Original Article

Ann Rehabil Med 2018;42(5):670-681
pISSN: 2234-0645 • eISSN: 2234-0653
https://doi.org/10.5535/arm.2018.42.5.670

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Annals of Rehabilitation Medicine

Long-Term Outcomes of FIM Motor Items Predicted From Acute Stage NIHSS of Patients With Middle Cerebral Artery Infarct

Jun Saito, MD[1], Tetsuo Koyama, MD, PhD[2,3], Kazuhisa Domen, MD, PhD[3]

[1]Department of Rehabilitation Medicine, Goshi Hospital, Hyogo; [2]Department of Rehabilitation Medicine, Nishinomiya Kyoritsu Neurosurgical Hospital, Hyogo; [3]Department of Rehabilitation Medicine, Hyogo College of Medicine, Hyogo, Japan

Objective To outline the association between the National Institutes of Health Stroke Scale (NIHSS) in the acute stage and the Functional Independence Measure (FIM) of motor items several months later.

Methods Seventy-nine infarct cases with middle-cerebral-artery region transferred to long-term rehabilitation facilities were analyzed. Patients were allocated to either the model-development group or the confirmatory group at a 2:1 ratio. Independent variables were based on the NIHSS during the acute care and on demographic factors such as age and modified Rankin Scale (mRS) before onset. Multivariate logistic analyses were performed to predict the independence of each FIM motor item. These models were evaluated in the confirmatory group.

Results Multivariate logistic analyses in the model-development group (n=53) indicated that at least one NIHSS item was statistically significantly associated with the functional independence of a single FIM motor item. Of the NIHSS items, the affected lower extremity item was the most widely associated with 11 of the FIM motor items, except for eating and shower transfer. The affected upper extremity function was the second widely involved factor associated with 7 of the FIM motor items including eating, grooming, bathing, toileting, bed transfer, toilet transfer, and shower transfer. Age and mRS were also statistically significant contributing factors. The obtained predictive models were assessed in the confirmatory group (n=26); these were successful except for the stairs climb item.

Conclusion In combination with age and pre-stroke status, the NIHSS items (especially the affected extremity items) may be useful for the prediction of long-term outcome in terms of activities in daily living.

Keywords Rehabilitation, NIHSS, FIM, Prediction, Middle cerebral artery infarction

Received December 5, 2017; Accepted February 14, 2018
Corresponding author: Jun Saito
Department of Rehabilitation Medicine, Goshi Hospital, Amagasaki, Hyogo, Japan. Tel: +81-75-331-8778, Fax: +81-75-332-5988, E-mail: suction9@gmail.com
ORCID: Jun Saito (https://orcid.org/0000-0002-2986-1213); Tetsuo Koyama (https://orcid.org/0000-0002-1838-0684); Kazuhisa Domen (https://orcid.org/0000-0001-7712-7606).

INTRODUCTION

As the elderly population is increasing worldwide [1], the number of stroke patients is also rapidly rising; the number of first time stroke patients worldwide was 16.9 million in 2010 [2]. These patients often suffer from neural sequelae such as hemiparesis, which results in disabilities whereby the patient requires assistance for their activities in daily living (ADL) [3]. This aspect imposes a heavy burden on both medical and social welfare costs. The goals of rehabilitative treatment for stroke patients are to alleviate patients' disabilities and to thus reduce social costs. To design an effective rehabilitative treatment, outcome prediction is critically important.

Several test scales have been used in daily clinical practices for stroke patients. In the acute stage, the National Institute of Health Stroke Scale (NIHSS) is the most commonly used because of its practical applicability at the bedside [4]. However, this impairment assessment may undermine its applicability for the long-term outcome prediction when disability in ADL is often considered to be the most serious clinical concern.

The Functional Independence Measure (FIM) [5] is also a frequently used assessment tool for stroke patients. FIM calculates 13 motor and 5 cognitive items in reference to ADL, and directly reflects the burdens of care. Nevertheless, scoring FIM is often difficult within a few days after the onset at the bedside, where activities of FIM items are usually not allowed (e.g., bathing and/or stairs climb). In contrast to NIHSS, which is often assessed during the acute stage, FIM is often used in long-term rehabilitation settings, several months after onset.

As mentioned above, a long-term outcome prediction is needed in terms of ADL from the acute stage, when only impairment level assessment is currently possible. However, only a few studies have been carried out that outline the association between NIHSS in the acute stage and FIM motor items several months later. In this study, we assessed the relationships between NIHSS and FIM motor assessment items with adjustments made to demographic and clinical data such as age and lesion size in order to address this gap. To minimize variability of stroke symptoms, we focused on cerebral infarct in the middle cerebral artery (MCA) areas, the most common type of stroke [6].

MATERIALS AND METHODS

This is a retrospective cohort study. The Ethics and Hospital Committees of Goshi Hospital approved this study.

Patients

We sampled patients with MCA infarct who were admitted to Goshi Hospital from October 2011 to April 2014. The diagnosis of infarct was made using a diffusion-weighted magnetic resonance imaging (MRI) scanner (Intera 1.5T Pulsar; Philips, Eindhoven, The Netherlands) at the Department of Emergency of Goshi Hospital. According to the Japanese medical insurance system, a stroke patient typically receives inpatient medical treatments of a few weeks in an acute medical service hospital and is then transferred to a long-term rehabilitative facility. Therefore, to focus on the long-term outcomes that were accurately assessed by FIM, we sampled the patients who were transferred to 13 long-term rehabilitation facilities allied with Goshi Hospital via the local healthcare network system. Their maximal therapy sessions were 3 hours per day, 7 days a week.

Exclusion criteria for patients were worsening clinical courses by primary disease or severe comorbidity (e.g., neurological deterioration due to branch atheromatous disease, fracture, etc.) in acute care and/or long-term rehabilitative facilities, as well as refusal of rehabilitative treatment and/or incomplete dataset for NIHSS or FIM.

From the medical records during hospitalization, we collected the patients' data including age, gender, mRS [7] before the onset, lesion laterality, diffusion-weighted MRI imaging-Alberta Stroke Program Early CT Score +deep white matter lesions (DWI-ASPECTS+W) [8], infarction type, use of recombinant tissue plasminogen activator (rt-PA), removal of thrombosis of internal carotid artery, carotid artery stenting, botulinum toxin injection, length of stay of acute care hospital and rehabilitation facilities, and day of initiation of rehabilitative treatment.

NIHSS and FIM measurements

NIHSS is a scale used to measure the patients' level of stroke impairment by scoring the following 15 items: consciousness (3 subclasses), gaze, visual-field loss, facial palsy, right and left upper extremity motor strength, right and left lower extremity motor strength, limb ataxia, sensory loss, language, dysarthria, and extinction/attention items. The total score (ranging from 0 to 42) is often used as an index of stroke severity. NIHSS data obtained on the first day of rehabilitative treatment were entered into the analytical database for the current study. In this study, the right or left sides of the NIHSS items were categorized as 'affected' or 'unaffected' depending on the lesion side.

FIM consists of 13 motor items and 5 cognitive items. In this study, we focused on the FIM motor assessment items of eating, grooming, bathing, dressing upper body, dressing lower body, toileting, bowel management, bladder management, transfers to bed/chair/wheelchair, transfers to toilet, transfers to tub/shower, walking or wheelchair propulsion, and stair climb. Each item was scored on a 7-point scale: (1) total assistance; (2) maximal assistance; (3) moderate assistance; (4) minimal contact assistance; (5) supervision or set-up; (6) modified independence; and (7) complete independence. FIM motor scores recorded at discharge from the long-term rehabilitative facilities were entered into the analytical database for the current study.

Statistics

First, we allocated the participating patients to either the model-development group or the confirmatory group in a 2:1 ratio according to a computer-generated schedule. To determine the relationships between NIHSS and FIM motor items, we then employed multivariate logistic modeling analyses for the model-development group. In the analyses, the NIHSS items were set as explanatory variables and the FIM motor items were set as target values. In an attempt to adjust the logistic models between NIHSS and FIM, we added demographic and clinical data such as age, gender, and mRS before the onset. To ensure the dataset was fit for logistic modeling, we organized our raw data as follows.

For explanatory values, ordinal variables such as NIHSS items and mRS were converted into multiple categorical dichotomous variables [9]. The method used to generate multiple categorical dichotomous variables depended on the number of classification levels (2 to 5 levels) for the items. Therefore, we set four levels of classification for the 5-level assessment of upper extremity and lower extremity functions (Fig. 1). The nominal variables of the explanatory variables such as gender and lesion laterality were converted to a dichotomous variable (man=1; woman=0; right=1; left=0).

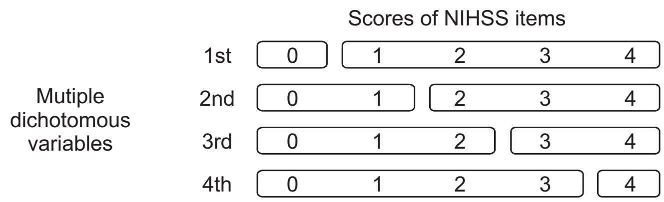

Fig. 1. Method of changing ordinary variables of the National Institutes of Health Stroke Scale (NIHSS) item into multiple dichotomous variables.

For target values, we converted the outcome variables of each FIM item to dichotomous variables, such as 'independence' or 'dependence'. Previous FIM studies [5,10] defined FIM values greater than 5 as the patient not requiring any help, implying 'independence', while a value equal to or less than 5 implies 'dependence'. According to the previous literature, the level of independence in bathing, shower transfer, and stairs climb have been shown to be more difficult than other items [10,11]. Taking this into consideration, retaining the supervision level (FIM 5) is a realistic goal for MCA infarct patients for these difficult items. Accordingly, for the two FIM items of 'dependence' and 'independence', we defined FIM values equal to or greater than 5 (supervision) as 'independence' while FIM values less than 5 were defined as 'dependence'.

Multiple logistic analyses were performed as follows. Variables showing a value of $p<0.20$ in the forward selection method were included in the multivariate model, provided that only one variable of each NIHSS item was selected. For example, even if the probability of the 2nd affected lower extremity is under 0.20, it was not considered when the 1st affected lower extremity had already been entered into the model. Statistically useless variables such as those that showed a 95% confidence of unit odds ratio interval including 1 were also excluded. A multivariate logistic model with $p<0.05$ was considered as statistically significant. Additionally, we assessed the regression coefficient of the predictive model obtained from each multivariate logistic regression equation.

Finally, we confirmed the predictive accuracy of the obtained logistic models by applying them to the confirmatory group. We used the proportion by chance accuracy criteria, whereby the accuracy rates were sufficiently high when the models showed 25% higher accuracy than the chance rate [12]. In a dichotomous logistic regression, this rate of chance, which occurs accidentally, can be calculated by squaring and summing the proportion of two real FIM outcome variables such as independence and dependence. For example, in the case of 70% independence and 30% dependence, the chance accuracy rate can be calculated as $0.7^2+0.3^2=0.49+0.09=0.58$. This shows that this prediction meets accidentally with a probability of 58%. Therefore, we can judge this regression equation as excellent when the accuracy rate is higher than 72.5%, calculated as 0.58×1.25=0.725.

All statistical analyses in the present study were performed using the JMP software version 10.0.2 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Fig. 2 presents the flow diagram of patients. Of the total 118 patients, 79 MCA region infarcted patients fulfilled the criteria, while 29 were excluded due to comorbidities or complications, 2 were excluded due to rehabilitation refusal, and 8 were excluded due to missing information. Hence, we allocated these 79 patients into two groups at a 2:1 ratio (53 in the model-development group and 26 in the confirmatory group). Table 1 shows the demographic profiles of these two groups. No statistically significant differences were found in age, gender, mRS, lesion laterality, DWI-ASPECTS+W, infarct type, contents of infarct therapy, length of stay of acute and rehabilitation facilities, and hospital day when the rehabilitative treatment began. Fig. 3 presents the characteristics of the 53 patients of the model-development group. The scatter diagrams show the relevance between the total score of NIHSS and the independence/dependence of each motor item of FIM.

Tables 2 and 3 indicate the results obtained from the multiple logistic regression analyses performed in the model-development group. A statistically significant correlation was found for at least one single NIHSS item for each FIM motor item. Of the NIHSS items, the most commonly involved factor was the affected lower extremity item. Among the 13 FIM motor items, affected lower extremity item contributed to 11 regression equations, but did not contribute to the eating and shower transfer items, indicating the importance of the lower extremity function of the affected side for the long-term ADL outcome. The second commonly involved NIHSS item was the affected upper extremity item, which accounted for 7 regression equations for the items of eating, grooming, bathing, toileting, bed transfer, toilet transfer, and shower transfer.

To adjust the correlation analyses between the NIHSS and FIM motor items, we added parameters from demographic and clinical data. Of these items, in combination with several NIHSS items, age showed statistically significant relationships for six items including grooming, toileting, bladder management, bed transfer, toilet transfer, and shower transfer. For example, the result for the FIM item for bed transfer produces the prediction equation of 19.63-(0.20×Age)-(3.39×Affected upper extremity 3rd)-(3.91×Affected lower extremity 2nd) (Table 2). Fig. 4 shows the logistic curve obtained from this formula. When the value of the affected upper extremity is under 3 and that of the affected lower extremity is under 2, these values can be converted to 0 (referring to Fig. 1). The positive number of this equation indicates independence: $19.63-(0.20\times Age)>0$, namely $\frac{19.63}{0.20}=98.15>Age$. This means that a patient under 98 years old who can show anti-gravitational upper extremity movement and hold the affected lower extremity at 30° in the supine position (NIHSS definition) during the acute phase, is predicted

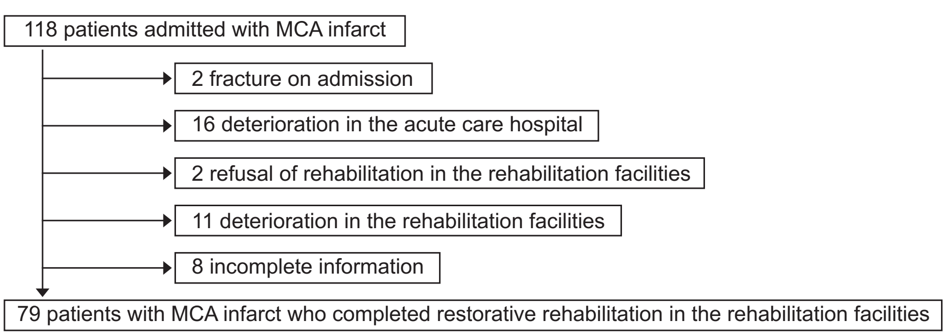

Fig. 2. Flow diagram of patients included and excluded in the study. MCA, middle cerebral artery.

Table 1. Baseline characteristics of the two groups

	Model-development group (n=53)	Confirmatory group (n=26)	p-value
Age (yr)	74 (67–80)	74 (61.25–78.5)	0.75[a]
Sex, male	33	19	0.45[b]
Modified Rankin Scale	0 (0-1)	0 (0–0.75)	0.09[a]
Laterality, right	23	14	0.47[b]
DWI–ASPECTS+W	9 (9-10)	9 (8.25–10)	0.84[a]
Infarction type			0.99[c]
Lacunar	21	10	
Atherome	22	11	
Cardiac emboli	10	5	
Recombinant tissue plasminogen activator therapy	8	3	1.0[b]
Removal of thrombosis of internal carotid artery	1	0	1.0[b]
Carotid artery stenting	0	2	0.11[b]
Botulinum toxin injection	5	1	0.66[b]
Length of stay in hospital (day)			
Acute	32 (26–38)	30 (25–34.5)	0.33[a]
Rehabilitation	105 (65–137)	87.5 (45–141.5)	0.50[a]
Initial rehabilitation	2 (1–2)	2 (1–2)	0.99[a]
NIHSS total score	9 (5–14)	6 (4.25–11.25)	0.06[a]
FIM motor total score	80 (51–87)	78 (60–85.5)	0.82[a]
FIM cognition total score	30 (19–35)	27.5 (24–35)	0.57[a]
FIM total score	110 (70–119)	107.5 (84.5–118.75)	0.80[a]

Values are presented as median (25%–75% interquartile range).
DWI–ASPECTS+W, diffusion-weighted magnetic resonance imaging–Alberta Stroke Program Early CT score+deep white matter lesion; NIHSS, National Institutes of Health Stroke Scale; FIM, Functional Independence Measure.
[a]Wilcoxon rank sum test, [b]Fisher exact test, [c]chi-square test.

to regain the ability to transfer between a bed and a wheelchair referring to Fig. 4. Apart from age, mRS before stroke onset was also detected as having statistically significant relationships for 5 items including upper body dressing, lower body dressing, bowel management, bladder management, and stairs climb (Tables 2 and 3).

Table 4 presents the accuracy rates of the model-development and confirmatory groups.

We employed the criteria using an accuracy rates 25% higher than the value based on the chance rate. According to that, our confirmatory group items were excellent except a stairs climb item. Thus, the prediction models derived from the multiple logistic models were confirmed for within-institutional validity for FIM motor items except stairs climb.

DISCUSSION

By using multivariate logistic regression statistics employing NIHSS assessed within a few days after stroke and adjusting factors such as age and pre-stroke independence level, we were able to develop prediction models for the long-term outcomes of FIM motor items. At least one single NIHSS item correlated with each FIM motor item, implying the applicability of acute phase NIHSS for the long-term outcome prediction in terms of disability. The accuracy rates in the confirmatory group were as high as those for the model-development group.

Of all NIHSS items, the degrees of paralysis in the affected upper and lower extremities most evidently affected the long-term FIM outcomes. In particular, the score for affected lower extremity was predictive for the FIM motor items, except for eating and shower trans-

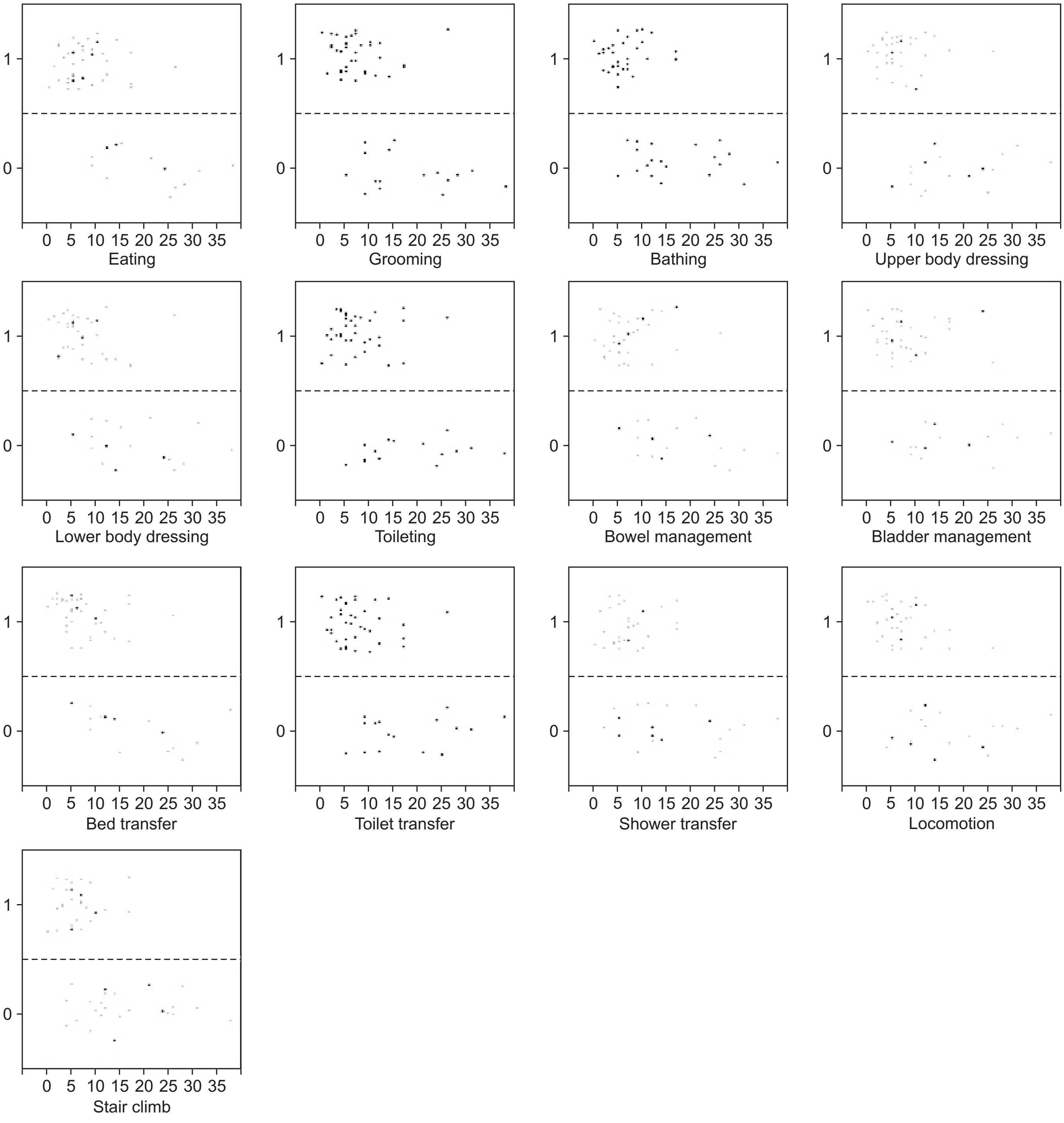

Fig. 3. Scatter diagrams showing the total score of the National Institutes of Health Stroke Scale on the x-axis, and independence or dependence of Functional Independence Measure defined in the text on the y-axis in 53 patients of the model-development group (1=independence, 0=dependence).

fer, implying that gross assessment of hemiparesis may be predictive for long-term ADL outcomes. In the daily clinical practice for stroke treatment, clinicians often use the manual muscle test (MMT/MRC) [13,14] to assess the gross levels of hemiparesis in the upper extremity and lower extremity. This method may be more widely used than NIHSS because NIHSS is an evaluation used specifically by stroke specialists. In reality, some stroke patients

Table 2. Multivariate logistic regression models

FIM item	Multivariate logistic regression equation	Coefficient of determination	p-value	Predictive model	
				Regression coefficient	Standard error
Eating	2.14-(2.55×Affected upper extremity 3rd)	0.23	0.0003	15.06	1734.98
Grooming	19.63-(0.20×Age)-(3.39×Affected upper extremity 2nd)-(3.91×Affected lower extremity 2nd)	0.62	<0.0001	1.00	0.30
Bathing	3.81-(2.82×Affected upper extremity 3rd)-(2.97×Affected lower extremity 2nd)-(3.39×Sensory 2nd)	0.57	<0.0001	0.40	0.13
Upper body dressing	4.85-(3.09×mRS 4th)-(3.79×Affected lower extremity 2nd)-(2.89×Extinction and inattention 2nd)	0.55	<0.0001	0.57	0.15
Lower body dressing	4.85-(3.09×mRS 4th)-(3.79×Affected lower extremity 2nd)-(2.89×Extinction and inattention 2nd)	0.55	<0.0001	0.57	0.15
Toileting	19.63-(0.20×Age)-(3.39×Affected upper extremity 3rd)-(3.91×Affected lower extremity 2nd)	0.62	<0.0001	1.00	0.30
Bowel management	4.85-(3.09×mRS 4th)-(3.79×Affected lower extremity 2nd)-(2.89×Extinction and inattention 2nd)	0.55	<0.0001	0.96	0.26
Bladder management	87.41-(0.91×Age)-(5.54×mRS 4th)-(9.68×LOC questions 2nd)-(19.15×Affected lower extremity 2nd)	0.80	<0.0001	1.00	0.49
Bed transfer	19.63-(0.20×Age)-(3.39×Affected upper extremity 3rd)-(3.91×Affected lower extremity 2nd)	0.62	<0.0001	1.00	0.30
Toilet transfer	19.63-(0.20×Age)-(3.39×Affected upper extremity 3rd)-(3.91×Affected lower extremity 2nd)	0.62	<0.0001	1.00	0.30
Shower transfer	6.73-(0.08×Age)-(1.84×Affected upper extremity 3rd)-(2.58×Sensory 2nd)	0.29	0.0001	1.00	0.35
Locomotion	4.23-(2.60×LOC questions 2nd)-(3.99×Affected lower extremity 2nd)-(2.92×Sensory 2nd)	0.48	<0.0001	0.75	0.22
Stair climb	2.75-(2.67×mRS 2nd)-(2.51×LOC 1st)-(2.58×Affected lower extremity 2nd)	0.39	<0.0001	0.62	0.20

The plus score of multivariate logistic regression analyses means independence or supervision.
Predictive model was assessed using the logit of each multiple logistic regression equation and the real outcome.
FIM, Functional Independence Measure; mRS, modified Rankin Scale; LOC, level of consciousness.
Affected upper extremity, Affected lower extremity, mRS, Extinction and inattention, and Sensory 2nd: when these values are <2, they can be converted to '0'; ≥2, converted to '1.'
Affected upper extremity 3rd: when this value is <3, it can be converted to '0'; ≥3, converted to '1.'
mRS 4th: when this value is <4, it can be converted to '0'; ≥4, converted to '1.'

Table 3. Unit and range ORs of multiple logistic regression models

FIM motor item	Affected lower extremity	Affected upper extremity	Age		mRS	Sensory	Extinction and inattention	LOC question	LOC
			Unit OR	Range OR					
Eating	-	0.08 (0.02, 0.32)	-		-	-	-	-	-
Grooming	0.02 (0.0005, 0.22)	0.03 (0.002, 0.29)	0.82 (0.66, 0.94)	$4.93e^{-5}$ ($1.69e^{-9}$, 0.05)	-	-	-	-	-
Bathing	0.05 (0.002, 0.39)	0.06 (0.006, 0.38)	-	-	-	0.03 (0.0008, 0.38)	-	-	-
Upper body dressing	0.02 (0.0008, 0.19)	-	-	-	0.05 (0.002, 0.43)	-	0.06 (0.005, 0.40)	-	-
Lower body dressing	0.02 (0.0008, 0.19)	-	-	-	0.05 (0.002, 0.43)	-	0.06 (0.005, 0.43)	-	-
Toileting	0.02 (0.0005, 0.22)	0.03 (0.002, 0.29)	0.82 (0.66, 0.94)	$4.93e^{-5}$ ($1.69e^{-9}$, 0.05)	-	-	-	-	-
Bowel management	0.02 (0.0008, 0.19)	-	-	-	0.05 (0.002, 0.43)	-	0.06 (0.005, 0.40)	-	-
Bladder management	$4.86e^{-9}$ ($9.0e^{-22}$, 0.002)	-	0.4 (0.11, 0.76)	$4.63e^{-20}$ (0, $1.20e^{-6}$)	0.004 ($2.91e^{-6}$, 0.31)	-	-	$6.27e^{-5}$ ($6.22e^{-22}$, 0.002)	-
Bed transfer	0.02 (0.0005, 0.22)	0.03 (0.002, 0.29)	0.82 (0.66, 0.94)	$4.93e^{-5}$ ($1.69e^{-9}$, 0.05)	-	-	-	-	-
Toilet transfer	0.02 (0.0005, 0.94)	0.03 (0.002, 0.29)	0.82 (0.66, 0.94)	$4.93e^{-5}$ ($1.69e^{-9}$, 0.05)	-	-	-	-	-
Shower transfer	-	0.16 (0.03, 0.70)	0.93 (0.85, 0.99)	0.02 (0.0003, 0.75)	-	0.08 (0.003, 0.58)	-	-	-
Locomotion	0.02 (0.0005, 0.15)	-	-	-	-	0.05 (0.001, 0.62)	-	0.07 (0.002, 0.76)	-
Stair climb	0.08 (0.01, 0.34)	-	-	-	0.07 (0.007, 0.44)	-	-	-	0.08 (0.009, 0.45)

Values are presented as (lower confidence limit, upper confidence limit).
OR, odds ratio; FIM, Functional Independence Measure; mRS, modified Rankin Scale; LOC, level of consciousness.

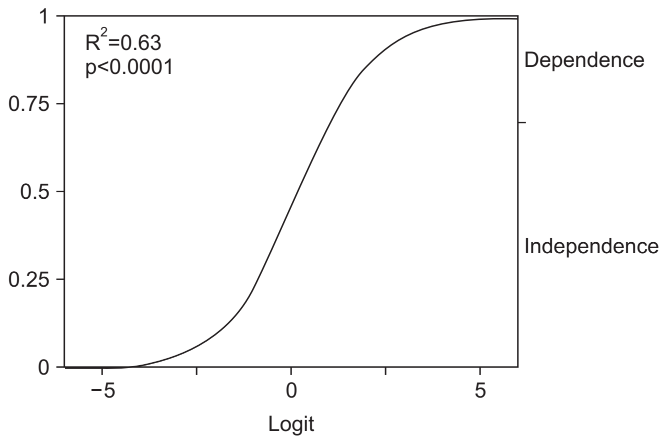

Fig. 4. Example of logistic curve obtained from multivariate logistic model (bed transfer). The model equation is as follows: 19.63-(0.20×Age)-(3.39×Affected Upper Extremity 3rd)-(3.91×Affected Lower Extremity 2nd). Zero in the horizontal axis indicates a logistic probability 0.50. The curve showed the probability of bed transfer independence. The distance from the bottom to the top of the graph curve is the probability of independence.

who are treated by general physicians are unfamiliar with NIHSS. The present findings suggest that the gross assessment of hemiparesis such as MMT/MRC in the acute stage may be partially predictive for long-term ADL.

In addition to NIHSS, age was shown to be a statistically significant contributing factor for the prediction of the long-term outcome assessed by FIM motor items. The previous studies indicated a correlation of age with general independence at a few months after the onset [15,16] and with walking independence at 6 months [17]. In this study, among the explanatory variables, statistics revealed that age had the greatest effect on the outcomes. However, age is only one explanatory variable that was assessed on an interval scale. Such an aspect might contribute to the greatest predictive power. Careful consideration should be given to the difference of the scales (nominal, ordinal, or interval) when the relative importance among explanatory variables is to be discussed.

In contrast to the previous studies on this topic [18,19], we included several patients who were not fully independent before the onset. Indeed, some patients in our database were recurrent stroke cases who were affected by previous episodes. To address this concern, in this study, we assessed ADL before the onset by using mRS. Analysis results showed that ADL status before stroke was also a powerful predictive factor for the long-term outcomes assessed by FIM motor items. In actual clinics, stroke cases often show recurrence and are accompanied with disability in ADL. The methodology in the present study may be more practical than that used in the previous studies on stroke outcome, in which only data on first-ever stroke cases who were fully independent before the onset were collected [20-22].

In this study, to assess the within-institutional validity, we employed the confirmatory group. The results obtained from the confirmatory group were very similar to those obtained from the model-development group (Table 4), indicating the obtained prediction models were sufficient. However, the results for stairs climb were negative. Previous studies indicated that the stairs climb item is the most difficult among the FIM motor items [10,11]. The negative finding for this item could be partially attributed to the ceiling effect, under which most of patients can gain a goal for its easiness. In addition, cognitive factors, one of which is considered to be falling risks [23], may influence the lower accuracy rate of stairs climb because NIHSS is not sufficient for the assessment of cognitive functions in terms of ADL [24].

This study has several limitations. First, the sample size was small, with only 53 cases in the model-development group and 26 cases in the confirmatory group. However, we detected statistically significant models for all 13 FIM motor items in the model-development group, and the validity of the success of all models except stair climb was confirmed. Despite the small sample size, the results from our analyses were relatively positive. Second, due to the nature of our sample, the findings need careful consideration when applying the models to wider stroke populations. The study samples were collected from patients who were transferred to long-term rehabilitative facilities after acute medical services. Therefore, mild or severe cases were omitted in the study sample; mild cases are usually discharged because of their minimum impairment, and severe ones are transferred to nursing facilities. Third, inter-facility validation was not assessed. For the study, to avoid variability of the treatment methodology during the acute medical service, we collected patients who were treated in a single acute hospital. The obtained results were positive. To further confirm the validity of the present study, a well-designed study for inter-facility validation is needed. Fourth, in this study, to simplify our analytical procedures, we defined 'indepen-

Table 4. Accuracy of multiple logistic regression models

FIM motor item	Model-development group				Confirmatory group			
	Independence/ Supervision	Dependence/ Physically assis-tance	Total	PCR×1.25 (%)	Independence/ Supervision	Dependence/ Physically assis-tance	Total	PCR×1.25 (%)
Eating (%)	34/38 (89)	9/15 (60)	43/53 (81)	>78.7	17/19 (89)	4/7 (57)	21/26 (81)	>80.6
Grooming	34/37 (92)	13/16 (81)	47/53 (89)	>72.5	18/21 (86)	5/5 (100)	23/26 (88)	>71.7
Bathing[a]	32/36 (89)	16/17 (94)	48/53 (91)	>66.3	16/21 (76)	3/5 (60)	19/26 (73)	>71.7
Upper body dressing	34/38 (89)	13/15 (87)	47/53 (80)	>70.6	18/24 (75)	2/2 (100)	20/26 (77)	>71.7
Lower body dressing	34/38 (89)	13/15 (87)	47/53 (80)	>70.6	18/24 (75)	2/2 (100)	20/26 (77)	>71.7
Toileting	34/37 (92)	13/16 (81)	47/53 (80)	>72.3	18/21 (86)	4/5 (80)	22/26 (85)	>75.8
Bowel management	34/38 (89)	13/15 (87)	47/53 (80)	>70.6	19/24 (79)	2/2 (100)	21/26 (81)	>75.8
Bladder management	37/39 (95)	13/14 (93)	50/53 (94)	>74.3	19/21 (90)	4/5 (80)	23/26 (88)	>80.6
Bed transfer	34/37 (92)	13/16 (81)	47/53 (89)	>72.3	17/21 (81)	3/5 (60)	20/26 (77)	>75.8
Toilet transfer	34/37 (92)	13/16 (81)	47/53 (89)	>72.3	17/21 (81)	4/5 (80)	21/26 (81)	>71.7
Shower transfer[a]	29/37 (78)	14/16 (88)	43/53 (81)	>64.3	15/21 (71)	4/5 (80)	19/26 (73)	>65.8
Locomotion	33/38 (87)	13/15 (87)	46/53 (87)	>72.3	17/21 (81)	4/5 (80)	21/26 (81)	>71.7
Stair climb[a]	28/38 (74)	15/15 (100)	43/53 (81)	>62.7	10/21 (48)	5/5 (100)	15/26 (58)	<65.8

Values are presented as number (%).
FIM, Functional Independence Measure; PCR, proportion by chance rate.

$$\text{PCR}=\{(\frac{\text{Dependence or Phyical assistence number}}{\text{Total number}})^2+(\frac{\text{Independence or Supervision number}}{\text{Total number}})^2\}\times 100$$

[a]Outcome variable is supervision or physically assistance.

dence' for the bathing, shower transfer, and stairs climb items as including supervision levels (FIM 5). Original FIM terminology does not include supervision as independence. However, as the patients with MCA infarct often suffer from severe hemiparesis, retaining supervision level (FIM 5) could be a realistic goal for these difficult items. We therefore employed a modified terminology for this study.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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