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Original Article

The items and level contributing to improve in less than 50 motor functional independence measure upon admission in the stroke recovery rehabilitation ward

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Abstract. [Purpose] To determine the motor Functional Independence Measure item and level that contribute to improvement in Functional Independence Measure gain in the recovery rehabilitation ward. [Participants and Methods] This study analyzed the data of 1,866 participants who were selected based on four criteria: age, number of days from onset to admission, length of hospital stay, and motor Functional Independence Measure upon admission. Moreover, all items examined were recorded. The participants were divided into two groups, the non-improving and improving group, based on a motor Functional Independence Measure gain of 22 points. The degree of contribution of each item was analyzed based on the median motor Functional Independence Measure. Logistic regression analysis was performed, with the two groups as dependent variables and the item with high contribution as independent variable; receiver operating characteristic analysis was performed. [Results] The items that highly contributed to motor Functional Independence Measure gain were bathing (level 3), dressing (lower body) (level 4), bladder management (level 5), and stair climbing (level 3). [Conclusion] The results of this study were suggested that the items that contribute to the improvement in motor Functional Independence Measure gain in stroke patients with a motor Functional Independence Measure of less than 50 were related to self-care and at least over moderate assistance.

Key words: Functional Independence Measure, Stroke, FIM gain

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INTRODUCTION

Previous studies have reported that functional recovery and activities of daily living (ADL) after stroke are accelerated during the acute period from the onset of stroke, but the recovery curve during the later stage until discharge tends to slowly decrease[1–3)]. Therefore, after the unstable acute period, early focused rehabilitation is important during the recovery phase for maximum ADL recovery[4, 5)].

According to Nobuhiko et al.[6)], gait disability after stroke influences ADL recovery, and locomotion is one of the foremost goals of persons with disability. These findings indicate that stroke rehabilitation should focus on locomotion.

Meanwhile, the ADL recovery process progresses in the following order: Eating, Grooming, Toilet activities, Dressing, and Gait[7)]. The level of difficulty was classified into three groups: easy (includes Eating, Grooming, and Bowel management), hard (includes Dressing (Lower body), Transfers to Tub/Shower, and Bathing), and other group (includes all the items of mFIM except for those in the groups)[8)]. Moreover, the speed of recovery of individual ADL item differs: while

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grooming continuously but slowly recovers, the ability to dress the lower body sharply recovers during the later stage toward discharge[8]. Difficulty in these items was reported to have a relationship with the motor Functional Independence Measure (mFIM). In previous studies, a prediction outcome after stroke was based on these relationships[4, 5, 9, 10]; however, only a few reports have been published on the level of difficulty of individual items[8, 11]. However, "item difficulty" is not equated with "item contribution." As for gait training, gait disability has greater contribution to the improvement of the mFIM despite being a harder item in ADL training, which tends to be more focused in rehabilitation after stroke. However, it is possible that difficult items do not always mean items with greater contribution because the level of difficulty of the item is harder. Therefore, when planning rehabilitation for ADL training, the contribution of an item in improving the mFIM, the order of recovery, and the level of difficulty of an item should be considered. Setting rehabilitation goals based on individual recovery by focusing on the appropriate ADL item in the order of recovery stage would be more efficient. However, the degree of contribution of each item is unclear. The objective of this study was to verify the contribution of individual item in improving the mFIM gain in patients with the mFIM <50 at admission.

PARTICIPANTS AND METHODS

The medical data of 1,866 patients with stroke had been extracted from the Japan Rehabilitation Database (JRD), stroke/recovery rehabilitation phase ward (April 2016 version). Patients with stroke with the following criteria were included: age, 15–99 years; days from onset to admission, 5–90 days; length of stay ward, 21–210 days; total mFIM at hospital admission, <50 points. All items to be examined were entered.

The data used in this study were observational data obtained in a normal clinical setting and were anonymized.

The primary outcome measures were mFIM scores at admission and discharge. The mFIM comprises 13 items in four subscales: Self-Care, Sphincter Control, Transfers, and Mobility. All items were scored using a 7-point ordinal scale. High FIM scores (7) indicate higher levels of independence. Information on age, days from onset to admission, and length of stay was also collected.

The participants were divided into two groups, the improving group (n=796) and the non-improving group (n=890), according to the median of mFIM gain (22 points). Gain was defined as the difference between the score at discharge and the score at admission. The Mann-Whitney U test was used to calculate the changes in each item outcome of the two groups.

Contribution analysis (Mahalanobis Taguchi method) was performed to determine the degree of contribution of individual mFIM item based on the median mFIM. It shows the degree of contribution to the observed results based on the reason why the observed results have occurred and their roles. Multivariable logistic regression analysis (least square method) was performed, with the two groups (non-improving group and improving group) as the dependent variable and the item in the mFIM with high contribution as the independent variable. High contribution was defined as a contribution of >10 points. Then, receiver operator characteristic (ROC) analysis was performed to evaluate the fitness of the calculated model. Furthermore, the prediction sensitivity and specificity and the Youden index were calculated; the maximum value of the Youden index was regarded as the optimal cutoff value for the prediction formula. χ^2 tests and Mann-Whitney U test were performed to determine the level necessary to improve FIM gain in the extracted contribution mFIM items.

The variables extracted from the data were used non-parametrically, and the statistical significance level was set at 0.05. All statistical analyses were conducted using IBM SPSS version 20 (IBM Corp., Armonk, NY, USA).

RESULTS

The results of the comparison of the groups were significant in each item (Tables 1 and 2). The contribution of each item [Stairs climbing, Bathing, Dressing (Lower body), and Bladder management] was >10 points (Table 3).

Multiple logistic regression analysis revealed that Stairs climbing (OR=1.53), Bathing (OR=2.31), Dressing (Lower body) (OR=2.64), and Bladder management (OR=2.21) (Table 4).

The area under the curve (AUC) was 0.97 (95% CI, 0.97–0.98; p<0.01), with sensitivity and specificity of 0.92 and 0.9, respectively, according to the Youden index (0.82).

Significant differences in the results of the Mann-Whitney U test for each group were found in all high-contribution items (non-improving group vs improving group, p<0.01). χ^2 test of each level of items revealed the following: Stairs climbing showed significant difference in all levels except in level 2 (Maximal assist) (Table 5-a); Bathing and Dressing (Lower body) showed significant difference in all levels (Table 5-b and 5-c); Bladder management showed significant difference in all levels except in level 4 (Minimal assist) (Table 5-d).

DISCUSSION

The recovery process of ADL for the mFIM after stroke and the relationship of mFIM improvement with individual mFIM items are shown in previous studies[1, 2, 9]. However, few reports are available on the contribution of individual mFIM items. This study indicated the contribution of the item and the FIM level of contribution of the item in improving the mFIM in stroke patients with mFIM <50 at admission.

Table 1. General characteristics of participants (N=1,866)

	Non-imporving group (N=890)	Imprvoing group (N=976)	Total
Age (years)**	75.31 ± 0.37	68.45 ± 0.42	71.73 ± 0.29
Length of day from onset to admission**	39.37 ± 0.52	35.22 ± 0.47	37.2 ± 0.35
Length of stay in the hospital**	105.36 ± 1.5	122.03 ± 1.2	114.08 ± 0.97
motor FIM (admission)**	24.18 ± 0.4	30.8 ± 0.36	27.64 ± 0.28
motor FIM (discharge)**	32.97 ± 0.55	68.45 ± 0.41	51.53 ± 0.53

Mean ± SD. **p<0.01.
FIM: Functnal Indepence Measure.

Table 2. Median scores of motor FIM 13 items

Item	Admission		Discharge		mFIM Gain	
	Non-imporving group	Imprvoing group	Non-imporving group	Imprvoing group	Non-imporving group	Imprvoing group
Eating	3	5**	5	6**	0	2**
Grooming	2	3**	3	6**	0	3**
Bathing	1	1**	1	4**	0	2**
Dressing upper body	1	2**	2	6**	0	3**
Dressing lower body	1	1**	2	6**	0	4**
Toileting	1	2**	2	6**	0	4**
Bladder management	1	2**	2	6**	0	3**
Bowel management	1	3**	2	6**	0	3**
Transfer-Toilet	2	3**	3	6**	1	3**
Transfer-Walking or wheelchair	1	3**	3	6**	1	3**
Tub/Shower transfer	1	1**	1	4**	0	3**
Walking or using wheelchair	1	1**	1	6**	0	4**
Stairs climbing	1	1	1	4**	0	3**
Total mFIM	20	30**	31	70**		

mFIM: motor Functnal Indepence Measure; Gain: At discharge −At admission.
**p<0.01.

Table 3. Contribution scores of individual item

	Contribution scores	Adjusted conribution scores
Stairs climbing	21.02	15.35
Bathing	33.35	14.69
Dressing lower body	56.9	12.99
Bladder management	22.69	12.09
Tub/Shower transfer	22.73	7.73
Grooming	15.45	7.53
Toileting	27.77	6.17
Bowel management	15.66	5.58
Transfer-Walking or wheelchair	21.27	5.43
Walking or using wheelchair	13.03	4.41
Eating	5.01	3.71
Dressing upper body	43.16	2.9
Transfer-Toilet	26.07	1.41

Adjusted contribution score: the adjusted value of the score in which the number of variables of the data set is taken into consideration.

Table 4. Logistic regression analysis of associations between extracted high contribution item

Item	B	Odds ratios	95% confidence interval	
			Low limit	Upper limit
Dressing lower body**	0.97	2.64	2.29	3.04
Bathing**	0.84	2.31	1.94	2.76
Bladder management**	0.79	2.21	1.97	2.48
Stairs climbing**	0.42	1.53	1.36	1.72
Constant	−4.4			

Nagelkerke-R2=0.82. Percentage of correct classifications=0.91.
**p<0.01.

Table 5. Contingency table and χ^2 tests to each FIM levels at discharge

5-a: Stairs climbing

	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Level 2	Other level	χ^2	Level 3	Other level	χ^2	Level 4	Other level	χ^2	Level 5	Other level	χ^2	Level 6	Other level	χ^2	Level 7	Other level	χ^2
Improving group	332	644	473.55**	43	933	0.07	69	907	6.84**	111	865	34.71**	261	715	193.79**	126	850	104.17**	34	942	29.66**
	(−21.81)	(21.81)		(0.39)	(−0.39)		(2.71)	(−2.71)		(5.98)	(−5.91)		(13.98)	(−13.98)		(10.30)	(−10.30)		(5.62)	(−5.62)	
Non-improving group	747	143		36	854		37	853		35	855		29	861		6	884		0	890	
	(21.81)	(−21.81)		(−0.39)	(0.39)		(−2.71)	(2.71)		(−5.91)	(5.98)		(−13.98)	(13.98)		(−10.30)	(10.30)		(−5.62)	(5.62)	

5-b: Bathing

	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Level 2	Other level	χ^2	Level 3	Other level	χ^2	Level 4	Other level	χ^2	Level 5	Other level	χ^2	Level 6	Other level	χ^2	Level 7	Other level	χ^2
Improving group	33	943	621.52**	82	894	32.59**	188	788	9.12**	259	717	70.34**	214	762	167.56**	108	868	99.56**	92	884	86.25**
	(−24.98)	(24.98)		(−5.78)	(5.78)		(3.08)	(−3.08)		(8.45)	(−8.45)		(13.01)	(−13.01)		(10.08)	(−10.08)		(9.39)	(−9.39)	
Non-improving group	494	396		154	736		124	766		99	791		18	872		1	889		0	890	
	(24.98)	(−24.98)		(5.78)	(−5.78)		(−3.08)	(3.08)		(−8.45)	(8.45)		(−13.01)	(13.01)		(−10.08)	(10.08)		(−9.39)	(9.39)	

5-c: Dressing lower body

	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Level 2	Other level	χ^2	Level 3	Other level	χ^2	Level 4	Other level	χ^2	Level 5	Other level	χ^2	Level 6	Other level	χ^2	Level 7	Other level	χ^2
Improving group	20	956	567.66**	61	915	77.58**	83	893	7.05**	122	854	6.84**	166	810	56.17**	195	781	139.48**	329	647	336.42**
	(−23.88)	(23.88)		(−8.88)	(8.88)		(−2.73)	(2.73)		(2.69)	(−2.69)		(7.50)	(−7.50)		(11.88)	(−11.88)		(18.40)	(−18.40)	
Non-improving group	444	446		178	712		110	780		77	813		52	838		21	869		8	882	
	(23.88)	(−23.88)		(8.88)	(−8.88)		(2.73)	(−2.73)		(−2.69)	(2.69)		(−7.50)	(7.50)		(−11.88)	(11.88)		(−18.40)	(18.40)	

5-d: Bladder management

	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Level 2	Other level	χ^2	Level 3	Other level	χ^2	Level 4	Other level	χ^2	Level 5	Other level	χ^2	Level 6	Other level	χ^2	Level 7	Other level	χ^2
Improving group	29	947	508.2**	39	937	83.14**	47	929	13.92**	69	907	0.32	163	813	28.78**	144	832	70.00**	485	491	423.81**
	(−22.60)	(22.60)		(−9.20)	(9.20)		(−3.82)	(3.82)		(−0.65)	(0.65)		(5.43)	(−5.43)		(8.45)	(−8.45)		(20.64)	(−20.64)	
Non-improving group	427	463		150	740		83	807		70	820		74	816		30	860		56	834	
	(22.60)	(−22.60)		(9.20)	(−9.20)		(3.82)	(−3.82)		(0.65)	(−0.65)		(−5.43)	(5.43)		(−8.45)	(8.45)		(−20.64)	(20.64)	

Upper row: Group frequencies, Lower row: Adjusted standardized residual.
**p<0.01.

Eating, Grooming, and Bowel management are the items that improve easily, whereas Dressing (Lower body), Transfer to Tub/Shower, Bathing, and Stairs climbing are harder. Bladder management is moderately difficult[5, 8, 10, 11].

The extracted high-contribution items in this study were categorized as being more than moderately difficult, which implies that improving difficult items can possibly contribute to the improvement of the mFIM.

Additionally, other studies have reported low agreement rate for capability and performance ADLs (agreement rate) of Stairs climbing and Dressing (Lower body) and high agreement rate for Bladder management at discharge.

The agreement rate of Bathing was average. Gaps tend to develop in items such as Bathing, Dressing (Lower body), and Stairs climbing when comparing admission and discharge values[11].

Hence, it was assumed that the extracted high-contribution item for the mFIM not only has more than moderate difficulty but can also easily develop a gap between capability and performance ADLs.

Thus, it is inferred that improving the extracted high-contribution item not only lessens the development of a gap between admission and discharge for capability and performance ADLs, it also contributes to the improvement of the mFIM.

In the relationship of the mFIM and item difficulty in 50 points of the mFIM, Bathing and Dressing (Lower body) can reach levels 3 (Moderate assist) and 2[7]. Furthermore, improved level of Dressing (Lower body) was correlated with higher mFIM. Bladder management was the item that can possibly improve to level 7 (Complete independence) after mFIM of 30 point and correlates with improvement of the mFIM[8].

In χ^2 tests, Bathing had significant difference in the non-improving group until level 2. Moreover, over level 3 showed significant difference in the improving group (Table 5-b). Hence, over level 3 was considered more significant in improving FIM gain compared with levels 1 and 2. Furthermore, both capability and performance ADLs showed level 3 at discharge[10, 12]. Thus, it was assumed that the level that contributed to improved FIM gain was over level 3 in Bathing.

Dressing (Lower body) had significant difference in the non-improving group until level 3, but over level 4 was significantly different in the improving group. Thus, a grade over level 4 was considered more significant in improving FIM gain compared with levels 1 to 3 (Table 5-c). The average capability and performance ADL were 3.9 and 3.7, respectively[10, 12]. Therefore, it was assumed that a grade over level 4 in Dressing (Lower body) contributes to the improvement of the mFIM.

Regarding Bladder management, significant difference was noted until level 3 in the non-improving group, and it became more significant over level 5 (Supervision) compared with levels 1 to 3 in the improving group. The average capability and performance ADL of Bladder management were 4.3 and 4.2, respectively[10, 12]. Accordingly, it was assumed that a grade over level 5 in Bladder management contributes to improvement of the mFIM.

Finally, Stairs climbing showed significant difference in all levels except in level 2. Moreover, a significant difference was noted in level 1 in the non-improving group and over level 3 in the improving group. However, the odds of Stairs climbing were lower compared with those of other extracted mFIM items. Hence, it is possible that the contribution does not necessarily correspond with the influence of improving FIM gain in the case of very difficult activities such as Stairs climbing for stroke patients. The average capability and performance ADL of Stairs climbing were 2.8 and 2.2, respectively. Therefore, it was assumed that a grade at least over level 3 contributes to improvement of the mFIM in Stairs climbing.

The order of progression of the level of item difficulty was the following: Dressing (Lower body), Bathing, and Stairs climbing[5, 8, 10, 11]. Additionally, Dressing (Lower body) was directly related to balance function and abdominal muscle strength[13, 14]. Therefore, it was surmised that Bathing and Stairs climbing were possibly in level 5 and Dressing (Lower body) over level 5[12, 15]. The results of this study are similar to those of previous ones. It has been reported that a 50% possibility that Dressing (Lower body) is level 5 if the mFIM is 60 points[7]. Further, the mFIM was >45 points if Dressing (Lower body) was level 4 and 3 in right and left hemiplegia, respectively[16]. In level 3 of Bathing, the mFIM was >60 points in right and left hemiplegia[16]. As with Dressing (Lower body) and Bathing, the mFIM was >70 points in the case where Stairs climbing was level 3[16]. For the reasons stated above, it is assumed that the extracted high-contribution item can possibly improve FIM gain in stroke patients with mFIM <50 point at admission.

The limitation of this study is its focus on mFIM <50 points. Further studies are needed to determine the items that improve mFIM including mFIM >50 with consideration of the effective limit and different recovery speeds.

In conclusion, this study suggested that the high-contribution items that improve the mFIM in stroke patients with mFIM <50 points at admission were related with self-care and they were have to be over at least Moderate assistance as the following: Bathing (FIM level 3), Dressing (Lower body) (FIM level 4), Bladder management (FIM level 5), and Stairs climbing (FIM level 3) based on the JRD registration data.

Presentation at a conference

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