

Verification of the causes of and countermeasures for falls using fall assessment score sheets in a municipal hospital

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Aim. This study aimed to examine the causes and countermeasures concerning falls through evaluating patient falls assessment score sheets at admission and retrospectively examining medication use and biochemical evaluation results.

Methods. The medical records of patients hospitalized for 11 months from April 2018 to March 2019 were reviewed anonymously on the basis of medical safety and the safety of medical supplies, and the number of falls was determined. Moreover, the cause and number of falls were reviewed retrospectively based on patient falls assessment score sheets. On assessment of the causes of falls during hospitalization, activity restrictions were noted and physical restraints had been implemented to assist with activities of daily living due to suspected frailty syndrome. Results. As a result of the evaluation of the fall assessment score sheet, 256 patients (90.5%) were aged 65 years or older, and most of the hospitalized patients were elderly. Regarding the history of falls, the number of males aged 65 years or older (136 patients) with a history of falls was approximately 2.7 times that of those without a history (99 patients), and the number of female patients (120 patients) with a history of falls was twice that of those without a history of falls (80 patients). As fall assessment items, it was confirmed that needing assistance for elimination, patient use of accessories, IVs, gastric tubes, drains, and use of wheelchair toilets contributed to the cause of falls. Biochemical evaluations indicated that patients categorized as underweight, based on their body mass index, had lower total protein, albumin, and hemoglobin levels than obese patients.

Conclusions. To reduce the occurrence of falls, a patient's nutritional status and muscle mass should be considered using a falls assessment score sheet at admission. Furthermore, falls may be prevented through evaluating a patient's nutritional status from a biochemical perspective.

Key words: activity suppression and patients, assessment score, hospitalization falls, nutritional

INTRODUCTION

Japan currently has the highest percentage of older adults aged > 65 years worldwide and faces challenges concerning social security costs in terms of care for older adults and health insurance because of high healthy life expectancy^{1,2}. In 2025, many of those belonging to the baby boomer generation (that is, those born between 1946 and 1964) will be aged > 75 years, and an increase in chronic illness and cognitive dysfunction is predicted. Therefore, healthcare workers are likely to become increasingly burdened and access to medical treatment may become potentially more limited, with more challenging implications for managing supply and demand requirements. Thus, it is important to extend the healthy life expectancy of older adults through securing the most suitable medical treatment³ to improve the outcomes following cognitive dysfunction, joint diseases, fall prevention and bone fractures, other geriatric syndromes⁴⁻⁶. Saitama Prefecture, Japan, is aiming to promote a “prosperous and environment friendly city in Chichibu where the Japanese government is in harmonious partnership with its citizens”⁷. “The city is known for its high number of older adult citizens who live long and peaceful lives (a city where cooperation and warmth are felt)”. Based on this understanding, the “Healthy Chichibu 21 (2nd plan)” also comprised a “Chichibu Positive Health Plan”, which is an older adult citizen welfare program. Citizens aim for “healthy longevity in Chichibu” to live full and healthy lives. The “Healthy Chichibu 21 (2nd plan)” has five objectives, namely: (i) to extend healthy life expectancy; (ii) to prevent lifestyle related diseases and serious illnesses; (iii) to improve daily habits in relation to nutrition, eating habits, physical activity and exercise, sleeping, alcohol consumption, cigarette smoking, and oral health; (iv) to maintain and improve functions necessary for an active social life; and (v) to maintain a social environment that supports and protects good health⁷. In Chichibu city, it has been predicted that as the overall population decreases, the number of older adults will increase and that the aging rate will exceed 35% by 2025¹. A number of falls have occurred at the one of municipal hospital involving older adults, with causes related to previously reported factors such as frailty, recognition dysfunction prevention⁸. Falls are generally categorised into ‘internal’ and ‘external’ factors. In this process, falls which are considered to be characteristic of municipal hospital can be categorized as follows. The hospitalization process, the dementia caused by the disease, the frequency of urination at night, and medications: polypharmacy (multiple drug prescription with adverse events)⁹ are all factors. The reason for focusing on falls is that they are caused by the patient’s spontaneous

actions and the impact on the patient can be disabling, especially when fractures occur, leading to prolonged hospitalisation, muscle weakness and repeated falls. In the elderly, this can lead to death. And even if patients expect to return to their pre-hospital life, they often do not fully recover, causing changes in mental health and social aspects such as the implications for work and family. On the economic side, the patient may have to pay for extra treatment. The use of multiple medications is commonly referred to as polypharmacy. It is common for the elderly who suffer from multiple diseases to use more than one drug to treat each disease. Polypharmacy is associated with adverse outcomes including mortality, falls, adverse drug reactions, increased length of stay in hospital and readmission to hospital soon after discharge¹⁰. Polypharmacy and medications that increase the risk of falls are prevalent in patients discharged from orthopedic surgery after fracture of the hip^{11,12}. At present, nurses at municipal hospital evaluate the occurrence of falls using an assessment score sheet (Tab. I); however, determining a falls history, in terms of the number of previous falls, can be challenging. Since polypharmacy has been reported to be associated with falls in older adults, pharmacists should be involved in falls assessments to optimize patient medication¹³, as this may help reduce the number of fall related incidents due to medication. The medical records of patients hospitalized were reviewed anonymously on the basis of medical safety and the safety of medical supplies, and the number of falls was determined. Moreover, the cause and number of falls were reviewed retrospectively based on patient falls assessment score sheets. Therefore, in this report, we hope to discover new elements by summarizing and analyzing cases of falls in municipal hospitals, which will help to further build medical safety.

MATERIALS AND METHODS

SUBJECTS

The medical records of patients hospitalized for 11 months from April 2018 to March 2019 were reviewed anonymously on the basis of medical safety and the safety of medical supplies, and the number of falls was determined. Moreover, the cause and number of falls were reviewed retrospectively based on patient falls assessment score sheets. In total, 283 patients with a history of falls (men, *n* = 147; women, *n* = 136) who had been admitted to Chichibu Municipal Hospital. Patient information, including sex, age, height, weight, total protein, albumin, and hemoglobin levels; the type and number of medications administered, and, data concerning patient falls assessment score sheets,

were obtained from alphabetically organized electronic patient records. Data analysis was performed anonymously at Josai University, Sakado Campus. Permission to undertake this research was obtained from the Medical Science Course Study Ethics Review Committee at Josai University. All study procedures were conducted in compliance with the principles of the Declaration of Helsinki and its later amendments, as well as with the nationally applicable guidelines for research on human patients.

PATIENT FALLS ASSESSMENT SCORE SHEET

A patient falls assessment score sheet was used to evaluate a patient's status and hazardous factors to determine the risk of falling. This assessment comprises 11 items (A-K), and more than one answer is possible for each (Tab. I). A score was set for every observation, and the sum of the 11 items was indexed into a comprehensive falls assessment and classified as follows: dangerous degree I (1-9 points), dangerous degree II (10-19 points), and dangerous degree III (> 20 points). Changes in patient status during hospitalization were also considered; thus, patient risk assessments concerning falls were undertaken more than once during hospitalization. To investigate factors causing falls in inpatients in this study, a chart was used to record all checks and items derived from the assessment score sheet concerning patient falls. The influence of polypharmacy was also considered, as was patient history of medication and the number of medications administered.

CLINICAL BIOCHEMICAL EVALUATION

Sex, age, height, weight, and total protein, albumin, and hemoglobin levels were collected from the patients' electronic medical records at Chichibu Municipal Hospital and the respective distribution was estimated using a box-and-whisker plot. Body mass index (BMI) was classified as follows: low, < 18.5 kg/m²; healthy, 18.5 kg/m² to < 25 kg/m², and overweight, ≥ 25 kg/m², according to the Japanese overweight academic meeting. The distribution of patients' total protein, albumin, and hemoglobin levels, which were classified according to BMI, was estimated using a box-and-whisker plot.

EVALUATION OF MEDICATION

The number and type of medications taken were collected and anonymized from each patient's electronic

medical record at Chichibu Municipal Hospital. Data regarding the names of medication a patient had taken prior to a fall, the names of any discontinued medications, and their current medication were used.

RESULTS AND DISCUSSION

PREVIOUS HISTORY OF FALLS

An algorithm was used to analyze patients' age, sex, and history of falls at the Chichibu Municipal Hospital (S.I 1 and 2). In our study, 256 (90.5%) inpatients were > 65 years old. Females (n = 120) were twice as likely to have a past history of falls (n = 80 patients) and were approximately 2.7 times more likely to fall (n = 40 patients) than males who had no previous medical history (n = 37 patients), males aged > 65 years (n = 99 patients), and males with a past medical history (n = 136 patients). A history of falls was recorded in 2 patients aged > 10 years or less than 9 years and in 25 patients aged < 64 years. Therefore, we considered that falls were likely to occur in patients with a past history of falls.

PATIENT FALLS ASSESSMENT SCORE SHEET RESULTS

Figure 1 lists the patient falls assessment score sheet values. Patient age (A) and anamnesis (B) are detailed in Section 3.1. Cognition, knowledge, and memory (53.4%, 151 patients) (C) were significantly affected by recognition capacity (Fig. 2A). An older adult has approximately 90%, and Chichibu Municipal Hospital is expected to have many patients with a decline in recognition capacity. Medications used (D) were as follows: diuretics to lower blood pressure (84 patients; 46.6%), laxatives (64 patients; 22.6%), other drugs

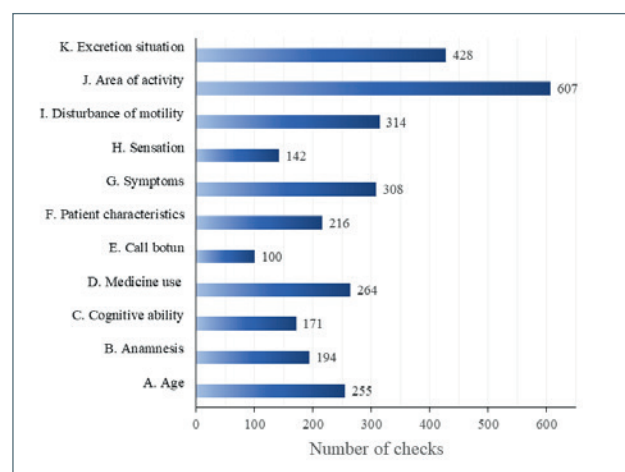


Figure 1. Results of the patient falls assessment score sheet (multiple answers possible).

Table I. Assessment score sheet for patient falling and tumble of Chichibu municipal hospital

Assessment score	Check List	Score
Situation of evaluation	Hospitalization first day	—
	Hospitalized two days after	
	At the start of rehabilitation, ADL/symptom change	
	Fall event occurrence, 4 weeks after chronic patients	
A. Age	≥ 65 years old, 9 years old and under	Yes: 2
B. Anamnesis	Fall history	Yes: 2
C. Cognitive ability	Dementia symptoms	Yes: 4 (yes, if even one is true)
	Disturbing behavior	
	Poor judgment, comprehension, and memory	
	Disorientation/turbidity	
D. Medicine use (history of prescription)	Sleep-inducing drugs/tranquilizers	Yes: 2, for sleep-inducing drugs and tranquilizers.
	Sedative (analgesic) drug	Yes: 1, furthermore, except for sleep-inducing drugs and tranquilizers, even one Yes equates to 1 point
	Medical narcotics	
	Laxative	
	Antihypertensive drug	
E. Call button	Acts without using the nurse call button	Yes: 4 (yes, if even one is true)
	Cannot recognize/use the nurse call button	
F. Patient characteristics	Conspicuous behavior	Yes: 2
	Try to do everything by myself	Yes: 1, furthermore, except for equipped with accessories, even one Yes is 1 point.
	Equipped with accessories (IVs, feeding tubes, drains, etc.)	
G. Symptoms	Fever (38° or higher)	Yes: 3, fever (38° or higher),
	Anemia tendency	Anemia tendency
	Dizziness on standing up	Lightheadedness (yes, if even one is true)
	Within 3 days after surgery	Yes: 2, Within 3 days after surgery
	Rehabilitation	Yes: 1, rehabilitation, decreased symptoms and ADL (yes, if either one is true)
	Decreased symptoms and ADL	
H. Sensation	Visual field impairment, hearing impairment	Yes: 1 (yes, if even one is true)
	Balance disorders	Yes: 3, for weak legs and weak muscles.
I. Disturbance of mobility	Weak legs and weak muscles	Yes: 1, furthermore, except for
	Numbness	
	Fatigue	Weak legs and weak muscles, even one yes is 1 point.
	Bone and joint abnormalities (restraint, deformity)	
J. Area of activity	Staggering	Yes: 3, staggering
	Wheelchair use	Yes: 2, wheelchair use, can move freely respectively.
	Can move freely	Yes: 1, need assistance when moving or bedridden (Yes, if either one is true)
	Needs assistance when moving	
	Bedridden (limbs can be operated)	
K. Excretion situation	Urinary incontinence, frequent urination	Yes: 3 (yes, if even one is true)
	Distance to the toilet, visits to the toilet at night	
	Portable toilet, wheelchair toilet	Yes: 1 (yes, if even one is true)
	Intravesical catheter, needs assistance with toileting	

(18 patients; 6.4%), supportive medicine (47 patients; 16.6%), and sleep medications or sedatives (29.7%, 84 patients; Figure 2B). In total, 68 (24%) patients used the call button (E), whereas 53 (18.7%) patients did not (Fig. 2C). Patient characteristics (F) were identified in relation to the presence of a J attachment, intravenous

drip, stomach pipe, and drains (128 patients; 43.7%). Patients who could move freely (20.8%, 61 patients) and those subject to some active bodily restrictions were predicted to experience more falls than patients with unlimited activities (Figs. 2D & 2H). Approximately 80% of the patients had a disturbance in motility, poor

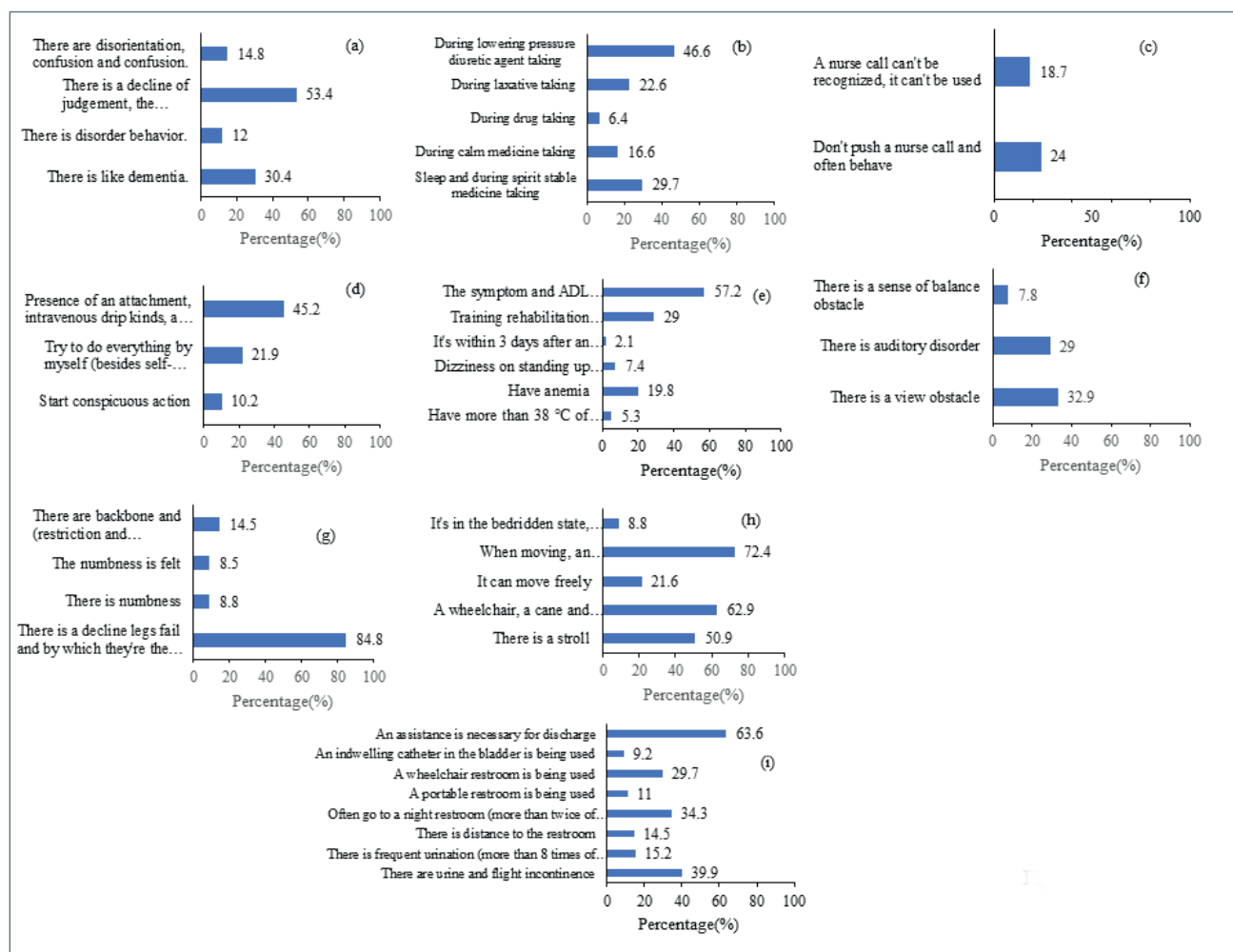


Figure 2. Results of each item in the patient falls assessment score sheet. (a) C, cognition; (b) D, medicine; (c) E, call button; (d) F, patient characteristics; (e) G, symptom; (f) H, sensation; (g) I, disturbance of motility; (h) J, area of activity; and (i) K, excretion (multiple answers possible).

leg function, and a decline in muscle strength (240 patients; 81.9%; Figure 2G). Assistance with toileting (K) was necessary for 180 patients (63.6%) for the following: an indwelling catheter (26 patients; 9.2%), a wheelchair toilet (84 patients; 29.7%), a portable toilet (31 patients; 11%), frequent toilet visits at night (> 2 times at night, 97 patients; 34.3%), assistance with walking to the toilet (41 patients; 14.5%), frequent urination (> 8 times at midday and > 2 times at night; 43 patients; 15.2%), and urinary incontinence (113 patients; 39.9%). Many patients required assistance (Fig. 2I). Older adults aged > 65 years accounted for approximately 90% of the patients. Most of the hospitalized patients are older than 65 years old, so physical weakness is expected. With many kinds of frail patients and those with active restrictions in daily life being admitted to municipal hospital, the need for fall prevention care is emphasized at this hospital.

CLASSIFICATION ACCORDING TO POLYPHARMACY FOR EVERY ITEM IN THE PATIENT FALLS ASSESSMENT SCORE SHEET

The presence of a past history of falls and its relationship to polypharmacy are shown using an algorithm (Fig. 3). One hundred and seventeen (41.3%) patients had a history of falls and were receiving multiple medications, 78 (27.6%) patients had a history of falls and were not receiving multiple medications, 53 (18.7%) patients had no history of falls and were receiving multiple medications, and 35 (12.4%) patients had no history of falls and were not receiving multiple medications. Previous studies have reported that the increased risk of falls in inpatients is related to the adverse effects of > 6 medications being administered^{10,11}. Patients with multiple drug prescriptions have a greater risk of falls than patients not prescribed multiple medications, irrespective of the presence of medical history. Therefore,

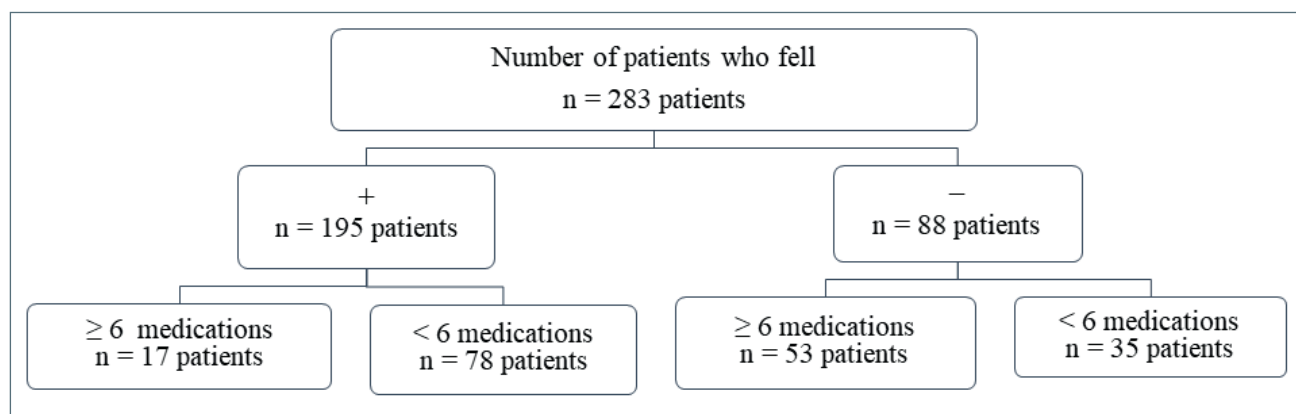


Figure 3. Patient medical and pharmacological history (a positive medical history [+]; a negative medical history [-]).

polypharmacy is considered to be related to the occurrence of a fall. In terms of the relationship between polypharmacy and falls, items on the patient fall assessment score sheet indicated an association between the presence of a history of falls and a history of multiple medications (Fig. 1). Cognition (C) and the need to use the call button (E) were compared and, an association was found between (C) and (E). A patient's ability to use the call button was also found to be a risk factor for falls (Fig. 4A & 4C). A medical history and the use of > 6 medications (D) also posed a risk of falls (Fig. 4B). Patient characteristics (F) and symptoms (G) that caused a fall were compared between patients who did and did not have a history of falls, showing that a patient taking > 6 medications was at risk of falling (Fig. 4D & 4E). Fall prevention can be facilitated through determining a patient's past history of falls on admission.

BIOCHEMICAL EVALUATION OF PATIENTS WHO FALL

BMI and total protein, albumin, and hemoglobin levels of patients with a history of falls are shown using a box-and-whisker plot (Fig. 5). Normal weight was defined as a BMI of 18.5 kg/m² and being overweight was defined as a BMI of approximately 25 kg/m². The median total protein level was approximately 6.0 g/dL, and approximately 50% of the patients had a total protein level of 4.5-6.0 g/dL (Fig. 5B). When BMI was taken into consideration, the median total protein level was proportional to the BMI value and increased with increase in BMI in some patients (Fig. 5(B)-1). However, 50% of the inpatients had a standard value < 6.0 g/dL irrespective of BMI. The median albumin level was approximately 3.0 g/dL. The general standard value was < 4.0 g/dL (Fig. 5C). When the patients were classified according to BMI, the median was proportional to the BMI and increased, but all values were below 4.0 g/dL in all patients, even those with a BMI > 25 kg/m². However, albumin levels generally indicate the nutritional

state. One study stated that albumin levels > 3.5 g/dL were favorable and that complications were rarely observed clinically when levels were > 3.0 g/dL¹⁴. The median albumin value of underweight patients with a BMI < 18.5 kg/m² and that of normal weight patients with a BMI > 18.5 kg/m² to < 25 kg/m² was < 3.0 g/dL. The risk of falls due to physical dysfunction in the elderly was also estimated, as shown in Figures 2G and 4G. The median hemoglobin level was approximately 11.0 g/dL, and approximately 50% of the study patients had values below the median (Fig. 5D). When the hemoglobin level was sex-segregated and classified according to BMI, both values were proportional to the BMI, and the median value increased. Hb values for males fell below the standard value (13.5 g/dL) in terms of the BMI compared to those in women (Fig. 5(E)-1). In females with a BMI of > 25 kg/m², the median hemoglobin level was 12 g/dL; however, in females with a BMI < 18.5 kg/m² or in those with a BMI ≥ 18.5 kg/m², these values were lower than the standard value compared with those with a BMI of < 25 kg/m² (Fig. 5(F)-1). As a result, there is a possibility of a reduction in total protein, albumin, and hemoglobin levels, and patients classified as underweight had an increased risk of falls. Therefore, given varying total protein and albumin levels because of increased energy demand due to illness, it is necessary for healthcare workers to periodically verify the nutritional status of patients.

EVALUATION OF THE TYPE OF MEDICATION TAKEN

Medication taken by a patient prior to a fall, discontinued medication, and medication taken immediately before the fall are shown in Table II. Given that polypharmacy was reported, such as taking sleeping tablets or non-benzodiazepine medication (case A), the possibility of a fall was estimated. Case B involved a patient who was intravenously infused with a mixture of amino acids, glucose, electrolytes, and vitamins. The patient presumably

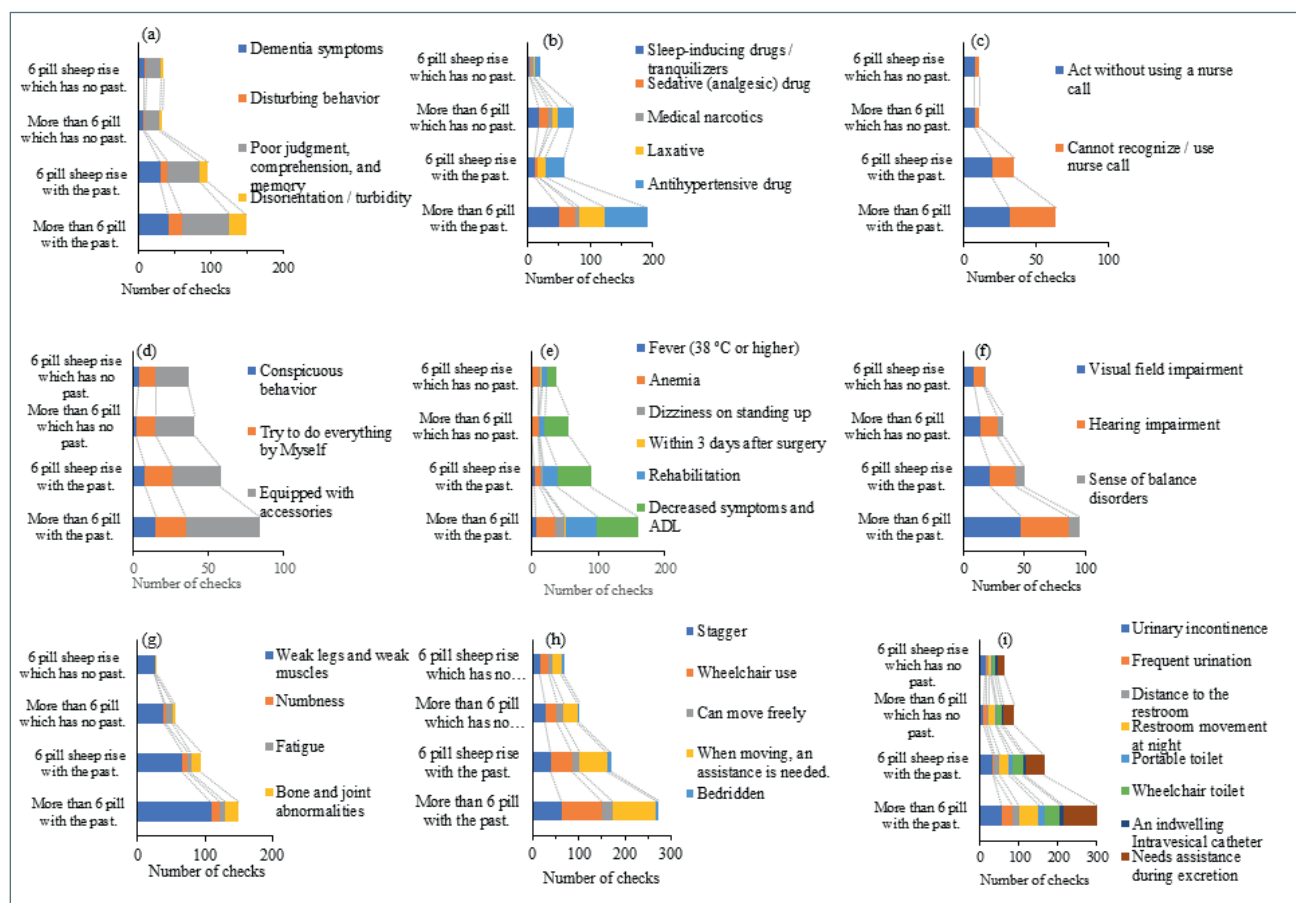


Figure 4. Items in the patient falls assessment score sheet indicate a past history of falls and the presence of multiple medications. (a) C, cognition; (b) D, medicine; (c) E, calling for the nurse; (d) F, patient characteristics; (e) G, symptom; (f) H, sensation; (g) I, disturbance of motility; (h) J, area of activity; and (i) K, excretion.

Table II. Three patients with the highest accident level.

Accident level	Additional medication	Discontinued medication	Medication taken prior to the fall
	Day 0: apixaban 10 mg	Day 7: quazepam 20 mg, daikenchuto	Day 11, 6 pm: apixaban 5 mg, sertraline 25 mg, magnesium oxide 660 mg, fluphenazine maleate 0.5 mg, mirtazapine 30 mg
	Day 6: magnesium oxide 660 mg, then changed to magnesium oxide 990 mg	Day 9: fluphenazine maleate 0.5 mg (twice a day after breakfast and dinner, then changed to once a day after dinner)	Day 11, 9 pm: zopiclone 7.5 mg, nitrazepam 2 mg
(a) Lv3b	Day 7: tazobactam sodium, piperacillin sodium IV push, then changed to levofloxacin 500 mg		
	Day 0: KCL 20 mEq, Amino acid, sugar, electrolyte and vitamin kit	No change	No change
(b) Lv3b	Day 3: Potassium chloride 1200 mg, daikenchuto 7.5 g		
(c) Lv3b	No change	No change	Day 0, 6 pm: acetaminophen 400 mg, isosorbide mononitrate 20 mg, magnesium oxide 330 mg, Day 0.9 pm: brotizolam 0.25 mg

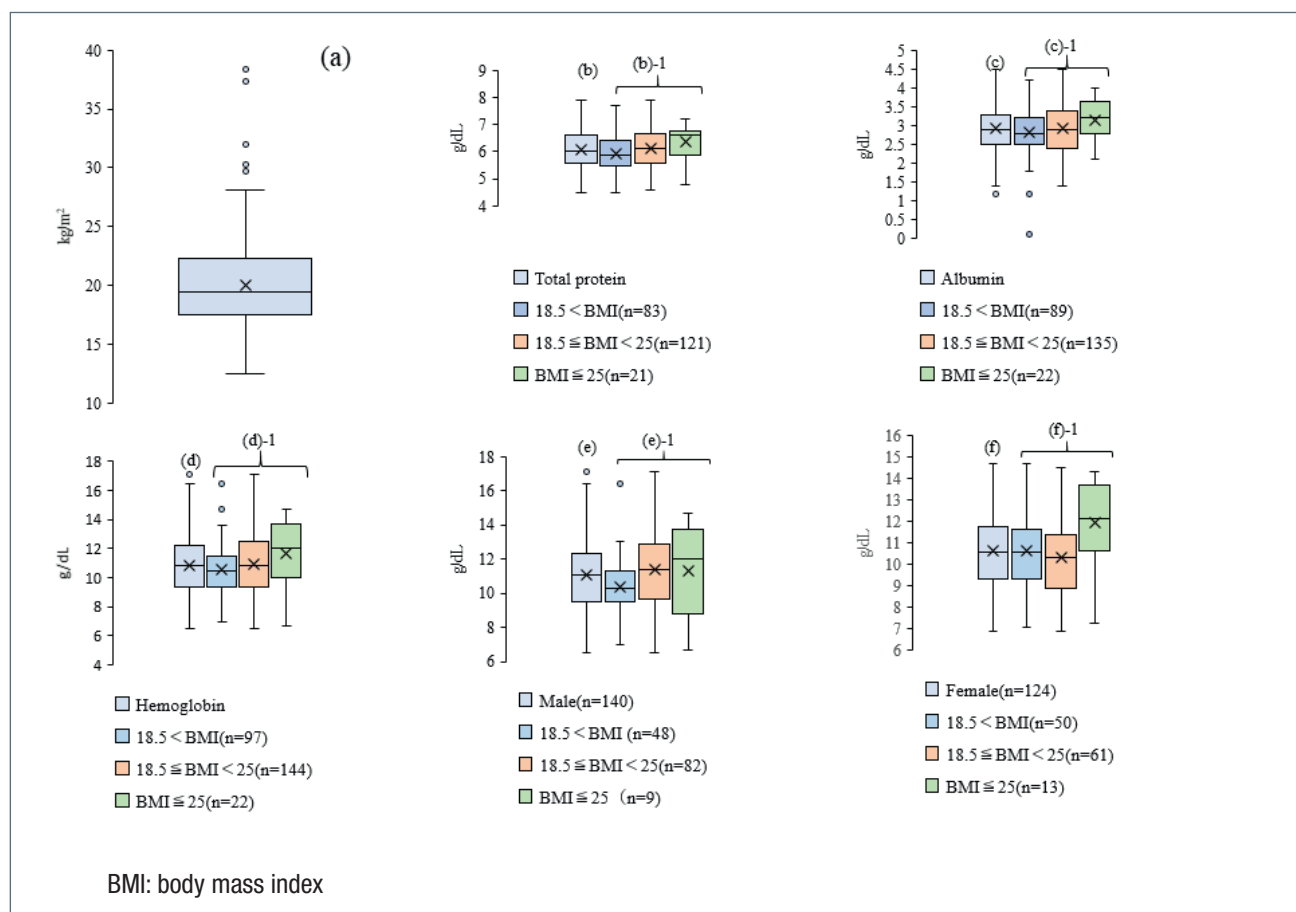


Figure 5. Biochemistry values for each patient. (a) BMI; (b) total protein; (b-1) total protein classified according to BMI; (c) albumin; (c-1) albumin classified according to BMI; (d) hemoglobin; (d-1) hemoglobin classified according to BMI; (e) sex-segregated male hemoglobin; (e-1) male hemoglobin classified according to BMI; (f) sex-segregated female hemoglobin; and (f-1) female hemoglobin classified according to BMI.

fell as a result of a poor nutritional status and limited physical activity (constraints) due to the intravenous infusion. The risk of falling was high because the patient had taken a sedative immediately prior to the fall. As shown in Table II, no relationship was observed between the type of medication used and the tendency to fall with regard to the time taken, due to inconsistent results in relation to the occurrence of a fall and the addition of a medication or its discontinuation. Some studies concerning reducing the risk of falls have reported digitizing incident reporting systems, installing fall prevention devices, and hourly rounds of nurses to assess fall trends in hospitals¹⁵. In addition, it has been reported that intervention by a physiotherapist may lead to a reduction in fall events for up to 6 months through providing falls prevention advice, health guidance, and exercise intervention¹⁶. According to the World Health Organization, multidisciplinary education will improve medical effectiveness of patient care. To construct a falls prevention framework for all healthcare

workers, NST support for hospitals and healthcare workers, such as nurses and physical therapists, is necessary to develop appropriate education and training in relation to this type of patient care¹⁷. Falls were more frequent in physically restrained patients. Based on these results, we consider that, to reduce the incidence of falls and to prevent falls, it is necessary to determine the nutritional status and muscle mass of patients, using a falls assessment score sheet at the time of admission and through evaluating the nutritional status of patients from a biochemical perspective. Again, the environment of the hospital where patients spend their hospitalization is different from the home they were used to living in. Added to that change in environment is the decline in physical strength and motor functions due to illness or injury. Therefore, along with the medical staff, it is also an important multidisciplinary collaboration to keep close informed with the relatives (family) about how the patient is living at home. In this study, it is necessary to take into account the characteristics of each

region and facility, so this is not a sufficient case study to provide information to readers as a general theory. Many falls result from interactions among multiple risk factors and the risk of falling increases linearly with the number of risk factors¹⁸. However, even among community-dwelling people aged 75 years and older without risk factors, approximately 10% fall during any given year¹⁹. Therefore, all older adults should be recognized as being at some increased risk of falling. However, many healthcare workers are continuously taking measures to prevent falls. Many facilities are taking measures to 1) reduce the factors that cause fall accidents, 2) monitor the mental and physical condition of patients, and 3) exercise to maintain physical functions²⁰. It suggested that we should conduct patient physical assessments in cooperation with multiple professions on a daily basis and work with the PDCA cycle to ensure medical safety. Falls prevention is a challenge facing staff not only at the Chichibu Municipal Hospital but also staff at other municipal hospitals across Japan.

CONCLUSIONS

To reduce the occurrence of falls, it is necessary to consider the nutritional status and muscle mass of patients using a falls assessment score sheet at the time of admission. Additionally, we consider that some falls can be prevented through evaluating the nutritional status of patients from a biochemical perspective.

Ethical consideration

The study was approved by Josai University ethical committee in Saitama Japan (ninirin-2019-12A).

Author contributions

M.S. Y.I. and A.I. performed the experiments, participated in the study design, and carried out sampling and helped prepare the manuscript. T.O. and Y.K. participated in experiments, carried out sampling, and planned the study design, analyzed the experimental data, and contributed suggestions regarding the manuscript. All authors read and approved the final manuscript.

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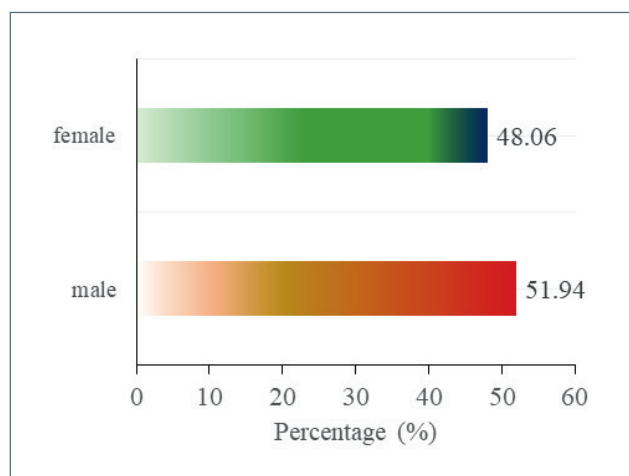
Conflict of interest

The Authors declare no conflict of interest.

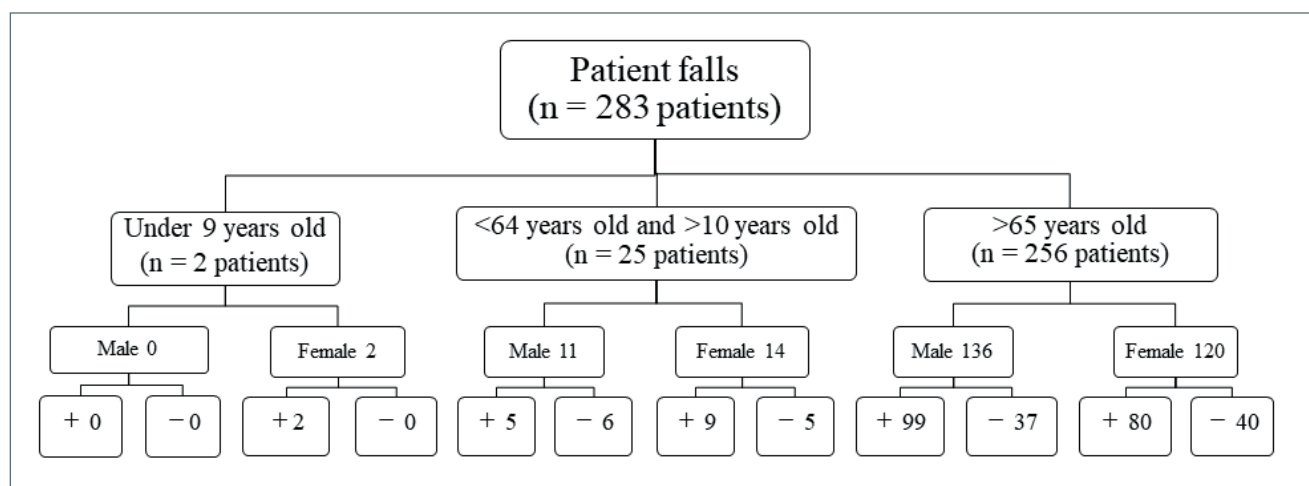
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S.I 1. Patient classification according to sex.



S.I 2. Patient age, sex, and medical history +, a positive medical history, -, a negative medical history