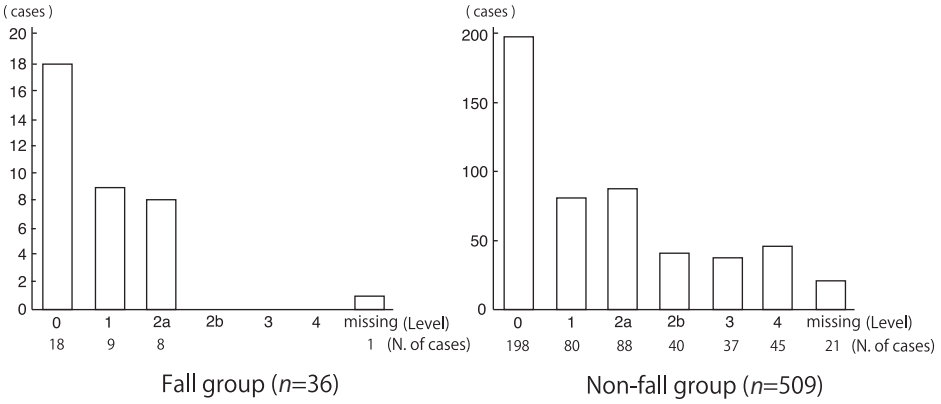

Figure 2. SIDE level of Fall group and Non-fall group.

Table 3. Logistic regression analysis for fall event.

	Wald	p-Value	Odds ratio	95% Confidence interval of Odds ratio	
				Lower	Upper
Lower body dressing	1.006	0.316	0.319	0.034	2.973
Stairs	1.190	0.275	0.526	0.166	1.668
Social interaction	0.001	0.970	0.985	0.450	2.155
Problem solving	4.316	0.038	0.292	0.092	0.933
Memory	0.141	0.708	0.745	0.160	3.469
Constant	55.691	0.000	0.155		

Hosmer-Lemeshow test, χ^2=2.76, p=0.838.

subjects with a SIDE level of 2b or higher experienced a fall. This suggests that individuals with a high SIDE level are less likely to fall.

In the logistic regression analysis, problem solving was identified as a factor affecting falls, and there is a likely involvement of problem solving items relating to metacognition and behavioral control disorders, such as "ask for the necessary care when making transfers," "ask for help to clean up spilt milk," "realize that you will fall if you attempt to get out of the wheelchair unaided," "use the call button when help is needed," "ask to be taken to the toilet if you want to go when sitting in bed," and "remember agreements." Studies to date that have investigated factors involved in falls using FIM subscales have reported the involvement of moving and problem solving [4, 19], and the results of the present study support such findings.

The causes of falls can generally be classified into internal factors relating to the patient's physical and mental condition, such as paralysis, visual impairment, or reduced ability to maintain balance, and external factors relating to the environment, such as footwear that comes off easily, steps, slippery floors, etc. However, the internal factors of physical and mental function play a greater part in an environment optimized for rehabilitation training, such as the *Kaifukuki* rehabilitation ward. Among the internal factors relating to falls, the ability to maintain balance is considered of paramount importance [20]. For

example, even a patient with dementia will not fall if their balance is good. In the present analysis, although values were missing for one case, no falls were seen among patients with an SIDE level of 2b or higher (patients able to maintain the tandem stance for≥5 s). Patients with good balance do not readily fall, implying that such patients may be able to be excluded from the evaluation of falling risk.

In addition, a tendency to fall was seen among individuals who did not know what actions they could safely perform without causing a fall because of deteriorated metacognition regarding their own balance ability, which is a problem-solving criterion for carrying out daily activities without falling. There was likewise a tendency to fall among individuals with reduced cognitive abilities regarding their environment, individuals who were unable to abide by agreements on behavior restriction, and individuals for whom constraints were ineffective even though they understood the danger.

To reduce falls during the early stage of hospitalization, there is a need for an assessment tool that combines a simple evaluation of the ability to maintain balance with a simple evaluation that allows measurement immediately after admission of metacognition relating to the ability to maintain balance and control of impulsivity, which are included in the FIM problem solving subscale.

A limitation of the present study was the retrospective nature of the study undertaken only at a single facility. In addition, the number of variables in the logistic regression was somewhat large in relation to the number of events, so the results may not be robust. Thus, there is a need for a prospective study at multiple facilities in the future.

Acknowledgments

The authors would like to thank the rehabilitation stuffs of the Nanakuri Memorial hospital.

References

1. Kaifukuki Rehabilitation Ward Association. Available from: http://www.rehabili.jp/ visitor.html (cited 2016 April 4).
2. Forrest G, Huss S, Patel V, Jeffries J, Myers D, Barber C, et al. Falls on an inpatient rehabilitation unit: risk assessment and prevention. Rehabil Nurs 2012; 27: 56–61.
3. Gilewski MJ, Roberts P, Hirata J, Riggs R. Discriminating high fall risk on an inpatient rehabilitation unit. Rehabil Nurs 2007; 32: 234–40.
4. Suzuki T, Sonoda S, Misawa K, Saitoh E, Simizu Y, Kotake T. Incidence and consequence of falls in inpatient rehabilitation of stroke patients. Exp Aging Res 2005; 31: 457–69.
5. Teranishi T, Kondo I, Tanino F, Miyasaka H, Sakurai H, Kaga J, et al. An analysis of falls occurring in a convalescence rehabilitation ward a decision tree classification of fall cases for the management of basic movements. Jpn J Compr Rehabil Sci 2013; 4: 7–13.
6. Murphy J, Isaacs B. The post-fall syndrome: a study of 36 elderly patients. Gerontology 1982; 28: 265–70.
7. Bhala RP, O'Donnell J, Thoppil E. Ptophobia: phobic fear of falling and its clinical management. Phys Ther 1982; 62:187–90.
8. Tinetti ME, Powell L. Fear of falling and low self-efficacy: a case of dependence in elderly persons. J Gerontol 1993; 48: 35–8.
9. Teranishi T, Kondo I, Sonoda S, Kagaya H, Wada Y, Miyasaka H, et al. A discriminative measure for static postural control ability to prevent in-hospital falls: reliability and validity of the Standing Test for Imbalance and Disequilibrium (SIDE). Jpn J Compr Rehabil Sci 2010; 1: 11–6.
10. Oliver D, Britton M, Seed P, Martin FC, Hopper AH. Development and evaluation of evidence based risk assessment tool (STRATIFY) to predict which elderly inpatients will fall: case-control and cohort studies. BMJ 1997; 315: 1049–53.
11. Nakagawa Y, Sannomiya K, Ueda A, Sawaguti Y, Kinoshita M, Yokoyama H, et al. Incidence and consequence of falls among stroke rehabilitation inpatients in convalescent rehabilitation ward: data analysis of the fall situation in multi-institutional study. Jpn J Rehabil Med 2010; 47: 111–9.
12. Morse JM, Morse RM, Tylko SJ. Development of a scale to identify the fall-prone patient. Can J Aging 1989; 8: 366–7.
13. Hendrich AL, Bender PS, Nyhuis A. Validation of the Hendrich II Fall Risk Model: a large concurrent case/control study of hospitalized patients. Appl Nurs Res 2003; 16: 9–21.
14. Haines TP, Hill K, Walsh W, Osborne R. Design related bias in hospital fall risk scoring tool predictive accuracy evaluations: systematic review and meta-analysis. J Gerontol 2007; 62: 664–72.
15. Liu M, Sonoda S, Domen K. Functional evaluation of stroke patients. In: Chino N, editor. Functional Evaluation of Stroke Patients. Tokyo: Springer-Verlag Tokyo; 1997. p. 52–96. Japanese.
16. Gibson MJ. Falls in later life. Improving the Health of Older People; A World View. New York: Oxford University Press; 1990. p. 296–315.
17. Uchida O. Logistic regression analysis with SPSS. Tokyo: Ohmsha; 2012. p. 119–20. Japanese.
18. Tsuchida S. Present state of fall prevention in our hospital—comparison between acute care ward and kaifukuki rehabilitation ward—. Osteoporosis Jpn 2007; 15: 33–4. Japanese.
19. Forrest G, Chen E. Efficient assessment of risk of fall. Rehabil Nurs 2016; 41: 1–6.
20. Teranishi T. Fall risk screening of elderly inpatients and fall prevention. MD Med Reha 2014; 170: 47–53. Japanese.