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# Characteristics of falls occurring during rehabilitation in an acute care hospital in older and non-older patients: A retrospective cohort study

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**Introduction:** Although falls are often reported in hospitals and are common in older individuals, no reports on falls during rehabilitation exist. This study evaluated patients with falls occurring during rehabilitation and identified the characteristics of older and non-older patients.

**Materials and methods:** Our study retrospectively analyzed reports of falls occurring during rehabilitation at a university hospital from April 1, 2020 to March 31, 2022. The survey items included the number of falls in the hospital as a whole and during rehabilitation, age, gender, mankin Scale (mRS) before admission and at the time of fall, functional independence measure (FIM) at admission, patient communication status at the time of fall, and whether a therapist was near the patient. Patients aged  $\geq 65$  were considered older; aged  $\leq 64$ , non-older; and those with the same age, gender, and clinical department, randomly selected as non-falling patients.

**Results:** Thirty-five falls occurred during rehabilitation (14 in the non-older and 21 in the older patients), significantly lower than the 945 for the entire hospital, without any significant difference between non-older and older patients. No significant differences in mRS before admission and FIM at admission were noted for both groups in comparison with the non-falling patient group. Furthermore, gender, mRS, FIM, good communication status, and presence of therapist near the patient were similar between non-older and older patients (non-older 71.4%, older 52.4%). Most falls were minor adverse events that did not require additional treatment.

**Conclusion:** The rate of falls during rehabilitation was much lower than that during hospitalization, and many falls had minimal impact on the patient. It was also difficult to predict falls in daily life and communication situations, and there was no difference in characteristics between the older and non-older groups. Since more than half of the falls occurred during training with the therapist, it is necessary to reconsider the training content.

#### KEYWORDS

incident, accident, patient safety, inpatients, rehabilitation

## Introduction

According to the World Health Organization's definition, a fall is "an event which results in a person coming to rest inadvertently on the ground or floor or other lower level" (1). Falls cause varying degrees of injury, loss of confidence, and reluctance to move. Furthermore, patients who fall during hospitalization have longer average lengths of stay and may incur additional costs than those who do not (2). Older adults often have several risk factors that increase the likelihood of falls, including impaired sensory and motor function, impaired integration of these systems (3), adverse drug events, and musculoskeletal disorders such as gait dysfunction and balance problems (4). Additionally, older patients in geriatric or rehabilitation wards have a higher risk of falls than that in other age groups (5, 6). Hospital falls are the most common safety incidents affecting older individuals, frequently causing family complaints, including civil claims. Therefore, an important medical safety measure includes understanding the characteristics of patients who experience falls and taking steps to prevent them. Preventive measures in hospitals include patient education, clinician education, environmental adaptation, use of assistive devices, exercise, scrutiny of medications, optimal nutritional guidance, cognitive impairment management, measures to mitigate disability due to falls, and development of leadership systems (7–11).

While falls in stroke patients admitted to rehabilitation wards and in older patients admitted to rehabilitation facilities are reported (12–14), no detailed investigations of falls that occur during actual rehabilitation practices exist. The authors have experienced adverse event (AE)s during rehabilitation that resulted in femur fractures, requiring additional surgery and prolonging hospital stays (15), and are keenly aware of the need to develop fall prevention strategies.

This study evaluated falls occurring during rehabilitation and obtained detailed information to improve risk management strategies for future rehabilitation care and identify characteristics of older and non-older patients.

## Materials and methods

### Study setting

As of 2022, Wakayama Medical University hospital has 760 general beds (including ten Intensive Care Unit beds) and 40 psychiatric beds, serving 27 clinical departments and 28 central medical treatment sections. Rehabilitation begins upon request from the physicians in various departments to the department of rehabilitation. Psychiatrists examine inpatients prior to rehabilitation and evaluate their diagnosis, disease state, and physical condition. Registered and skilled therapists then commence exercise therapy. Thus, rehabilitation therapies are performed based on a thorough clinical examination and in accordance with each patient's condition (16, 17).

### Study design

In this retrospective cohort study, we analyzed AE reports submitted by the Department of Rehabilitation Medicine to the Medical Safety Promotion Department at our hospital between April 2020 and March 2022.

### Data collection methods and procedures

At our hospital, all staff are required to report an AE to their corresponding risk manager. An AE during rehabilitation includes any instance that has caused or may have caused further physical or psychological injury to the patient (15).

The survey items were the number and contents of adverse events during the survey period, number of falls in the entire hospital and during rehabilitation, the age of fall patients, gender, modified Rankin Scale (mRS) at admission and time of fall, functional independence measure (FIM) at the time of admission, good communication rate of the patient at the time

of the fall, presence or absence of a nearby therapist, and main clinical department. In addition, patients with matching age, gender, and department, who had not experienced a fall, were randomly selected for comparison as non-falling patients, and the same data were collected. The mRS (defines six levels of disability) and FIM (basic indicator of the severity of disability) were evaluated as indicators of Activities of Daily Living (ADL) (18–22). The FIM consists of 18 items, with a motor subscale (13 items) and cognition subscale (5 items), each of which is assessed using a 7-point ordinal scale.

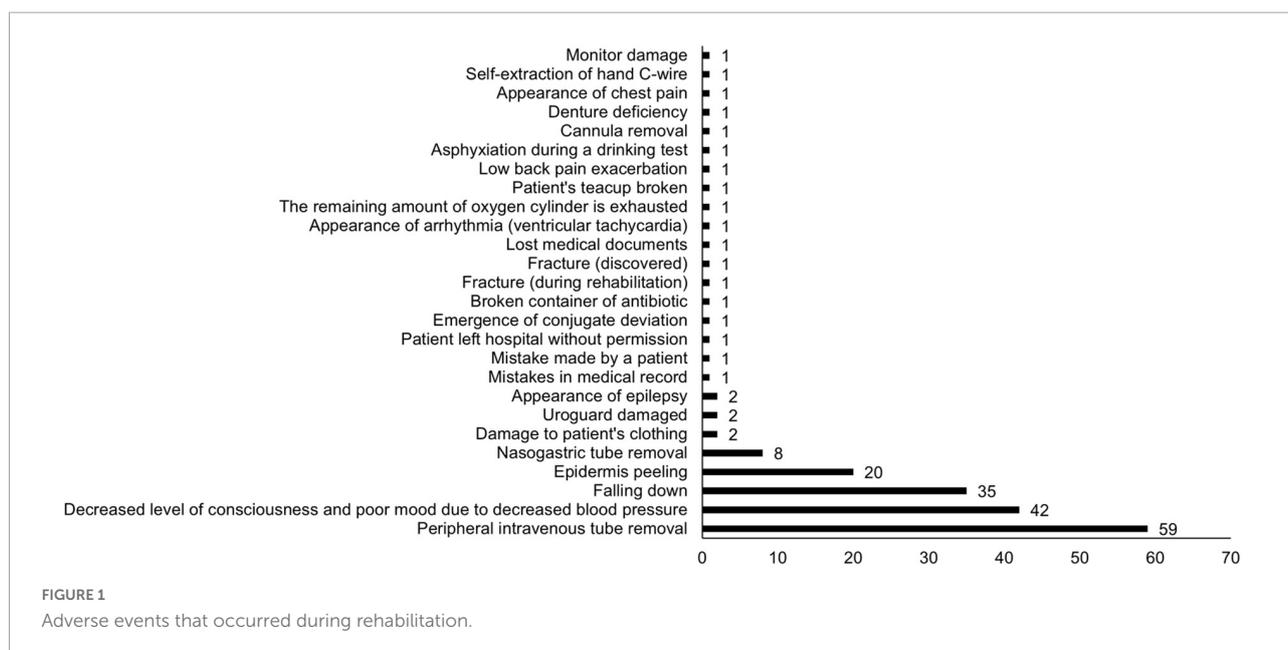
The degree of impact the AE had on the patient was determined by the Medical Safety Promotion Department (15). According to the National Coordination Council for Medication Error Reporting and Prevention index (23), impacts of AEs are categorized into nine levels, as follows: category A (no error); categories B to D (error but no harm); categories E to H (error and harm), and category I (error and death). For AEs in categories A to D, no additional treatment is required. Specifically, category B refers to an error occurring but not reaching the patient (an “error of omission” does reach the patient). While category C pertains to an error occurred that reaches the patient but does not cause harm, category D is an error that reaches the patient and requires monitoring to confirm that it did not harm the patient and/or required intervention to preclude harm. For AEs in category E, minor treatment is required; however, for those in category F, intensive treatments are required and/or extension of hospital stay is needed. If permanent disability and sequelae with no significant or with significant functional or cosmetic problems develop, severe AEs are defined as G or H, respectively. Categories A to D that do not require additional treatment are classified as minor AEs (15).

## Statistical analysis

Data were grouped by age  $\geq 65$  years and  $\leq 64$  years, defined as older in the author’s country (24). The values of the variables are given as numbers, mean  $\pm$  standard deviation (SD), and median (75th–25th percentiles), where applicable. The older and non-older and fall and non-fall groups were compared using the unpaired *t*-test for age and time from hospitalization and surgery to fall occurrence; the Mann–Whitney *U* test was used to evaluate the mRS and FIM; the  $\chi^2$ -test was used to evaluate the incidence of falls and gender differences, good communication rate of the patient, and whether a therapist was present at the time of the fall; and the Fisher’s exact test explored the main clinical departments of fallen patients. Differences were considered statistically significant at  $p < 0.05$ , and statistical evaluations were performed using the Graph Pad Prism 6 software (Graph Pad Software Inc, San Diego, California).

## Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the relevant ethics review committee (No. 3529). No additional risks were posed to patients during the data collection and analysis, and all related information was protected. Additionally, information concerning this study was posted on the university website, and patients or their families and relatives were given the opportunity to opt-out. The ethics review committee waived the requirement for patients’ written informed consent due to the retrospective nature of the study.



**TABLE 1** Number of falls occurring during hospitalization and rehabilitation.

	Number of falls	<i>p</i> -value
During hospitalization total ( <i>n</i> = 46050) <sup>a</sup>	945 (2.05%) <sup>c</sup>	<0.0001 <sup>e</sup>
During rehabilitation ( <i>n</i> = 13177) <sup>b</sup>	35 (0.27%) <sup>d</sup>	0.0555 <sup>f</sup>
Non-older ( <i>n</i> = 3406) <sup>b</sup>	14 (0.41%) <sup>d</sup>	
Older ( <i>n</i> = 9771) <sup>b</sup>	21 (0.21%) <sup>d</sup>	

<sup>a</sup>Is total number of hospitalized. <sup>b</sup>Is number of patients referred to department of rehabilitation. <sup>c</sup>Is number of falls/total number of hospitalized × 100. <sup>d</sup>Is number of falls/number of patients referred to department of rehabilitation × 100. <sup>e</sup>Is compares total inpatients to total falls during rehabilitation. <sup>f</sup>Is comparison between non-older and older patients.

## Results

In the 2 years from April 2020, 46,050 patients were admitted to our hospital, of which 13,177 were rehabilitated. All AEs and occurrences during rehabilitation are shown in **Figure 1**. Of the 188 AEs that occurred during the 2-year period, falls were the third most common, following peripheral intravenous tube removal, and decreased level of consciousness and poor mood due to decreased blood pressure. **Table 1** shows the number of falls that occurred during hospitalization

and rehabilitation. The number of falls in the entire hospital was 945 and during rehabilitation was 35 (14 and 21 in the non-older and older groups, respectively), and the fall rate during rehabilitation was significantly lower ( $p < 0.0001$ ) than that during hospitalization. While the incidence of falls during rehabilitation was 0.21 and 0.41% in the older and non-older patients, respectively, in older patients, it was about half that in the non-older patients; however, the difference was not significant ( $p = 0.0555$ ).

**Table 2** shows the characteristics of the patients who fell grouped by age and matched with non-fall patients. There were no significant differences in mRS before admission and FIM at admission in both the non-older and older groups compared to the non-falling patients group. Furthermore, a comparison of non-older and older patients who fell showed no significant differences in mRS before admission, FIM at admission, days from admission to fall occurrence, days from surgery to fall occurrence, or mRS at fall.

**Table 3** shows the details of the fall, patient's communication status at the time of the fall, and whether the therapist was with the patient. Ten of 14 (71.4%) of the non-older and 11 of 21 (52.4%) of older patients fell despite good communication; however, there was no significant difference between the two ( $p = 0.2598$ ). In addition, 10 of 14 (71.4%) non-older and 11 of 21 (52.4%) older patients fell even though the therapist

**TABLE 2** Characteristics of non-older and older adults who fell during rehabilitation.

	Non-older ( $\leq 64$ )				Older ( $\geq 65$ )			
	Total fall patients ( <i>n</i> = 35)	Fall patients ( <i>n</i> = 14)	Not-fall patients ( <i>n</i> = 14)	<i>p</i> -value	Fall patients ( <i>n</i> = 21)	Not-fall patients ( <i>n</i> = 21)	<i>p</i> -value	Non-older vs. older
Age (years)	65.0 ± 16.8	49.6 ± 16.3	49.8 ± 16.4	0.9821	72.1 ± 5.7	72.1 ± 5.8	0.9790	$p < 0.0001$
Sex (female/male)	15/20	4/10	4/10	1	11/10	11/10	1	$p = 0.1632$
Pre-admission mRS (median IQR)	1 (0–2)	1 (0–2.75)	1 (0–2.5)	0.6252	1 (0–2)	1 (0–2)	>0.9999	$p = 0.7397$
FIM at admission (median IQR)	79 (46–115.5)	74 (39.0–99.25)	92 (48.25–120)	0.4265	93 (52–125)	98 (58–115)	0.9950	$p = 0.3196$
Motor FIM	47 (18.0–82.5)	41.5 (13–66.5)	64.5 (14.75–85)	0.3058	58 (23–90)	55 (23–80)	0.9353	$p = 0.2035$
Cognition	33 (25–35)	33 (24.75–34.75)	34.5 (24.25–36)	0.4459	31 (25–35)	34 (28–35)	0.4843	$p = 0.8576$
FIM								
Days from hospitalization to occurrence	32.8 ± 31.5	39.4 ± 40.4			28.4 ± 23.2			$p = 0.3216$
Days from surgery to occurrence	26.1 ± 31.1	41.0 ± 47.3 ( <i>n</i> = 7)			17.4 ± 8.7 ( <i>n</i> = 12)			$p = 0.1178$
mRS at AE occurrence (median IQR)	4 (4–4)	4 (4–4)			4 (3–4)			$p = 0.5785$

mRS, modified Rankin Scale; IQR, 75th–25th percentiles; FIM, functional independence measure; AE, adverse event. The not-fall group was randomly selected from a group of patients matched by age, sex, and primary department.

**TABLE 3** About the communication ability of the patient at the time of the fall and details of the fall situation.

Non-older (n = 14)	Older (n = 21)
Good communication (n = 10)	Good communication (n = 11)
<u>The therapist was near the patient (n = 8)</u>	<u>The therapist was near the patient (n = 5)</u>
During stand-up training 1	During sitting training 1
During walking training 5	During walking training 4
Wheelchair-driven 1	<u>The therapist was not near the patient (n = 6)</u>
During transfer from bed to wheelchair 1	During stand-up training 1
<u>The therapist was not near the patient (n = 2)</u>	During walking training 1
During stand-up training alone 1	During walking alone 2
Legs touched the desk when moving 1	Legs touched the desk when moving 1
	Falling when doing exercises other than instructions 1
Poor communication (n = 4)	Poor communication (n = 10)
<u>The therapist was near the patient (n = 2)</u>	<u>The therapist was near the patient (n = 6)</u>
During walking training 1	During walking training 5
Falling out of a wheelchair 1	When standing from a wheelchair 1
<u>The therapist was not near the patient (n = 2)</u>	<u>The therapist was not near the patient (n = 4)</u>
During standing training 1	Resting in the sitting position 1
While climbing stairs alone 1	Standing up alone 2
	Falling out of a wheelchair 1

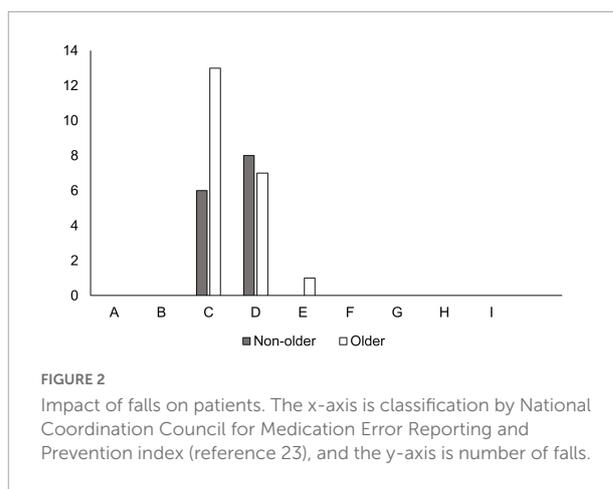
There was no significant difference between the two groups regarding the orientation status of non-older and older patients who fell and whether the therapist was near the patient.  $p = 0.2598$  for both.

was nearby (assisting), with no significant difference between the two ( $p = 0.2598$ ). Furthermore, falls in both groups most commonly occurred while walking.

The impact of falls on non-older patients was in categories C and D, where all fall patients did not require additional treatment. However, even in older patients, 20 out of 21 were in category C or D, with only one in category E in which a fall occurred during walking training while accompanied by a therapist and a wound was sutured due to an eyelid laceration (Figure 2). In the non-older group, more patients in the main departments of neurosurgery (28.6%), orthopedic surgery (14.3%), and rehabilitation (14.3%) had falls, while older patients also had more patient falls in neurosurgery (28.6%), orthopedic surgery (23.8%), and rehabilitation medicine (9.5%; Table 4). There was no significant difference in the main clinical departments of fallen patients between the non-older and older.

## Discussion

In this study, the number of falls that occurred during rehabilitation was significantly lower than that during



**FIGURE 2**  
Impact of falls on patients. The x-axis is classification by National Coordination Council for Medication Error Reporting and Prevention index (reference 23), and the y-axis is number of falls.

hospitalization and being older did not increase the number of falls. Furthermore, the ADL status before illness and at admission for both non-older and older patients was not related to the occurrence of falls. In addition, older patients with poor communication were not more likely to fall. This is the first report to investigate the characteristics related to patients who fall between non-older and older patients occurring during rehabilitation in an acute care hospital.

The risk of falls and injury increases with age and falls in older individuals are more likely to occur in association with social, behavioral, and physical risk factors, such as reduced physical fitness; impaired vision, balance, and gait; and multiple medications as well as physical environmental risk factors such as poor lighting and slippery floors (25, 26). People  $\geq 65$  years are at a high risk of falls, with 30%  $> 65$  and 50%  $> 80$  falling at least once a year (27). However, there was no significant difference in the incidence of falls in this study, and the actual incidence was 0.21% in older patients, lower than 0.41% in non-older patients. Lee et al. (13) reported that fall patients had a significantly lower total FIM score on admission than that of non-fall patients, and that patients with a low cognition FIM on admission had a higher risk of falls. Patients with Mini Mental State Examination (MMSE) scores  $< 28/30$  had a nearly threefold increased risk of falls compared to control patients with 30/30 scores, indicating a relationship between cognitive ability and falls (28). Thirty-two patients who were unable to communicate their basic needs (21.7%) were almost twice as likely to fall during hospitalization as those who were able to communicate (29). Furthermore, Teasell et al. (30) reported that the group of patients who fell had significantly lower scores on the Berg Balance Scale and FIM than those from the non-fall group. Additionally, the number of falls significantly increased with lower FIM in the patients who fell. Pils et al. (31) also reported that being older, gender (higher fall rates in men), and MMSE scores were associated with falls during hospitalization for rehabilitation after femur fracture. In our study, there were no significant differences in mRS, motor FIM,

TABLE 4 Main clinical departments of fallen patients.

	Total patients ( <i>n</i> = 35)	Non-older ( <i>n</i> = 14)	Older ( <i>n</i> = 21)	<i>p</i> -value
Neurosurgery	10 (28.6%)	4 (28.6%)	6 (28.6%)	>0.9999
Orthopedic surgery	7 (20.0%)	2 (14.3%)	5 (23.8%)	0.6760
Rehabilitation	4 (11.4%)	2 (14.3%)	2 (9.5%)	>0.9999
Diabetes, endocrine, and metabolic medicine	2 (5.7%)	1 (7.1%)	1 (4.8%)	>0.9999
Gastrointestinal, endocrine, and pediatric surgery	2 (5.7%)	1 (7.1%)	1 (4.8%)	>0.9999
Neuropsychiatry	2 (5.7%)	1 (7.1%)	1 (4.8%)	>0.9999
Cardiovascular medicine	1 (2.9%)	1 (7.1%)	0 (0%)	0.4000
Rheumatology and clinical immunology	1 (2.9%)	1 (7.1%)	0 (0%)	0.4000
Pediatrics	1 (2.9%)	1 (7.1%)	0 (0%)	0.4000
Emergency medicine	1 (2.9%)	0 (0%)	1 (4.8%)	0.4400
Cardiovascular, respiratory, and breast surgery	1 (2.9%)	0 (0%)	1 (4.8%)	0.4400
Plastic and reconstructive surgery	1 (2.9%)	0 (0%)	1 (4.8%)	0.4400
Nephrology (artificial dialysis)	1 (2.9%)	0 (0%)	1 (4.8%)	0.4400
Otolaryngology	1 (2.9%)	0 (0%)	1 (4.8%)	0.4400

cognition FIM before admission in the two groups, or in the ratio of mRS and good communication at the time of fall. Furthermore, there were no significant differences in either the older or non-older patients when compared to the matched non-fall group. Significantly, the incidence of falls during acute rehabilitation was not related to ADL performance or degree of communication as previously reported.

Schwendimann et al. (32) investigated 3,842 fall patients out of 34,972 inpatients, of which 2,552 (66.4%) were intact and 1,142 (29.7%) had minor injuries such as pain, bruise, blood type, and laceration. Additionally, 148 (3.9%) reported serious AEs such as fractures and intracranial hemorrhage. Of the 1,472 patients admitted to the rehabilitation center, 140 fell during their stay; 90% did not suffer harm, while 8/10 who did suffer harm had minor contusions, lacerations, or abrasions, and 2/10 suffered fractures (13). Saverino et al. (33) also reported 40/320 post-acute orthopedic and neurologic inpatients fell during hospitalization, with one sustaining a rib fracture; however, the falls otherwise had minor effects. The results of our study support previous findings that most falls do not have serious consequences, as 34/35 total falls were minor AEs that did not require additional treatment. However, follow-up studies of older adults who fell show that even non-injurious falls are associated with subsequent decline in basic and instrumental ADLs. Additionally, two or more non-injurious falls are associated with decreased social activity, and at least one injurious fall is associated with decreased physical activity (34). Therefore, attention to fall prevention is necessary regardless of the degree to which a fall affects the patient.

In this study, falls were more common in neurosurgical patients in both groups. In a one-year survey of falls in acute care hospitals (35), 826 of 49,059 inpatients experienced falls, with the most common primary diseases being neurological 214 (26%), gastroenterological 145 (18%), pediatrics 57 (7%),

respiratory 51 (6%), cardiac 41 (5%), otolaryngology 40 (5%), orthopedics 33 (4%), and others 245 (30%). Eileen et al. (36) reported 3.38 falls per 1,000 patients per day in an academic hospital with 1,300 beds, with the highest rate of falls in neurology and internal medicine at 6.12. Stroke patients have a higher risk of experiencing falls due to multiple intrinsic risk factors, including impaired consciousness, cognitive impairment, ADL impairment, and depressive symptoms (37, 38). However, it is difficult to generalize as the disease severity of patients, severity of the disease to be treated at the study facility, number of patients accepted, and presence or absence of rehabilitation are unknown, more attention to fall prevention during rehabilitation for both older and non-older patients with cerebrovascular disorders should be paid, as in previous reports.

In previous studies, more than 80% falls in hospitals were not witnessed, and most falls occurred in situations where no one was nearby (9, 39). However, more than half of the falls during this study occurred in situations where the therapist was nearby (assisting) both the older and non-older groups. Patients offered rehabilitation in this hospital often have multiple serious motor, cognitive, and ADL impairments, and require a high amount of assistance. The difference in results as compared to previous studies may be related to the fact that the falls occurred during rehabilitation therapy sessions and that therefore the severity of the patient's disability was different.

This study has the limitation of being a single-site, retrospective cohort study, which affects generalizations. Thus, it is important to conduct a larger, multi-site study in the future.

## Conclusion

The rate of falls during rehabilitation was significantly lower than that during hospitalization, and many falls had minimal

impact on the patient. It was also difficult to predict falls by ADL and communication status, and there appeared to be no difference in characteristics between the older and non-older groups who experienced falls. However, since more than half of falls occur during training with a therapist near the patient, it is necessary to scrutinize the patient's disability status and training content.

## Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The studies involving human participants were reviewed and approved by the study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Review Committee of Wakayama Medical University. Written informed consent from the participants or their legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

TK and YN conceptualized and designed the study, drafted, reviewed, and revised the manuscript. YU, YK, SK, YY,

and KM designed the data collection instruments, collected data, performed the initial analyses, reviewed, and revised the manuscript. FT designed the data collection instruments, coordinated and supervised data collection, and critically reviewed the manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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