A short form of the modified Japanese Nursing Association’s fall-risk assessment tool

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ABSTRACT

Falls remain a significant concern for the safety of hospitalized patients internationally. We developed a short form of the modified Japanese Nursing Association's fall-risk assessment tool to assess inpatients' fall risks. We conducted a retrospective cohort study to evaluate the predictive validity of two brief versions of a fall-risk assessment tool in 7-, 14-, 21-, and 28-day observation periods. The study was conducted at a Japanese university hospital. Among 11,333 patients (median age: 61 years, 51.3% women), 123 patients fell within 28 days of admission. Neither the modified Japanese Nursing Association's fall-risk assessment tool nor the short-form version 1 achieved sensitivity and specificity of >.70; therefore, we developed a 2nd version by eliminating two items (i.e., bone/joint problems and laxatives) and adding two items (i.e., impaired extremities and decreased strength). The second version exhibited good predictive validity used as a brief assessment of fall risks: sensitivity=.76, specificity=.78, positive likelihood ratio=3.47, negative likelihood ratio=.30, and the area under the receiver operating characteristics curve of .83 in a 7-day observation sample. We recommend that the study hospital implements the short-form (version 2) with careful monitoring of patients' fall rate and collects feedback from clinical nurses.
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Key words: accidental falls, assessment tool development, inpatients, nursing assessment, reproducibility of the results

INTRODUCTION

Prevention of inpatient falls has been of great interest to clinicians and researchers for several decades; however, falls remain a significant concern for the safety of hospitalized patients. The fall rate per 1000 patient-days doubled from .41 in 1998 to .88 in 2008 in Australian hospitals[1)], and Danish hospitals reported that the rate of fall-related major injuries increased 11.4% annually between 2007 and 2012[2)]. While 16-29% of inpatient fallers suffer injuries, 1.5-2.0% of fallers died from hip fractures or intracranial hemorrhage due to falls in the United States[3, 4)]. In the United States, the Centers for Medicare and Medicaid Services not only ceased reimbursement for the costs associated with treating fall injuries during hospitalization[5)], but also withheld 1% of their reimbursement if the hospital performed poorly on the "Hospital Acquired

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Conditions" score, which is calculated by hospital acquired infection and patient safety indicators (including postoperative hip fracture rates)[6]. While human factors, such as communication and leadership, are the most common root causes of sentinel events reported to the Joint Commission, assessment was the most frequently reported root cause of fall-related events resulting in patient death or permanent loss of function[7].

The Joint Commission[8] and Australian Commission on Safety and Quality in Healthcare[9] recommends using a standardized and validated fall-risk assessment tool to prevent patient falls. This modified Japanese Nursing Association (JNA) tool comprises many (37) items compared with well validated and commonly used tools overseas: the STRATIFY (five items)[10], the Morse Fall Scale (six items)[11], and the Hendrich II Fall Risk Model (eight items)[12]. A systematic review concluded that neither the Hendrich II Fall Risk Model nor STRATIFY displayed strong enough predictive validity among older adults in acute hospital settings[13].

Lee et al. developed an automated fall-risk assessment system using 10 variables available in an electronic medical record to eliminate additional nursing workload[14]. The effort to reduce nurse workload is important; however, there is a concern if this risk assessment could lead to nursing interventions to prevent falls because most items included in this automated system, such as maximum pulse, length of stay, medical department, and type of room, are not linked to fall risk factors. A rigorous, large, randomized controlled study conducted in Australian acute hospitals found that their program combining modified STRATIFY and six interventions was ineffective in decreasing neither fall rate nor injurious fall rate[15].

Study aims

This study aimed to develop a short form of the modified JNA fall-risk assessment tool and to evaluate its predictive validity.

METHODS

Study design, setting, and patients

This study was a retrospective cohort design and conducted at a Japanese university hospital. We included patients aged 15 years and older with a length of stay≧2 days and who were admitted from October 2014 to November 2015. We adopted the inclusion and exclusion criteria of a previous study[16] as follows. Patients admitted to the neuropsychiatry, intensive care unit, or clinical decision unit were excluded because of the difference in patients' characteristics and nurse-to-patient ratio. We also excluded patients with no fall-risk assessment conducted within two days of admission, an assessment conducted on the discharge date, or patients with inconsistent assessment results (Fig. 1).

In a previous study[16], patients discharged before observation points were excluded when calculating predictive validity indices in different observation periods to reduce the risk of information bias. However, this could result in excluding more than half of the patients at a 7-day observation point because of the shorter length of stays in the hospital. Therefore, we decided not to exclude patients by their length of stay in this study.

Fall definition and identification

The theoretical definition of falls was "inadvertently coming to rest on the ground, floor, or other lower level, excluding intentional change in position to rest in furniture, wall, or other objects"[17]. The operational definition was a free-text description of one of the following: patients found on the floor either laying or sitting; report of falls from patients him/herself, patients' family, other patients, or other hospital staff; hospital staff assisted transfer of patients, but had to lower the patient to the floor; patient dropped from bed/chair; patient was unable to maintain sitting position and unintentionally leaned on the bed or bedrails; and healthcare professionals used the word "fell" or "fell down." All the free-text descriptions in the incident reports were reviewed by two of the researchers independently.

Measurements

1. Modified JNA tool

The fall-risk assessment tool used in this study (Fig. 2) was a modified version of the JNA fall-risk assessment tool[18]. Two items targeting younger inpatient populations, aged≦9 years and infants' developmental stage, were not included in the analyses. The predictive validity of the modified JNA tool was sufficient for clinical practice: sensitivity=.82, specificity=.71, positive likelihood ratio=2.83, negative likelihood ratio=.26 at a cut-off point of≧6, and the area under the receiver operating characteristic (ROC) curve=.83; however,

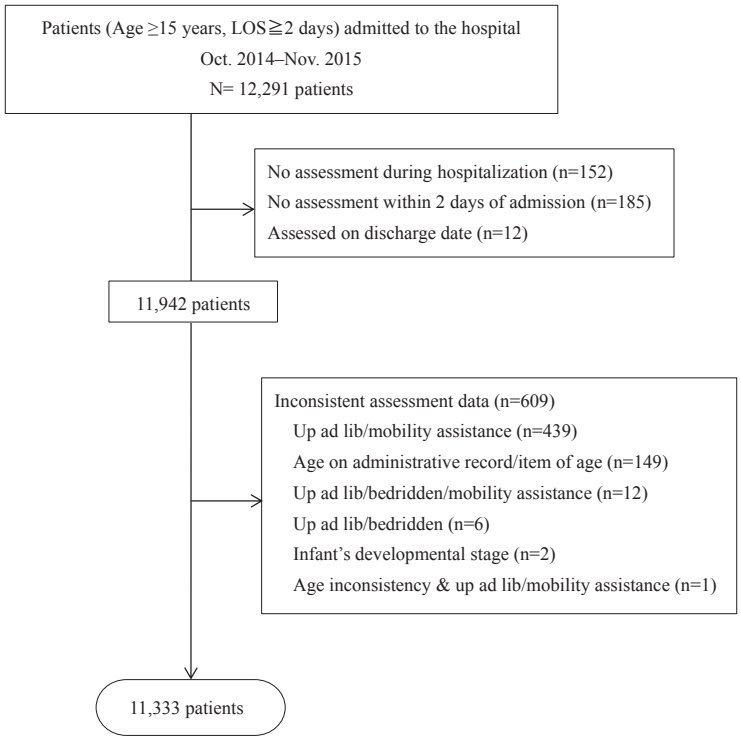

Fig. 1 **Flowchart of patient selection**

Items		Score
Age	65 years and older[a] or 9 years and younger[b]	1
History	Fall history within 1 year	1
Sensory Functions	Visual impairment that affects daily life	1
	Hearing impairment that affects daily life	
Motor Functions	Problems in the extremities (paralysis, numbness)	1
	Bone and/or joint problem	
	Muscle weakness	1
Mobility	Up ad lib	1
	Unstable when standing and/or walking	1
	Use wheelchair, cane, or walker	1
	Requires mobility assistance	1
	Bedridden but able to move extremities	
	Cast, IV lines, or other tubes	1
	Infant's developmental stage (roll over, crawl, etc.)[b]	1
Cognition	Feeling restless because of anxiety or worried about something	1
	Recently feeling forgetful	
	Impaired judgment and/or understanding	
	Unable to use a call light	1
Medications	Analgesics	1
	Laxatives	
	Diuretics	
	Chemotherapy	
	Antiparkinsonians	
	Hypnotics/tranquilizers	1
	Antihypertensives	
Elimination	Waking up more than 2 times at night for toileting	1
	Urinary and/or bowel incontinence	1
	Requiring toileting assistance	
	Using a commode chair[a]	
Treatment stage	In rehabilitation stage[a]	1
	Anemia and/or orthostatic hypotension[a]	1
	Decreased strength due to fever, diarrhea, vomiting, etc.[a]	
	Within 3 days of surgery[a]	1
Personality	Hesitant to use a call light to ask for nurse's help[a]	1
	Does not like to depend on others[a]	
Environment	New to the ward or hospital environment[a]	1

[a]Not included in the Japanese Nursing Association's tool. [b]Not included in the analyses.

Fig. 2 **Modified Japanese Nursing Association fall risk assessment tool**

only 21 out of 35 items showed significantly larger proportions among fallers compared to non-fallers[16].

2. The short form of the modified JNA tool

The items selected for the version 1 and the version 2 of the 17-item tools are shown in Table 1.

1) The 17-item tool (version 1)

First, we used the cohort from a previous study[16] and calculated the area under the ROC curve by adding items one-by-one following the order of highest to the lowest value of relative risk for 21 items that demonstrated a significantly larger proportion among fallers compare to non-fallers in the previous study[16]. The area under the ROC curve (AUC) was highest with 15 items (0.86); however, it demonstrated a decrease in sensitivity (.78)

Table 1 **Items included in analyses**

Modified JNA tool	15 items	17 items (version 1)	17 items (version 2)
Age ≧ 65 years			
Fall history	○	○	○
Sensory impairment			
Visual impairment		○	○
Hearing impairment			
Motor functions			
Impaired extremities			○
Bone/joint problems	○	○	
Muscle weakness	○	○	○
Mobility			
Up ad lib			
Unstable when standing/walking	○	○	○
Mobility assistive devices	○	○	○
Requiring mobility assistance	○	○	○
Bedridden			
Cast, IV lines, or tubes			
Cognition			
Restless/anxious			
Forgetful	○	○	○
Impaired judgment/understanding	○	○	○
Unable to use a call light			
Medication			
Analgesics	○	○	○
Laxatives	○	○	
Diuretics			
Chemotherapy			
Antiparkinsonian			
Hypnotics/tranquilizers		○	○
Antihypertensive			
Elimination			
Toileting ≧ 2x per night	○	○	○
Urinary/bowel incontinence	○	○	○
Requiring toileting assistance			
Commode chair use	○	○	○
Treatment stage			
Rehabilitation			
Anemia/orthostatic hypotension			
Decreased strength			○
Surgery within 3 days			
Personality			
Hesitant to use a call light	○	○	○
Does not like to depend on others	○	○	○
Environment			
New to the hospital environment			

Note: JNA: Japanese Nursing Association; IV: intravenous.

compared to the modified JNA (.82)[16]. Therefore, the researchers considered adding two more items (i.e., visual impairment and hypnotics/tranquilizer). Visual impairment is an important risk factor newly added to the guideline regarding assessment and prevention of falls in older adults by the National Institute for Health and Care Excellence[19]. Hypnotics/tranquilizer is a risk factor consistently showed to increase fall risks in meta-analyses[20-22].

We did not use a logistic regression analysis to select items for the short-form because key risk factors could be eliminated if they had a strong association with other risk factors and there was not a sufficient number of fallers in the previous study cohort (at least 210 fallers) to enter 21 items in a logistic equation[23]. We wanted a tool not only to predict falls, but also to address crucial fall risk factors identified in the guidelines and in previous studies.

2) The 17-item tool (version 2)

Neither the modified JNA tool nor version 1 of 17-item tool achieved both a sensitivity and specificity of >.70 in the validation cohort. Therefore, we developed a second version of 17-item tool by eliminating two items that showed no significant association with falls (i.e., bone/joint problems and laxatives) and adding two items that had a significant association with falls in both a previous study[16] and validation cohort (i.e., impaired extremities and decreased strength) (Table 1).

Data collection

The hospital's information systems department extracted patients' background information and their fall risk assessment results from the electronic charting system and provided the data in an Excel® file (Microsoft Corporation, Redmond, USA). A clerical assistant from the hospital's safety management department obtained falls/fallers information from the incident reporting system in an Excel file. Lastly, a lead researcher created a database for analyses by combined information on two Excel files by patient ID number and their dates of admission and discharge.

Statistical analysis

Descriptive statistics were used to summarize patients' characteristics. The length of stay of patients discharged after December 28, 2015 was calculated as if they were discharged on December 28, 2015 as falls followed this date. Pearson's chi-square test and Fisher's exact test was used to examine the associations between nominal variables and fall status within 28 days of admission. Patients' age, length of stay, and total assessment score were compared between fallers and non-fallers using the Mann-Whitney U test because their distributions were skewed. Relative risks and associated 95% confidence intervals were also calculated for each item of the modified JNA tool. Predictive validity was estimated in different observation periods of 7-, 14-, 21-, and 28-days using the ROC curve, the AUC, sensitivity, specificity, and positive and negative likelihood ratios. The optimal cut-off points were determined for each tool as the point that achieved sensitivity and specificity to be>.70 per Oliver et al.'s criteria[24] or nearest to .70. The cut-off points of the modified JNA tool, version 1, and version 2 were≧6,≧3, and≧4, respectively. Finally, differences in AUCs among the three tools were compared by Pearson's chi-square test. Statistical analyses were performed using SPSS version 19 (IBM Corp, Armonk, NY) or MedCalc Statistical Software version 13.0 (MedCalc Software, Ostend, Belgium); p-values less than .05 were considered statistically significant; and associated 95% confidence intervals were calculated when applicable.

Ethical considerations

The Ethics Committee for Epidemiological Research of the researchers' university approved this study (approval number 322). Consistent with the ethical guidelines by Japan's Ministry of Health, Labour and Welfare and Ministry of Education, Culture, Sports, Science and Technology[25], no informed consent was obtained; however, research information was disclosed by posting to inpatient wards and outpatient areas. This study was conducted in accordance with the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000 and Brazil 2013).

RESULTS

Patients' characteristics

Patients' characteristics are shown in Table 2. During their hospital stay, 241 falls occurred by 206 patients (1.42 falls per 1,000 patient-days; faller rate=1.7%). The first falls were most frequently

Table 2 **Patients of the validation cohort's characteristics**

Characteristics	Total (*N*=12,291)	Patients after exclusion (*n*=11,333)	28 days of admission		*p*-value
			Fallers (*n*=123)	Non-fallers (*n*=11,210)	
Age (years), median	61 (45, 72)	61 (44, 72)	67 (60, 77)	61 (44, 72)	<.001 †
(Q1, Q3), range	15–105	15–105	16–88	15–105	
Women, n (%)	6305 (51.3)	5814 (51.3)	62 (50.4)	5752 (51.3)	.84 ‡
Median length of stay	7 (3, 15)	7 (3, 15)	26 (12, 42)	6 (3, 14)	<.001 †
(days), (Q1, Q3), range	2–416	2–416	2–144	2–416	
Clinical specialty, n (%)					
Internal Medicine	2873 (23.4)	2559 (22.6)	41 (33.3)	2518 (22.5)	
Surgeries	1584 (12.9)	1466 (12.9)	15 (12.2)	1451 (12.9)	
Ophthalmology	1979 (16.1)	1824 (16.1)	4 (3.3)	1820 (16.2)	
Obstetrics/Gynecology	1695 (13.8)	1615 (14.3)	7 (5.7)	1608 (14.3)	
Urology	811 (6.6)	759 (6.7)	6 (4.9)	753 (6.7)	
Otorhinolaryngology	927 (7.5)	874 (7.7)	5 (4.1)	869 (7.8)	
Orthopedics	514 (4.2)	492 (4.3)	7 (5.7)	485 (4.3)	
Dermatology	593 (4.8)	535 (4.7)	11 (8.9)	524 (4.7)	
Maxillofacial Surgery	368 (3.0)	347 (3.1)	2 (1.6)	345 (3.1)	
Neurosurgery	513 (4.2)	475 (4.2)	17 (13.8)	458 (4.1)	
Radiology	212 (1.7)	198 (1.7)	7 (5.7)	191 (1.7)	
Pediatrics	102 (0.8)	95 (0.8)	0 (0.0)	95 (0.8)	
Anesthesiology	46 (0.4)	26 (0.2)	0 (0.0)	26 (0.2)	
Emergency	21 (0.2)	16 (0.1)	1 (0.8)	15 (0.1)	

Q1: first quartile; Q3: third quartile.
† Mann-Whitney test, ‡ Pearson's χ^2 test.

occurred in 1-7 days after admission (32%).

We excluded 337 patients without fall-risk assessment results within two days of admission, 12 patients with an assessment on their discharge date, and 609 patients for inconsistent assessment results (Fig. 1). The number of patients included in the analyses was 11,333, and 123 patients fell within 28 days of admission. Fallers were significantly older (median 67 years vs. 61 years) and had longer hospital stays (median 26 days vs. 6 days) than non-fallers did.

Assessment results of the modified JNA tool

Fall risk assessment scores of fallers were significantly higher than non-fallers (median 7 vs. 4, p<.001). Twenty-one items out of 35 items from the modified JNA tool showed significantly larger proportions among fallers compared to non-fallers. "Up ad lib" was the only item with a significantly larger proportion among non-fallers than fallers (Table 3).

Predictive validity

Predictive validity indices of the modified JNA tool and 17-item tool of versions 1 and 2 are shown in Table 4. In all three tools, predictive validity indices were achieved best in the 7-day observation samples. The modified JNA tool in 7-day observation samples and version 1 of the 17-item tool in 7- and 14-day observation samples demonstrated sensitivity>.70; however, their specificity was slightly lower (.70 or .69) than Oliver's criteria[24]. The second version of the 17-item tool exhibited sensitivity of .76 and specificity of .78 in the 7-day observation sample and showed a positive likelihood ratio of 3.47, a negative likelihood ratio of .30, and an AUC of .83. The AUCs of the 17-item tool (version 2) were significantly larger than the AUCs of the 17-item tool (version 1) on 7-day (p=.047); however, the difference was not significant for the other observation periods. There was no statistical difference between the modified JNA tool and the 17-item tools (version 1 and version 2).

Table 3 **Fall risk assessment tools and falls within 28 days of admission in the validation cohort**

Variables	Total (N=11,333)	28 days of admission		p-value	RR (95% CI)
		Fallers (n=123)	Non-fallers (n=11,210)		
Modified JNA score, median (Q1, Q3)	4 (3, 6)	7 (5, 9)	4 (3, 6)	<.001 †	
The short-form ver. 1 score, median (Q1, Q3)	1 (0, 3)	4 (2, 6)	1 (0, 3)	<.001 †	
The short-form ver. 2 score, median (Q1, Q3)	1 (0, 3)	4 (2, 6)	1 (0, 3)	<.001 †	
Fall risk assessment tool items, *n* (%)					
Age ≧ 65	4520 (39.9)	68 (55.3)	4452 (39.7)	<.001	1.86 (1.31–2.65)
Fall history	1126 (9.9)	42 (34.1)	1084 (9.7)	<.001	4.70 (3.25–6.79)
Visual impairment	1119 (9.9)	25 (20.3)	1094 (9.8)	<.001	2.33 (1.51–3.60)
Hearing impairment	817 (7.2)	17 (13.8)	800 (7.1)	0.004	2.06 (1.24–3.43)
Motor functions					
Impaired extremities	1808 (16.0)	33 (26.8)	1775 (15.8)	0.001	1.93 (1.30–2.87)
Bone/joint problems	659 (5.8)	11 (8.9)	648 (5.8)	0.14	1.59 (.86–2.94)
Muscle weakness	2606 (23.0)	56 (45.5)	2550 (22.7)	<.001	2.80 (1.97–3.98)
Mobility					
Up ad lib	9435 (83.3)	67 (54.5)	9368 (83.6)	<.001	.24 (.17–.34)
Unstable when standing/walking	1888 (16.7)	60 (48.8)	1828 (16.3)	<.001	4.76 (3.36–6.76)
Mobility assistive devices	1815 (16.0)	54 (43.9)	1761 (15.7)	<.001	4.10 (2.88–5.84)
Requiring mobility assistance	1253 (11.1)	43 (35.0)	1210 (10.8)	<.001	4.32 (3.00–6.23)
Bedridden	260 (2.3)	8 (6.5)	252 (2.2)	0.007	2.96 (1.46–6.00)
Cast, IV lines, or tubes	2006 (17.7)	36 (29.3)	1970 (17.6)	0.001	1.92 (1.31–2.83)
Cognition					
Feeling restless	1438 (12.7)	27 (22.0)	1411 (12.6)	0.002	1.94 (1.27–2.96)
Forgetful	1104 (9.7)	21 (17.1)	1083 (9.7)	0.006	1.91 (1.20–3.04)
Impaired judgment/understanding	520 (4.6)	15 (12.2)	505 (4.5)	<.001	2.89 (1.70–4.92)
Unable to use a call light	298 (2.6)	5 (4.1)	293 (2.6)	0.26	1.57 (.65–3.81)
Medication					
Analgesics	1750 (15.4)	34 (27.6)	1716 (15.3)	<.001	2.09 (1.41–3.10)
Laxatives	1220 (10.8)	19 (15.4)	1201 (10.7)	0.09	1.51 (.93–2.46)
Diuretics	651 (5.7)	11 (8.9)	640 (5.7)	0.13	1.61 (.87–2.98)
Chemotherapy	686 (6.1)	8 (6.5)	678 (6.0)	0.83	1.08 (.53–2.20)
Antiparkinsonian	40 (.4)	2 (1.6)	38 (.3)	0.07	4.67 (1.19–18.23)
Hypnotics/tranquilizers	1663 (14.7)	36 (29.3)	1627 (14.5)	<.001	2.41 (1.64–3.54)
Antihypertensive	3584 (31.6)	47 (38.2)	3537 (31.6)	0.11	1.34 (.93–1.92)
Elimination					
Toileting ≧ 2x per night	4347 (38.4)	68 (55.3)	4279 (38.2)	<.001	1.99 (1.40–2.83)
Urinary/bowel incontinence	631 (5.6)	15 (12.2)	616 (5.5)	0.001	2.36 (1.38–4.02)
Requiring toileting assistance	950 (8.4)	36 (29.3)	914 (8.2)	<.001	4.52 (3.08–6.63)
Commode chair use	143 (1.3)	2 (1.6)	141 (1.3)	0.67	1.29 (.32–5.18)
Treatment stage					
Rehabilitation	148 (1.3)	4 (3.3)	144 (1.3)	0.08	2.54 (.95–6.79)
Anemia/orthostatic hypotension	811 (7.2)	16 (13.0)	795 (7.1)	0.01	1.94 (1.15–3.26)
Decreased strength	627 (5.5)	16 (13.0)	611 (5.5)	<.001	2.55 (1.52–4.29)
Surgery within 3 days	92 (.8)	0 (0)	92 (.8)	0.63	.49 (.03–7.81)
Personality					
Hesitant to use a call light	1000 (8.8)	16 (13.0)	984 (8.8)	0.10	1.55 (.92–2.60)
Does not like to depend on others	680 (6.0)	10 (8.1)	670 (6.0)	0.32	1.39 (.73–2.63)
New to the hospital environment	3579 (31.6)	45 (36.6)	3534 (31.5)	0.23	1.25 (.87–1.80)

Note: RR: relative risk; CI: confidence interval; JNA: Japanese Nursing Association; IV: intravenous; Q1: first quartile, Q3: third quartile. All Pearson's χ^2 test or Fisher's exact test, except † Mann-Whitney U test.

Table 4 **Predictive validity indices of the modified Japanese Nursing Association fall risk assessment tool and its short-form in 7-, 14-, 21-, and 28-day observation samples**

Obs. periods	Prev., %	Modified JNA tool at cut-off ≧ 6					17-item tool (version 1) at cut-off ≧ 3					17-item tool (version 2) at cut-off ≧ 4				
		Sensitivity (95% CI)	Specificity (95% CI)	+LR (95% CI)	-LR (95% CI)	AUC (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	+LR (95% CI)	-LR (95% CI)	AUC (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	+LR (95% CI)	-LR (95% CI)	AUC (95% CI)
7-day	.45	.78 (.65–.89)	.70 (.69–.71)	2.61 (2.3–3.0)	.31 (.2–.5)	.83 (.82–.83)	.78 (.65–.89)	.69 (.68–.70)	2.53 (2.2–2.9)	.31 (.2–.5)	.82 (.81–.82)	.76 (.63–.87)	.78 (.77–.79)	3.47 (3.0–4.1)	.30 (.2–.5)	.83 (.82–.84)
14-day	.79	.70 (.59–.79)	.70 (.69–.71)	2.33 (2.0–2.7)	.43 (.3–.6)	.77 (.76–.78)	.71 (.60–.80)	.69 (.68–.70)	2.3 (2.0–2.6)	.42 (.3–.6)	.75 (.75–.76)	.64 (.53–.74)	.78 (.77–.79)	2.92 (2.5–3.4)	.46 (.3–.6)	.77 (.76–.77)
21-day	1.01	.66 (.57–.75)	.70 (.69–.71)	2.21 (1.9–2.5)	.48 (.4–.6)	.74 (.74–.75)	.67 (.58–.75)	.69 (.68–.70)	2.17 (1.9–2.5)	.48 (.4–.6)	.74 (.73–.74)	.61 (.51–.70)	.78 (.77–.79)	2.78 (2.4–3.2)	.50 (.4–.6)	.74 (.73–.75)
28-day	1.09	.65 (.56–.73)	.70 (.69–.71)	2.18 (1.9–2.5)	.50 (.4–.6)	.74 (.73–.75)	.67 (.58–.75)	.69 (.68–.70)	2.17 (1.9–2.5)	.48 (.4–.6)	.73 (.72–.74)	.60 (.51–.69)	.78 (.77–.79)	2.75 (2.4–3.2)	.51 (.4–.6)	.74 (.73–.75)

Note: Obs. periods: observation periods; Prev: prevalence of fallers; +LR: positive likelihood ratio; -LR: negative likelihood ratio; CI; confidence interval; AUC: area under the receiver operating characteristic curve.

DISCUSSION

We developed and evaluated the predictive validity of a short form of the modified JNA fall-risk assessment tool. While the number of items was decreased from 35 items to 17 items, the predictive validity of the second version of the short form in 7-day observation samples was adequate for use in clinical practice per Oliver et al.'s criteria[24], as sensitivity and specificity were>.70. Predictive validity indices in 14-, 21-, and 28-day observation samples were inferior to the 7-day observation samples, which was consistent with a previous study[16]. This could be because patients' conditions changed during hospitalization.

The 17 items selected for the second version were not only useful in predicting patients' falls, but also addressed most risk factors identified in the National Institute for Health and Care Excellence's (NICE) guidelines[19]. Unstable or missing footwear and syncope syndrome were included in the NICE guidelines and the Australian Commission on Safety and Quality in Healthcare[9]; however, they are not included in the modified JNA or the short form.

When reviewing descriptions of fall situations in the incident reports, we came across several falls possibly related to vasovagal syncope. Vasovagal syncope is the most common causes of syncope and other common causes include cardiac arrhythmias, transient ischemic attacks, migraine, orthostatic hypotension, decrease in cardiac output, and situations such as micturition and defecation[26]. If a patient reports a history of syncope during a fall risk assessment, a nurse would ask about the situation and symptoms in detail, which would trigger a nurse to perform a physical examination or refer the patient to a physician for a medical examination and treatment. Additionally, educating patients to sit up or stand up slowly, lower the body when experiencing premonitory symptoms of the syncope, or ensuring a nurse is present to supervise a situation where a patient often experiences syncope could prevent falls. Therefore, history of syncope should be included in the short-form.

Commode chair use showed the highest relative risk in a previous study[16]; however, no significant association was found on the validation cohort. The nursing staff carefully evaluated patients' fall risk when using a commode chair and followed hospital's guidelines of removing the chair from the bedside after the patient used it. Additionally, the fact that nurses encourage patients to use a restroom instead of a bedside commode might influence the association between patient falls and commode chair use.

Personality traits, hesitant to use a call light, patients not wishing to depend on others were unique items included in the modified JNA and on the short-form. They are not included in other common assessment tools such as the Morse Fall scale[11], Hendrich II Fall Risk Model[12], or the STRATIFY[10]. These two items showed significant association with falls in a previous study[16], but not in the current study. While the proportion of patients with these personality traits did not differ in a total sample and non-fallers, the proportion of these traits in fallers reduced by half (hesitant 26.5% vs. 13.0%; do not like to depend 16.3% vs. 8.1%). This could be

because of successful fall prevention education explaining their fall risk and asking patients to use a call-light. Additionally, in 2013, the hospital implemented a new nursing delivering model called the Partnership Nursing System® (PNS®), where two nurses were assigned per patient[27]. In a survey conducted in an acute hospital using PNS®, more than 80% of patients reported that nurses responded to their needs promptly and frequently visited patients' rooms[28]. If nurses delay responding to patients' calls, patients may attempt to transfer to a wheelchair or ambulate without assistance or no longer use a call light for assistance. Therefore, it is possible that changing the nursing delivery model will influence the association between falls and personality traits. Further studies are necessary to examine this theory.

Fall rate per 1000 patient days increased from 1.38 in a previous cohort study[16] to 1.42 in the validation cohort. The median age of the patients in the two cohorts did not differ (60 years vs. 61 years); however, the median length of stay decreased from 10 days to 7 days. Because no information was gained on patients' acuity level or comorbidities, it is unclear if the increase in fall rate was due to a change in patients' characteristics, an improvement in healthcare staff's attitudes toward reporting fall incidents, or dysfunction in fall prevention care. The fall rate in the study hospital was lower than the average fall rate (2.66 per 1000 patient days) among 308 Japanese general hospitals[29]. This is partly explained by the fall rate in the general hospitals, which was calculated using all submitted incident reports and usually includes near fall events and duplicate reports for the same fall event.

Implications for practice

The short form (version 2) demonstrated strong enough predictive validity to be used in the Japanese university hospital. When implementing the short form in clinical practice, we need to carefully monitor patients' fall rate and actively listen to clinical nurses' perspectives as the number of items was reduced by half. The findings from the study also suggest that evaluating tools' validity once is not sufficient and re-evaluation is especially important when a change in patients' characteristics and nursing practice occurred.

Limitations

This study had several limitations. First, the study was conducted in a single hospital in Japan; therefore, generalization of the findings to other patient groups or settings is limited. Second, the underreporting of falls (approximately 28-40%) should be considered as falls were only identified by submitted incident reports[30, 31]. The underreporting of falls could underestimate sensitivity and overestimate specificity, which also influences other predictive validity values. Third, inaccurate entry of fall risk assessment results might be present; however, we attempted to eliminate inaccurate entries by crosschecking item inconsistencies.

CONCLUSIONS

The devised short form (version 2) of the modified JNA fall-risk assessment tool demonstrated satisfactory predictive validity in 7-day observation samples even though we decreased the number of items to 17. However, repeating periodical assessment is required as predictive validity declined with longer observation periods.

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