Exploring Risk Factors of Patient Falls: A Retrospective Hospital Record Study in Japan

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Patient falls are common adverse medical events in hospitals. The objectives of this study were to clarify the factors of patient falls at hospitalization or transfer to another ward, which could be assumed that patients experience new environment. Patients who were hospitalized or transferred to another ward at a hospital in Japan, between January 14 and February 14, 2014 were included. We used a risk assessment sheet and applied stepwise regression analysis to identify factors of patient falls. We also investigated changes in patient conditions on the risk assessment sheet by the chi-square test. A total of 1,362 patients (53.2% female; mean age, 57.1 ± 18.0 years) were eligible for analysis, and 38 (2.8%) fell during the study period. The fallers were significantly older than the non-fallers (63.8 ± 18.0 vs. 56.9 ± 18.7 years, P = 0.03), but no significant difference was seen in sex (55.3% vs. 53.1% female). “History of falls”, “Tubes inserted”, “Need assistance/supervision for toileting” and “Excretion more than two times per night” were significantly related to patient falls (adjusted odds ratios [95% confidence interval]: 2.41 [1.05-5.53], 3.64 [1.57-8.43], 4.52 [2.00-10.23] and 3.92 [1.38-11.09]). Among 30 fallers, “Overestimation or non-understanding of own physical abilities” was significantly more frequent after falls (30.0%) than before falls (6.7%, P = 0.02). The factors found in this study might be useful for identifying patients at higher risk of falls.

Keywords: falls; hospital; inpatients; risk assessment; safety

Introduction

Patient falls are often preventable. However, patient falls remain one of the major causes of death and severe morbidity in hospitals (Institute of Medicine (US) Committee on Quality of Health Care in America et al. 2000; Fields et al. 2015). Patient falls represent 69.3% of adverse medical events (Fagin and Vita 1965), with a rate of about 2.3 to 17.1 per 1,000 patient days (Hitcho et al. 2004; Galbraith et al. 2011). Patient falls also cause a considerable financial burden on the health care system (Institute of Medicine (US) Committee on Quality of Health Care in America et al. 2000; Fields et al. 2015). About 30% of patients who fall suffer injuries and 6% develop severe morbidity (Hitcho et al. 2004; Nadkarni et al. 2005; Bradley 2011). Therefore, prevention of patient falls in healthcare facilities is crucial to ensure patient safety.

National patient safety programs implemented in a number of countries have led to a decrease in the occurrence of patient falls (Baines et al. 2015). Although a safety project was introduced in Japan in 2000 (http://ndpjapan.org/; last accessed: December 19, 2015), the prevention of patient falls was not a high priority; therefore, the optimal strategy for prevention of patient falls in Japan remains unclear. Some hospitals outside of Japan have implemented risk assessment strategies to prevent patient falls (Chu et al. 2015). Similar strategies for institutionalized elderly people have been implemented in Japan (Izumi et al. 2002); however, to our knowledge, current assessment strategies are not available for patients from a wide age range across all hospital departments. Moreover, it remains unclear whether factors of patient falls change between before and after
Table 1. Risk assessment sheet for patient falls.

| Risk Assessment Sheet for Falls | No. |
|--------------------------------|-----|
| ID: __________ Name: __________ Age: __________ Sex: male/female |

- **On the day of hospitalization**: □ □ □ □
- **On the day of transfer to another ward**: □ □ □ □
- **On the day of the fall**: □ □ □ □

*You may write additional information in the blank space to the right of each column.*

| History of falls | Patient has fallen within one year before admission |
|-----------------|---------------------------------------------------|
| **Lifestyle**   | Patient sleeps on a futon (not a bed) at home |
| **Condition**   | Within three days from the day of hospitalization or transfer from another ward |
|                 | Within three days after surgery |
|                 | Fever (≥ 38°C) |
|                 | Anemia (Hb ≤ 8 mg/dL) |
|                 | Dizziness (orthostatic hypertension) |
|                 | Tubes inserted |
|                 | Condition or activities of daily living got better or worse rapidly |

| Physical activity | Need assistance/supervision to walk |
|-------------------|-----------------------------------|
|                   | Need assistance/supervision to transfer |
|                   | Need assistance/supervision for toileting |

| Motor function | Muscle weakness of leg (being unsteady while standing) |
|----------------|--------------------------------------------------------|
|                 | Paralysis (unable to intentionally move limbs due to neurological disorder) |
|                 | Parkinsonism symptoms (particularly bradykinesia or postural instability) |
|                 | Deformed/contracted bones/joints |

| Sensory function | Hearing loss (poses an obstacle to communication) |
|------------------|--------------------------------------------------|
|                  | Vision impairment (poses an obstacle to daily life) |
|                  | Balance disturbance (dizziness resulting from inner ear disorder) |
|                  | Numbness and hyperesthesia of leg |

| Cognitive function | Unable to call nurse call due to impaired cognitive function |
|--------------------|----------------------------------------------------------|
|                    | Consciousness disorder, delirium |
|                    | Diminished attention (inattention, lack of concentration due to problems with cognitive function) |
|                    | Overestimation or non-understanding of own physical abilities |
|                    | Cognitive dysfunction (dementia or suspected dementia) |
Risk Factors for Patient Falls

**Table 1. Continued.**

| Behavioral psychology                              | Diminished attention with anxiety (no problems with cognitive function) | □ | □ | □ | □ |
|---------------------------------------------------|-------------------------------------------------------------------------|---|---|---|---|
|                                                   | Hesitating/resisting to be treated (patient does not call for a nurse) | □ | □ | □ | □ |
| Treatment                                         | Under radiation therapy                                                | □ | □ | □ | □ |
|                                                   | Narcotic use (injections, internal, patch, or other)                    | □ | □ | □ | □ |
|                                                   | Using psychotropics (sedative, tranquilizer, psychotropic, antidepressant, anxiolytic, anticonvulsant) | □ | □ | □ | □ |
|                                                   | Using analgesics (regular or single use of injections/ internal medicine) | □ | □ | □ | □ |
|                                                   | Under or after chemotherapy                                            | □ | □ | □ | □ |
|                                                   | Laxative use (regular or single, enema)                                | □ | □ | □ | □ |
|                                                   | Diuretic use (regular or single)                                       | □ | □ | □ | □ |
|                                                   | Tube insertion (including non-continuous cases)                         | □ | □ | □ | □ |
| Sleep                                             | Difficulty initiating sleep (require more than one hour to fall asleep, have trouble sleeping) | □ | □ | □ | □ |
|                                                   | Nocturnal awakening (constantly waking up throughout the night after falling asleep) | □ | □ | □ | □ |
|                                                   | Day-night reversal (cannot sleep smoothly at night, dozes off during the day) | □ | □ | □ | □ |
| Excretion                                         | Incontinence (urine/feces)                                             | □ | □ | □ | □ |
|                                                   | Frequent urination (≥10 times/day)                                     | □ | □ | □ | □ |
|                                                   | Excretion more than two times per night (urine/feces)                   | □ | □ | □ | □ |
|                                                   | Use of a urinal (including temporary use)                              | □ | □ | □ | □ |
|                                                   | Use of a portable toilet (including temporary use)                     | □ | □ | □ | □ |
| Environment                                       | Difference in floor levels between bathroom and room                   | □ | □ | □ | □ |
|                                                   | Disorderly items around the bed                                        | □ | □ | □ | □ |

**Action needed to prevent falls** (Please check the most appropriate plan of action from items 1 through 3.)

1. Take fall prevention measures such as adding a surveillance monitor, adding a sensor to detect when the patient leaves the bed, or increasing the number of side rails

2. Improve observation by visiting the room and watching the patient when they are transferred or moved

3. No action needed

Signature of the individual who checked the assessment sheet each day

A risk assessment sheet applied in the present research is shown.
falls. Therefore, the objectives of this study were to clarify the factors of patient falls at hospitalization or transfer to another ward, and to compare patient conditions between before and after falls among fallers.

**Methods**

This study was conducted at Tohoku University Hospital, Japan. In addition to functioning as an educational institution, Tohoku University Hospital provides third-level medical care for both inpatients and outpatients. As of March 31, 2014, Tohoku University Hospital had 1,262 beds. Each department at Tohoku University Hospital routinely assesses the risk of patient falls at the following three time points using a risk assessment sheet: at hospitalization; after patient transfer to another ward; and on the day of any patient fall occurrence. Recently, the Working Group for the Prevention of Falls at Tohoku University Hospital developed a new risk assessment sheet. The new risk assessment sheet is composed of 45 assessment items and the following 12 main elements: “History of falls”, “Lifestyle”, “Condition”, “Physical activity”, “Motor function”, “Sensory function”, “Cognitive function”, “Behavioral psychology”, “Treatment”, “Sleep”, “Excretion”, and “Environment” (Table 1). The risk assessment sheet also includes a section regarding the required action plan for preventing patient falls. The action plan has the following three options: “Take fall prevention measures such as adding a surveillance monitor, adding a sensor to detect when the patient leaves the bed, or increasing the number of side rails”, “Improve observation by visiting the room and watching the patient when they are transferred or moved”, and “No action needed”. For the purposes of this study, the first two plans were regarded as “preventive action needed” and the third plan was regarded as “no preventive action needed”; these assessment data were then used to analyze factors associated with patient falls. The study protocol was approved by the institutional review board at Tohoku University Graduate School of Medicine.

This study included all patients who were hospitalized or transferred to another ward at Tohoku University Hospital between January 14 and February 14, 2014. For patients who were hospitalized or transferred more than once, we used the data from the first risk assessment sheet only. Observational period of patient falls was from January 14 to February 28, 2014. Patients whose fall risk was not assessed at hospitalization or transfer to another ward, and those whose assessment sheets had incomplete data regarding sex or age were excluded.

Although patient falls are recorded on the assessment sheets, we confirmed each case by checking the Tohoku University Hospital incident reports, which are generated as part of an institutional patient safety management system. The incident reporting system was created based on the 2002 Guidelines of the National University Hospital Medical Safety Management Council. In the guidelines, “incidents” are considered to encompass the following: 1) situations in which a patient was injured (with some exceptions); 2) situations in which a patient might have been injured; and 3) complaints from patients or families in relation to medical practice. More specific details regarding any reported incident include the following: a) failure of a medical device (e.g., medical equipment or materials); b) falls or slips; c) suicide or attempted suicide; d) discharge against medical advice; e) unexpected complications; f) delay in discovery and response (treatment); g) mistakes in relation to self-managed medication; and h) needlestick injuries or similar incidents. Ideally, as soon as an incident occurs, a report is completed by the involved party or the discoverer and turned in to a risk manager. The risk manager then confirms the content and returns it for clarification if anything is unclear. Once the risk manager accepts the report, it is turned in to a general risk manager. When the general risk manager judges the report as acceptable, the report is saved digitally. At Tohoku University Hospital, incidents are evaluated by several different committees, including the Medical Safety Promotion Committee, the Incident Response Committee, the Incident Deliberations Committee and the Medical Accident Investigation Committee. The Medical Safety Promotion Office organizes all of these committees and analyzes each case independently.

To analyze the patients’ characteristics and the results at first assessment, we used the chi-square test, Fisher’s exact test, or the t test appropriately. At first, analysis was performed for all patients, and then stratified according to whether preventive action was needed. To identify factors of patient falls, we conducted stepwise regression analysis using age, sex, and any items that were significantly different between fallers and non-fallers in bivariate analysis as confounders. Among fallers, we also used the chi-square test to compare items of the risk assessment sheet between before and after falls. SAS (version 9.4, SAS Institute, Inc., Cary, NC, USA) was used for statistical analysis.

**Results**

During the study period, fall risk was assessed in 1,391 patients. A total of 27 patients were excluded because their fall risk was not assessed at hospitalization or transfer to another ward, and two patients were excluded due to incomplete data regarding sex or age. Therefore, 1,362 patients (53.2% female; mean age, 57.1 ± 18.0 years) were eligible for analysis. Among these patients, 108 (7.9%) had a history of falls, and 38 (2.8%) fell during the study period. None of the fallers died or suffered fracture. Out of 38 fallers, 18 of them had tumor. The following diagnostic diseases had two fallers for each: cirrhosis, abdominal aortic aneurysm, pneumonia, and diabetes mellitus. Ten fallers had one of the following: pancreatitis, sepsis, pharyngolaryngitis, knee osteoarthritis, chronic kidney disease, supra-nuclear palsy, cerebral palsy, stroke, ischemic heart disease, or disuse syndrome. Two fallers’ diagnoses were not reported. The fallers were significantly older than the non-fallers (63.8 ± 18.0 vs. 56.9 ± 18.7 years, respectively; P = 0.03) (Table 2), but no significant difference was seen in regard to sex (55.3% vs. 53.1% female, respectively; P = 0.8) (Table 2). The most significant difference between fallers and non-fallers on the risk assessment sheets at first assessment was “Need assistance/supervision for toileting” (42.1% vs. 7.3%, respectively; P < 0.01). No patients in either group were assessed as “Disorderly items around the bed”.

Preventive action was needed for 178 (13.1%) patients, and 18 (10.2%) of them fell during the study period. In contrast, 20 (1.7%) of 1,184 patients whose preventive action was not necessary fell (Table 3). Among all patients needing or not needing preventive action, a significant difference was observed between fallers and non-fallers for
### Table 2. Patients' characteristics and conditions at first assessment.

|                          | Non-fallers (N = 1,324) | Fallers (N = 38) | P       |
|--------------------------|-------------------------|-----------------|---------|
| **Age, years**           | 56.9 ± 18.7             | 63.8 ± 18.0     | 0.03    |
| **Sex (female)**         | 703 (53.1)              | 21 (55.3)       | 0.8     |
| **History of falls**     | 99 (7.5)                | 9 (23.7)        | < 0.01  |
| **Life style**           | Sleeps on a “futon” (not a bed) at home | 207 (15.6) | 8 (21.1) | 0.4 |
|                         | Within three days from the day of hospitalization or transfer from another ward | 1270 (95.9) | 29 (76.3) | < 0.01 |
| **Condition**            | Within three days after surgery | 32 (2.4) | 7 (18.4) | < 0.01 |
|                         | Fever                    | 23 (1.7)        | 1 (2.6) | 0.5 |
|                         | Anemia                   | 23 (1.7)        | 0       | 1.0 |
|                         | Dizziness                | 27 (2.0)        | 3 (7.9) | 0.048 |
|                         | Tubes inserted           | 95 (7.2)        | 14 (36.8) | < 0.01 |
|                         | Condition or ADL got better or worse rapidly | 51 (3.9) | 7 (18.4) | < 0.01 |
| **Physical activity**    | Need assistance/supervision to walk | 137 (10.4) | 18 (47.4) | < 0.01 |
|                         | Need assistance/supervision to transfer | 125 (9.4) | 18 (47.4) | < 0.01 |
|                         | Need assistance/supervision for toileting | 96 (7.3) | 16 (42.1) | < 0.01 |
| **Motor function**       | Muscle weakness of leg   | 100 (7.6)       | 9 (23.7) | < 0.01 |
|                         | Paralysis                | 32 (2.4)        | 3 (7.9) | 0.07 |
|                         | Parkinsonism symptoms    | 16 (1.2)        | 1 (2.6) | 0.4 |
|                         | Deformed/contracted bones/joints | 33 (2.5) | 0 | 1.0 |
| **Sensory function**     | Hearing loss             | 48 (3.6)        | 3 (7.9) | 0.2 |
|                         | Vision impairment        | 70 (5.3)        | 5 (13.2) | 0.053 |
|                         | Balance disturbance      | 12 (0.9)        | 1 (2.6) | 0.3 |
|                         | Numbness and hyperesthesia of leg | 84 (6.3) | 6 (15.8) | 0.03 |
| **Cognitive function**   | Unable to call nurse call due to impaired cognitive function | 26 (2.0) | 3 (7.9) | 0.04 |
|                         | Consciousness disorder, delirium | 15 (1.1) | 1 (2.6) | 0.4 |
|                         | Diminished attention     | 38 (2.9)        | 4 (10.5) | 0.03 |
|                         | Overestimation or non-understanding of own physical abilities | 36 (2.7) | 2 (5.3) | 0.3 |
| **Behavioral psychology**| Diminished attention with anxiety | 23 (1.7) | 2 (5.3) | 0.2 |
|                         | Hesitating/resisting to be treated | 17 (1.3) | 3 (7.9) | 0.02 |
| **Treatment**            | Under radiation therapy  | 10 (0.8)        | 1 (2.6) | 0.3 |
|                         | Narcotic use             | 29 (2.2)        | 2 (5.3) | 0.2 |
|                         | Using psychotropics      | 85 (6.4)        | 5 (13.2) | 0.1 |
|                         | Using analgesics         | 69 (5.2)        | 7 (18.4) | < 0.01 |
|                         | Under or after chemotherapy | 58 (4.4) | 0 | 0.4 |
|                         | Laxative use             | 65 (4.9)        | 1 (2.6) | 1.0 |
|                         | Diuretic use             | 52 (3.9)        | 1 (2.6) | 1.0 |
|                         | Tube insertion           | 252 (19.0)      | 13 (34.2) | 0.03 |
| **Sleep**                | Difficulty initiating sleep | 54 (4.1) | 3 (7.9) | 0.2 |
|                         | Nocturnal awakening      | 38 (2.9)        | 4 (10.5) | 0.03 |
|                         | Day-night reversal       | 6 (0.5)         | 0       | 1.0 |
| **Excretion**            | Incontinence             | 40 (3.0)        | 6 (15.8) | < 0.01 |
|                         | Frequent urination       | 37 (2.8)        | 1 (2.6) | 1.0 |
|                         | Excretion more than two times per night | 46 (3.5) | 5 (13.2) | 0.01 |
|                         | Use of a urinal          | 24 (1.8)        | 1 (2.6) | 0.5 |
|                         | Use of a portable toilet | 19 (1.4)        | 1 (2.6) | 0.4 |
| **Environment**          | Difference in floor levels between bathroom and room | 18 (1.4) | 1 (2.6) | 0.4 |
|                         | Disorderly items around the bed | 0 | 0 | - |

ADL, activities of daily living.
Data are expressed as the mean ± standard deviation and n (%).
Risk of falls for patients who were hospitalized or transferred to the other ward first time during the study period was assessed and analyzed between fallers and non-fallers.
Table 3. Patients’ characteristics and condition at first assessment without/with the need for preventive action.

|                         | No preventive action needed | Preventive Action needed |
|-------------------------|-----------------------------|--------------------------|
|                         | Non-fallers (N = 1164) | Fallers (N = 20) | Non-fallers (N = 160) | Fallers (N = 18) |
| Age, years              | 55.7 ± 17.6                | 58.0 ± 21.4            | 65.5 ± 18.2                | 70.2 ± 12.9          |
| Sex (female)            | 621 (53.4)                 | 11 (55.0)             | 82 (51.3)                  | 10 (55.6)            |
| History of falls        | 68 (5.8)                   | 3 (15.0)              | 31 (19.4)                  | 6 (33.3)             |
| Life style              | Sleeps on a futon (not a bed) at home | 182 (15.6) | 5 (25.0)              | 25 (15.6) | 3 (16.7) |
|                         | Within three days of the day of hospitalization or transfer from another ward | 1124 (96.6) | 14 (70.0)** | 146 (91.3) | 15 (83.3) |
| Condition               | Fever                       | 18 (1.6) | 3 (15.0)** | 14 (8.8) | 4 (22.2) |
|                         | Anemia                      | 14 (1.2) | 1 (5.0)              | 9 (5.6) | 0 precision |
|                         | Dizziness                   | 13 (1.1) | 0                   | 10 (6.3) | 0 precision |
|                         | Tubes inserted              | 19 (1.6) | 1 (5.0)              | 8 (5.0) | 2 (11.1) |
| Physical activity       | Condition or ADL got better or worse rapidly | 55 (4.7) | 4 (20.0)* | 40 (25.0) | 10 (55.6)** |
| Motor function          | Need assistance/supervision to walk | 21 (1.8) | 2 (10.0) | 30 (18.8) | 5 (27.8) |
| Sensory function        | Need assistance/supervision to transfer | 42 (3.6) | 4 (20.0)** | 95 (59.5) | 14 (77.8) |
| Cognitive function      | Need assistance/supervision for toileting | 44 (3.8) | 3 (15.0)* | 81 (50.6) | 15 (83.3)** |
| Behavioral psychology   | Muscle weakness of leg      | 36 (3.1) | 1 (5.0)              | 64 (40.0) | 8 (44.4) |
|                         | Paralysis                   | 12 (1.0) | 2 (10.0)* | 20 (12.5) | 1 (5.6) |
|                         | Parkinsonism symptoms      | 8 (0.7) | 0                   | 8 (5.0) | 1 (5.6) |
|                         | Deformed/contracted bones/joints | 22 (1.9) | 0 | 11 (6.9) | 0 precision |
|                         | Hearing loss                | 26 (1.3) | 0 | 22 (13.8) | 3 (16.7) |
|                         | Vision impairment           | 47 (4.0) | 2 (10.0) | 23 (14.4) | 3 (16.7) |
|                         | Balance disturbance         | 6 (0.5) | 0 | 6 (3.8) | 1 (5.6) |
|                         | Numbness and hyperesthesia of leg | 56 (4.7) | 2 (10.0) | 28 (17.5) | 4 (22.2) |
|                         | Unable to call nurse call due to impaired cognitive function | 4 (0.3) | 0 | 22 (13.8) | 3 (16.7) |
|                         | Consciousness disorder, delirium | 4 (0.3) | 0 | 11 (6.9) | 1 (5.6) |
|                         | Diminished attention        | 12 (1.0) | 0 | 26 (16.3) | 4 (22.2) |
|                         | Overestimation or non-understanding of own physical abilities | 14 (1.2) | 1 (5.0) | 22 (13.8) | 1 (5.6) |
|                         | Cognitive dysfunction       | 13 (1.1) | 2 (10.0)* | 32 (20.0) | 4 (22.2) |
|                         | Diminished attention with anxiety | 12 (1.0) | 1 (5.0) | 11 (6.9) | 1 (5.6) |
|                         | Hesitating/resisting to be treated | 3 (0.3) | 1 (5.0) | 14 (8.8) | 2 (11.1) |
|                         | Under radiation therapy     | 8 (0.7) | 0 | 2 (1.3) | 1 (5.6) |
|                         | Narcotic use                | 21 (1.8) | 0 | 8 (5.0) | 2 (11.1) |
|                         | Using psychotropics         | 59 (5.1) | 3 (15.0) | 26 (16.3) | 2 (11.1) |
|                         | Using analgesics            | 44 (3.8) | 2 (10.0) | 25 (15.6) | 5 (27.8) |
|                         | Under or after chemotherapy | 55 (4.7) | 0 | 3 (1.9) | 0 precision |
|                         | Laxative use                | 46 (4.0) | 0 | 19 (11.9) | 1 (5.6) |
|                         | Diuretic use                | 42 (3.6) | 0 | 10 (6.3) | 1 (5.6) |
|                         | Tube insertion              | 189 (16.2) | 6 (30.0) | 63 (39.4) | 7 (38.9) |
| Sleep                   | Difficulty initiating sleep | 38 (3.3) | 1 (5.0) | 16 (10.0) | 2 (11.1) |
|                         | Nocturnal awakening         | 27 (2.3) | 2 (10.0) | 11 (6.9) | 2 (11.1) |
|                         | Day-night reversal          | 3 (0.3) | 0 | 3 (1.9) | 0 precision |
| Excretion               | Incontinence                | 9 (0.8) | 1 (5.0) | 31 (19.4) | 5 (27.8) |
|                         | Frequent urination          | 27 (2.3) | 0 | 10 (6.3) | 1 (5.6) |
|                         | Excretion more than two times per night | 30 (2.6) | 1 (5.0) | 16 (10.0) | 4 (22.2) |
|                         | Use of a bed                | 7 (0.6) | 1 (5.0) | 17 (10.6) | 0 precision |
|                         | Use of a portable toilet    | 8 (0.7) | 0 | 11 (6.8) | 1 (5.6) |
| Environment             | Difference in floor levels between bathroom and room | 17 (1.5) | 0 | 1 (0.6) | 1 (5.6) |
|                         | Disorderly items around the bed | 0 | 0 | 0 | 0 precision |

ADL, activities of daily living.

Data are expressed as the mean ± standard deviation and n (%).

*P < 0.05, **P < 0.01 between without and with preventive action for falls using Fisher’s exact test or the chi-square test.

Risk of falls for patients who were hospitalized or transferred to the other ward first time during the study period was assessed and analyzed between patients who needed any preventive action from falls among fallers and non-fallers respectively.
“Tube inserted”, “Need assistance/supervision to transfer”, and “Need assistance/supervision for toileting”. Among the patients not needing preventive action, “Within three days from the day of hospitalization or transfer from another ward”, “Within three days after surgery”, “Need assistance/supervision to walk”, “Paralysis” and “Cognitive dysfunction” were more frequent in fallers than in non-fallers.

Stepwise regression analysis identified “History of falls” “Tubes inserted”, “Need assistance/supervision for toileting” and “Excretion more than two times per night” as risk factors for falls at hospitalization or transfer to another ward (Table 4).

Of the 38 fallers, 30 (78.9%) were assessed both before and after falls. These 30 patients experienced “Overestimation or non-understanding of own physical abilities” more frequently after falls (30.0%) than at hospitalization or transfer to another ward (6.7%, P = 0.02) (Table 5).

**Discussion**

In this study, we found that “History of falls”, “Tubes inserted”, “Need assistance/supervision for toileting” and “Excretion more than two times per night” at hospitalization or transfer to another ward were risk factors of patient falls. We also analyzed changes in patient conditions between before and after falls, and found that patients with “Overestimation or non-understanding of own physical abilities” significantly more frequently after falls compared with before falls.

During our study period, 2.8% (38/1,362 participants) fell among the participants. Another article mentioned that 3 to 20% of inpatients (number was not shown) experienced falls at least once during their stay (Inouye et al. 2009). Usually, incidents or accidents are underreported. Therefore, there might have been more falls during the study period.

Abreu et al. (2015) previously reported that urinary incontinence had a relative risk of 5.67. However, based on our analysis, excretion-related factors were remarkable. In particular, we found that needing excretion assistance and having a high frequency of excretion were possible factors related to patient falls. History of falls was identified as a possible risk factor in a previous study (Chu et al. 2015), and that result was consistent with our findings. On the other hand, Abreu et al. (2015) also reported that the use of laxatives had a relative risk of 4.4; this was not identified as a risk factor in our study. This disparity may have been the result of differences in the risk assessment items and the methods of the analysis. The risk assessment sheet used in our study was created by the Working Group for the Prevention of Falls at Tohoku University Hospital; therefore a design-related bias might have influenced the analysis. Haines et al. (2007) reviewed articles related to fall risk assessment and found that study design may affect predictive accuracy. Our study identified possible factors for patient falls at hospitalization or transfer to another ward, as well as compared patient conditions between before and after falls. The assessment sheet needs to be validated with identified possible factors before it can be used in other facilities. We are planning to conduct a second assessment in Tohoku University Hospital; therefore, the need for validation of the risk assessment sheet should be taken into account.

Drug use has also been considered as a factor affecting patient falls. Findley and Bulloch (2015) reported that patient falls were more frequent among users of nonsteroidal anti-inflammatory drugs than among non-users, and Obayashi et al. (2013) reported that the use of some types of hypnotic drugs affected falls among hospitalized patients. The risk assessment sheet which we used in this study also included items on the use of drugs such as narcotics, psychotropics, analgesics, chemotherapy, laxatives and diuretics. Although a higher proportion of fallers than non-fallers was using analgesics, this difference was not significant on stepwise regression analysis. This might be because our risk assessment sheet categorized each drug as part of a group; therefore, it might be necessary to assess the risk of individual drugs for patient falls in a future study.

Falls occurred more frequently in patients who needed preventive action than in those who did not. Patients who were at a higher risk of falls tended to need action plans. This phenomenon was also observed in a previous study (Anderson et al. 2016). This suggests that more patients would have fallen if high risk patients were not taken preventive action.

“Overestimation or non-understanding of own physical abilities” was identified as a variable factor in patient falls. The result suggested that it was difficult for medical staff to recognize patients’ understanding of their own physical abilities correctly for a few days from hospitalization or transfer from a former ward. We were unable to analyze enough how patients’ understanding of their diseases.
changed. However, our result suggests that subsequent assessments of patients’ understanding of their condition are necessary. Our results also suggest that in some cases, the first assessment by the hospital staff might have not been sufficient to prevent falls, which may explain the differences between before and after patient falls for the item “Overestimation or non-understanding of own physical abilities”. Further study is necessary for clarify the factors underlying these differences.

This study had some limitations. First, we did not collect information on circumstances such as patient disease, hospital ward/department, characteristics of the medical staff involved in the fall risk assessments, and the infrastructure and other features of the hospital system. Considering such circumstances might be necessary to achieve better risk assessment in relation to patient falls. In particular, we could not conduct research for all seasons because of the difficulty on practical issue to apply this trial for whole hospital departments. We need to assess the seasonal trend once we apply the new assessment sheet in the

Table 5. Patient conditions before and after falls among 30 fallers who were assessed twice.

| Condition                                                                 | Before fall | After fall | P    |
|---------------------------------------------------------------------------|-------------|------------|------|
| Within three days from the day of hospitalization or transfer from another ward | -           | -          | -    |
| Within three days after surgery                                           | 6 (20.0)    | 4 (13.3)   | 0.5  |
| Fever                                                                     | 1 (3.3)     | 2 (6.7)    | 1.0  |
| Anemia                                                                    | 0           | 1 (3.3)    |      |
| Dizziness                                                                 | 2 (6.7)     | 4 (13.3)   | 0.7  |
| Tubes inserted                                                            | 12 (40.0)   | 7 (23.3)   | 0.2  |
| Condition or ADL got better or worse rapidly                             | 7 (23.3)    | 6 (20.0)   | 0.8  |
| Physical activity                                                         |             |            |      |
| Need assistance/supervision to walk                                       | 14 (46.7)   | 11 (36.7)  | 0.4  |
| Need assistance/supervision to transfer                                   | 14 (46.7)   | 12 (40.0)  | 0.6  |
| Need assistance/supervision for toileting                                 | 13 (43.3)   | 11 (36.7)  | 0.6  |
| Motor function                                                            |             |            |      |
| Muscle weakness of leg                                                    | 5 (16.7)    | 10 (33.3)  | 0.1  |
| Paralysis                                                                 | 2 (6.7)     | 2 (6.7)    | 1.0  |
| Parkinsonism symptoms                                                     | 0           | 0          |      |
| Deformed/contracted bones/joints                                           | 0           | 0          |      |
| Sensory function                                                          |             |            |      |
| Hearing loss                                                              | 3 (10.0)    | 2 (6.7)    | 1.0  |
| Vision impairment                                                         | 4 (13.3)    | 3 (10.0)   | 1.0  |
| Balance disturbance                                                       | 1 (3.3)     | 1 (3.3)    | 1.0  |
| Numbness and hyperesthesia of leg                                         | 5 (16.7)    | 6 (20.0)   | 0.7  |
| Cognitive function                                                        |             |            |      |
| Unable to call nurse call due to impaired cognitive function              | 3 (10.0)    | 4 (13.3)   | 1.0  |
| Consciousness disorder, delirium                                          | 1 (3.3)     | 5 (16.7)   | 0.2  |
| Diminished attention                                                      | 3 (10.0)    | 5 (16.7)   | 0.7  |
| Overestimation or non-understanding of own physical abilities             | 2 (6.7)     | 9 (30.0)   | 0.02 |
| Cognitive dysfunction                                                    | 5 (16.7)    | 6 (20.0)   | 0.7  |
| Behavioral psychology                                                     |             |            |      |
| Diminished attention with anxiety                                         | 1 (3.3)     | 2 (6.7)    | 1.0  |
| Hesitating/resisting to be treated                                        | 3 (10.0)    | 7 (23.3)   | 0.2  |
| Treatment                                                                 |             |            |      |
| Under radiation therapy                                                   | 1 (3.3)     | 1 (3.3)    | 1.0  |
| Narcotic use                                                              | 2 (6.7)     | 3 (10.0)   | 1.0  |
| Using psychotropics                                                       | 4 (13.3)    | 10 (33.3)  | 0.07 |
| Using analgesics                                                          | 6 (20.0)    | 7 (23.3)   | 0.8  |
| Under or after chemotheraphy                                              | 0           | 2 (6.7)    | 0.5  |
| Laxative use                                                              | 1 (3.3)     | 2 (6.7)    | 1.0  |
| Diuretic use                                                              | 1 (3.3)     | 1 (3.3)    | 1.0  |
| Tube insertion                                                            | 12 (40.0)   | 14 (46.7)  | 0.6  |
| Sleep                                                                     |             |            |      |
| Difficulty initiating sleep                                               | 3 (10.0)    | 4 (13.3)   | 1.0  |
| Nocturnal awakening                                                       | 3 (10.0)    | 5 (16.7)   | 0.7  |
| Day-night reversal                                                        | 0           | 1 (3.3)    | 1.0  |
| Excretion                                                                 |             |            |      |
| Incontinence                                                              | 4 (13.3)    | 6 (20.0)   | 0.5  |
| Frequent urination                                                        | 0           | 0          |      |
| Excretion more than two times per night                                   | 3 (10.0)    | 4 (13.3)   | 1.0  |
| Use of a urinal                                                           | 1 (3.3)     | 2 (6.7)    | 1.0  |
| Use of a portable toilet                                                  | 1 (3.3)     | 1 (3.3)    | 1.0  |
| Environment                                                               |             |            |      |
| Difference in floor levels between bathroom and room                      | 1 (3.3)     | 2 (6.7)    | 1.0  |
| Disorderly items around the bed                                           | 0           | 0          |      |

ADL, activities of daily living.
Data are expressed as n (%).
Out of 38 patients, 30 patients were assessed both before and after fall.
Items from the risk assessment sheet were compared between before and after falls only among 30 fallers who assessed both before and after falls.
future. Second, because our study had a relatively small sample size, the results might not be easily generalizable. However, our study site was one of the largest hospitals in Japan. Therefore, the results might be representative of other hospitals that have similar functions. Third, we could not assess changes in patient conditions among the non-fallers. Therefore, it remains unclear whether non-fallers also experience “Overestimation or non-understanding of own physical abilities”. Clarifying changes in conditions among non-fallers in future studies could be useful in confirming our results. Finally, we could not assess actual correlation between the risk assessment and factors for falls, because the information for the situation at fall was not available. Further analysis whether falls are consistent with risk assessment for each case should be conducted as well as the type of patient characteristics.

In conclusion, we assessed risk factors of patient falls at hospitalization or transfer to another ward, as well as risk factors that could change during hospitalization. “History of falls”, “Tubes inserted”, “Require assistance for excretion” and “Excretion more than two times per night” were identified as risk factors for falls. “Overestimation or non-understanding of own physical abilities” was experienced more frequently after falls than at hospitalization or transfer to another ward. These results are expected to be useful in identifying patients at a higher risk of falls.

Acknowledgments

We would like to thank all of the participants who took part in this study, as well as the staff at Tohoku University Hospital for their cooperation.

Conflict of Interest

The authors declare no conflict of interest.

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