

The Motor Functional Independence Measure Items and Targeted Minimal level Contributing to Improved Motor Functional Independence Measure Gain in Stroke Patients in the Recovery Rehabilitation Ward

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Abstract

Objective: To determine motor Functional Independence Measure items and Functional Independence Measure levels that contribute to motor Functional Independence Measure gain after stroke.

Methods: This was a multicentre cross-sectional study including a total of 5,454 stroke patients who were registered in the Japan Rehabilitation Database. All participants were selected based on age, days from onset to admission, length of ward stay, and motor Functional Independence Measure items upon admission. Participants were divided into three subgroups based on the motor Functional Independence Measure items upon admission, and then further classified into non-improving and improving subgroups based on the mean of motor Functional Independence Measure gain. Multiple logistic regression and contribution analyses were used to analyse variables that contribute to the increase of motor Functional Independence Measure items. The Mann-Whitney U test and Chi-squared test was used to analyse the Functional Independence Measure level of contribution items.

Results: Items that highly contributed to motor Functional Independence Measure increase were as follows: Stairs, Bathing, and Dressing (Lower Body), which are considered to require moderate assistance, and Bladder management and Toileting, which require supervision or set-up. The odds ratio value of Stairs was lower than that of other items even though its contribution score was the highest in groups 1 and 2.

Conclusion: Items related to gait, self-care, and sphincter control were identified, and each required modified dependence and supervision or set-up level at discharge.

Keywords: mFIM gain; Functional Independence Measure; Stroke; Recovery rehabilitation ward; Activities of Daily Living; Self-care; Gait

Introduction

Improving the motor Functional Independence Measure (mFIM) has been shown to be related to improved activities of daily living (ADL). Previous studies have reported that functional recovery and ADL after stroke rapidly improve during the acute period from the onset of stroke, but during the later stage until discharge, the recovery curve tends to slowly decline [1-3]. Several studies reported that self-care and locomotion-related mFIM items were associated with ADL improvement. The ADL recovery process progresses in the following order: eating, grooming, sphincter control, Dressing, transfer, Toileting, walking, Bathing, and Stairs. Moreover, the generally accepted basic ADLs in the order of difficulty after stroke are rolling over in bed, sitting up, standing up, and walking [4,5]. Thus, rehabilitation of stroke patients is expected to be properly executed in accordance with this recovery process [4-6]. Conversely, some studies also reported that gait training should be prioritized without waiting for independent self-care and transfer [7]. Stroke guidelines recommend gait training as Grade A from an early stage to prevent disuse syndrome and promote early ADL improvement. Gait disability after stroke influences ADL recovery, and locomotion is one of the foremost goals for persons with disability. Some reports indicate that stroke rehabilitation should focus on locomotion [8]. Furthermore, improving gait ability has been shown to affect ADL improvement [9,10]. Therefore, stroke rehabilitation should focus on gait training.

However, few studies have been published regarding the contribution and difficulty of each mFIM item with respect to ADL improvement; Furthermore, the targeted minimum FIM.

Level was not shown in the previous review. For example, gait recovery was the last priority in the recovery of basic ADL [4] and improving mFIM has been shown to be related to improve ADL. Therefore, our study aimed to determine mFIM items and FIM levels that contribute to mFIM gain after stroke.

Research Methodology

The medical data of 5,454 patients with stroke were extracted from the Japan Rehabilitation Database (JRD) and stroke/recovery rehabilitation phase ward (January 2016 version). This study used observational data obtained in normal clinical settings, which were anonymized. Therefore, the need for informed consent was waived due to the observational design of the study.

Patients with stroke who met the following criteria were included: age, 15-99 years; days from onset to admission, 5-90; and length of ward

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Received: March 19, 2019; **Accepted:** May 08, 2019; **Published:** May 15, 2019

Citation: Kimura T (2019) The Motor Functional Independence Measure Items and Targeted Minimal level Contributing to Improved Motor Functional Independence Measure Gain in Stroke Patients in the Recovery Rehabilitation Ward. Int J Phys Med Rehabil 7: 514. doi: [10.4172/2329-9096.1000514](https://doi.org/10.4172/2329-9096.1000514)

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stay, 21-210 days. All items to be examined were collected. The primary outcome measures were mFIM scores at admission and discharge. Information on age, days from onset to admission, and length of hospital stay was also collected. Data were divided into three groups based on mFIM scores at admission: group 1, mFIM <50 points; group 2, ≤ 50 mFIM <70 points; and mFIM ≥ 70 points. Then, each group was further divided into two subgroups, the improving and non-improving groups, based on the median mFIM gain: group 1, 23 points; group 2, 20 points; and group 3, 22 points. mFIM gain was defined as the difference between the scores at discharge and admission. Previous reports have shown that after stroke the ADL gain of elderly people is lower than that of younger people; however, the age difference was not shown significant. As with age differences, the differences in gender were not significant much, and were reported on this are limited. [11,12]. In addition, the type of stroke does not influence stroke prognosis in general [13]. Therefore, these items were excluded from this study.

The FIM is reported to have high reliability and validity with regard to the ADL evaluation after stroke. It consists of 13 mFIM items and 5 cFIM items [14,15]. 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: level 1, Total Assist; level 2, Maximal Assist; level 3, Moderate Assist; level 4, Minimal Assist; level 5, Supervision; level 6, Modified Independence; and level 7, Complete Independence. The mFIM items fall into four categories: self-care, i.e., eating, grooming, Bathing, Dressing (upper body and lower body), and Toileting; sphincter control, Bladder Management, and bowel management; transfers, i.e., transferring to bed/chair/wheelchair, transferring to the toilet, transferring to the tub/shower; and locomotion, i.e., walking or wheelchair, and Stairs.

The Mann-Whitney U test was used to calculate outcome changes

in each item of the two subgroups for each group. Contribution analysis (Mahalanobis Taguchi method) was performed to determine the contribution score of individual mFIM items based on the median mFIM, which shows the contribution score of the observed results based on their occurrence and roles. Multivariable logistic regression analysis (least square method) was performed, with two groups (non-improving and improving) as the dependent variable and the mFIM items with high contribution as the independent variable. High contribution score was defined as a contribution of >10 points. Lastly, the Mann-Whitney U test was used to determine the difference in the distribution, and the Chi-squared test was used to analyse the difference of frequency value between admission and discharge. The variables extracted 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 indicated items in the non-improving and improving subgroups for each group are presented in Table 1. Comparison between non-improving and improving subgroups revealed that improvement in all outcome measures was statistically significant. A total of 5,453 cases were divided into three groups based on mFIM scores at admission: group 1 (N=1866), mFIM of <50 points; group 2 (N=1158), ≤ 50 mFIM <70 points; group 3 (N=2429), >70 points. Then, each group was further divided into non-improving and improving subgroups based on the median mFIM gain as follows: group 1, 890 non-improving and 976 improving; group 2, 581 non-improving and 577 improving; and group 3, 1,134 non-improving and 1,295 improving.

Table 2 shows the contribution score in each group. There were four individual mFIM items with >10-point adjusted contribution

Variables	mFIM at Admission < 50 (N=1866)		50 ≤ mFIM at Admission < 70 (N=1158)		70 ≤ mFIM at Admission (N=2429)	
	Non-improving group (N=890)	Improving group (N=976)	Non-improving group (N=581)	Improving group (N=577)	Non-improving group (N=1134)	Improving group (N=1295)
Age	75.31 ± 0.37	68.45 ± 0.42**	74.33 ± 10.62	68.05 ± 12.82**	72.71 ± 0.36	67.50 ± 0.37**
Length of days from onset to admission	39.37 ± 0.52	35.22 ± 0.47**	49.04 ± 154.77	37.08 ± 15.64**	37.99 ± 0.44	34.32 ± 0.40**
Length of stay at the hospital	105.36 ± 1.5	122.03 ± 1.2**	108.44 ± 46.75	124.93 ± 38.1**	103.30 ± 1.27	116.48 ± 1.14**
motor-FIM at admission	24.18 ± 0.4	30.8 ± 0.36**	17.53 ± 5.88	21.92 ± 6.45**	40.91 ± 0.62	37.21 ± 0.43**
cognitive-FIM at admission	11.62 ± 6.35	15.88 ± 6.6**	11.62 ± 6.36	14.53 ± 5.82**	20.24 ± 0.27	21.59 ± 0.23**
motor-FIM at discharge	32.97 ± 0.55	68.45 ± 0.41**	24.25 ± 10.27	61.46 ± 13.67**	53.94 ± 0.73	72.53 ± 0.38**
cognitive-FIM at discharge	17.21 ± 0.27	26.57 ± 0.21**	14.51 ± 7.19	23.66 ± 6.42**	22.99 ± 0.25	27.61 ± 0.18**
motor-FIM gain	8.8 ± 0.24	37.64 ± 0.35**	6.72 ± 6.37	39.54 ± 5.75**	13.02 ± 0.19	35.32 ± 0.30**
Eating gain	0.82 ± 0.04	1.74 ± 0.05**	0.96 ± 0.06	2.29 ± 0.07**	0.82 ± 0.03	1.54 ± 0.04**
Grooming gain	0.70 ± 0.04	2.66 ± 0.05**	0.68 ± 0.04	3.13 ± 0.07**	0.90 ± 0.03	2.46 ± 0.04**
Bathing gain	0.41 ± 0.03	2.55 ± 0.05**	0.23 ± 0.55	2.39 ± 1.48**	0.89 ± 0.04	2.59 ± 0.04**
Dressing (Upper body) gain	0.73 ± 0.04	3.42 ± 0.05**	0.56 ± 0.87	3.39 ± 1.63**	1.06 ± 0.03	3.16 ± 0.04**
Dressing (Lower body) gain	0.59 ± 0.03	3.46 ± 0.05**	0.33 ± 0.67	3.26 ± 1.76**	1.01 ± 0.03	3.25 ± 0.04**
Toileting gain	0.74 ± 0.04	3.60 ± 0.05**	0.4 ± 0.77	3.68 ± 1.6**	1.01 ± 0.03	3.19 ± 0.04**
Bladder management gain	0.53 ± 0.04	2.94 ± 0.06**	0.33 ± 0.79	3.49 ± 1.97**	0.66 ± 0.03	2.51 ± 0.06**
Bowel management gain	0.66 ± 0.04	2.70 ± 0.06**	0.58 ± 1.15	3.54 ± 1.75**	0.66 ± 0.03	2.29 ± 0.05**
Transfers - bed/chair/wheelchair gain	0.99 ± 0.04	2.92 ± 0.04**	0.9 ± 1.04	3.2 ± 1.3**	1.18 ± 0.03	2.61 ± 0.04**
Transfers - toilet gain	0.93 ± 0.04	3.11 ± 0.04**	0.73 ± 1.05	3.47 ± 1.29**	1.11 ± 0.03	2.76 ± 0.04**
Transfers - bath/shower gain	0.47 ± 0.03	2.68 ± 0.05**	0.25 ± 0.65	2.35 ± 1.57**	0.99 ± 0.04	2.72 ± 0.04**
Walk/wheelchair gain	0.91 ± 0.05	3.45 ± 0.06**	0.67 ± 1.21	3.54 ± 1.66**	1.40 ± 0.05	3.40 ± 0.05**
Stairs gain	0.33 ± 0.03	2.42 ± 0.06**	0.1 ± 0.48	1.81 ± 1.9**	1.33 ± 0.06	2.83 ± 0.06**

*p<0.05, **p<0.01
 Mean ± Standard Error
 FIM, Functional Independence Measure; gain, Discharge - Admission.

Table 1: General characteristics of Participants and the results of comparison between groups in 3 groups.

degree in groups 1 and 2: Stairs, Bathing, Dressing (lower body), and Bladder management (Bladder). However, these contribution ranks were different. Each contribution item rank was as follows: Bathing was 2nd-3rd-7th; Dressing lower body was 3rd-4th-4th; Bladder was 4th-2nd-1st; and Toileting was only performed in group 3, 7th-5th-2nd (in groups 1, 2, and 3, respectively).

Table 3 shows the results obtained from logistic regression analysis of the extracted contribution items. The odds ratios (OR) with 95% confidence interval (CI) resulting from logistic regression (2 subgroups [0: non-improving, 1: improving] as dependent and extracted contribution item as independent items) are presented. Both groups were significantly associated with extracted contribution item as follows: group 1, Dressing lower body (OR 2.64; 95% CI: 2.3-3.04), Bathing (OR 2.31; 95% CI 1.94-2.76), Bladder (OR 2.21; 95% CI: 1.97-

2.48), and stairs (OR 1.53; 95% CI 1.36-1.72); group 2, Bathing (OR 4.16; 95% CI: 2.96-5.86), Dressing lower body (OR 3.55; 95% CI: 2.7-4.68), Bladder (OR 3.1; 95% CI: 2.49-3.86), and stairs (OR 1.91; 95% CI: 1.44-2.53); group 3, Toileting (OR 3.03; 95% CI: 2.73-3.53) and Bladder (OR 1.69; 95% CI: 1.56-1.83).

Significant differences in the results of the Mann-Whitney U test for each group were found in all high-contribution items (non-improving vs. improving group, $p < 0.01$). The results of the Chi-squared test in each group at discharge were as follows: group 1, individual FIM level in high-contribution items was significant difference, except in levels 4 (Bladder) and 2 (stairs) (Table 4); group 2, significant difference was detected, except in levels 2 (Bathing) and 3 (Bladder) (Table 5); group 3, individual FIM level in high-contribution items differed significantly, except in levels 3 (Toileting) and 4 (Bladder) (Table 6).

Item gain	mFIM at Admission < 50 (N=1866)			50 ≤ mFIM at Admission < 70 (N=1158)			70 ≤ mFIM at Admission (N=2429)		
	Contribution degree	Adjusted Contribution degree		Contribution degree	Adjusted Contribution degree		Contribution degree	Adjusted Contribution degree	
Stairs	21.02	15.35	(1)	29.44	22.77	(1)	6.69	4.06	(13)
Bathing	33.35	14.69	(2)	29.7	15.63	(3)	14.09	7.02	(7)
Dressing (Lower body)	56.9	12.99	(3)	53.76	14.9	(4)	42.55	9.23	(4)
Bladder management	22.69	12.09	(4)	31.04	19.02	(2)	24.36	13.74	(1)
Transfers - bath/shower	22.73	7.73	(5)	20.23	7.08	(6)	10.75	5.86	(11)
Grooming	15.45	7.53	(6)	12.71	1.94	(7)	14.95	8.84	(5)
Toileting	27.77	6.17	(7)	34.29	8.58	(5)	25.16	10.52	(2)
Bowel management	15.66	5.58	(8)	12.82	1.75	(9)	20.89	9.58	(3)
Transfers - bed/chair/wheelchair	21.27	5.43	(9)	15.02	1.52	(10)	21.33	6.81	(8)
Walk/wheelchair	13.03	4.41	(10)	9.79	1.02	(11)	8.77	6.37	(10)
Eating	5.01	3.71	(11)	2.93	1.79	(8)	6.79	6.57	(9)
Dressing (Upper body)	43.16	2.9	(12)	32.11	0.9	(12)	39.52	7.07	(6)
Transfers - toilet	26.07	1.41	(13)	22.34	0.86	(13)	27.73	4.3	(12)

Item gain, Discharge - Admission.
() rank.

Table 2: The contribution degree of individual mFIM item in 3 groups.

3-a: Group 1 (mFIM at Admission < 50, N = 1866)						
Independent variables	Coefficient	SE	OR	95%CI		
				Lower	Upper	
Dressing (Lower body)**	0.97	0.07	2.64	2.30	3.04	
Bathing**	0.84	0.09	2.31	1.94	2.76	
Bladder management**	0.79	0.06	2.21	1.97	2.48	
Stairs**	0.42	0.06	1.53	1.36	1.72	
Constant	-4.40	0.23				
3-b: Group 2 (50 ≤ mFIM at Admission < 70, N = 1158)						
Independent variables	Coefficient	SE	OR	95%CI		
				Lower	Upper	
Bathing**	1.43	0.17	4.16	2.96	5.86	
Dressing (Lower body)**	1.27	0.14	3.55	2.70	4.68	
Bladder management**	1.13	0.14	3.10	2.49	3.86	
Stairs**	0.65	0.14	1.91	1.44	2.53	
Constant	-4.83	0.35				
3-c: Group 3 (70 ≤ mFIM at Admission, N = 2429)						
Independent variables	Coefficient	SE	OR	95%CI		
				Lower	Upper	
Toileting**	1.11	0.05	3.03	2.73	3.53	
Bladder management**	0.53	0.04	1.69	1.56	1.83	
Constant	-2.7	0.11				

* $p < 0.05$, ** $p < 0.01$
FIM, Functional Independence Measure.
SE, standard error; OR, odds ratio, 95%CI, 95% confidence interval.

Table 3: Binomial logistic regression model results in 3 groups.

4-a: Dressing (Lower Body)																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 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)	
4-b: Bathing																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 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)	
4-c: Bladder Management																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 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)	
4-d: Stairs																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 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)	

*p<0.05, **p<0.01
(), adjusted standardized residuals

Table 4: Contingency Table and Chi Square Tests to each FIM levels at discharge in Group 1 (mFIM at admission < 50).

5-a: Bathing																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 7	Other level	χ^2
Improving group	39	538	557.57**	81	496	1.56	161	416	95.09**	138	439	125.96**	95	482	102.03**	41	536	40.74**	22	555	20.58**
	(-23.67)	(23.67)		(-1.33)	(1.33)		(9.83)	(-9.83)		(11.31)	(-11.31)		(10.21)	(-10.21)		(6.54)	(-6.54)		(4.75)	(-4.75)	
Non-improving group	437	144		98	483		36	545		10	571		0	581		0	581		0	581	
	(23.67)	(-23.67)		(1.33)	(-1.33)		(-9.83)	(9.83)		(-11.31)	(11.31)		(-10.21)	(10.21)		(-6.54)	(6.54)		(-4.75)	(4.75)	
5-b: Dressing (Lower Body)																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 7	Other level	χ^2
Improving group	21	556	509.07**	67	510	23.00**	81	496	14.24**	91	486	65.43**	115	462	105.72**	92	485	98.46**	110	467	120.18**
	(-22.62)	(22.62)		(-4.87)	(4.87)		(3.87)	(-3.87)		(8.19)	(-8.19)		(10.38)	(-10.38)		(10.03)	(-10.03)		(11.06)	(-11.06)	
Non-improving group	391	190		130	451		41	540		12	569		7	574		0	581		0	581	
	(22.62)	(-22.62)		(4.87)	(-4.87)		(-3.87)	(3.87)		(-8.19)	(8.19)		(-10.38)	(10.38)		(-10.03)	(10.03)		(-11.06)	(11.06)	
5-c: Bladder management																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 7	Other level	χ^2
Improving group	40	537	423.61**	41	536	40.63**	51	526	0.81	61	516	13.64**	112	465	94.24**	80	497	75.53**	192	385	219.52**
	(-20.64)	(20.64)		(-6.46)	(6.46)		(1.01)	(-1.01)		(3.80)	(-3.80)		(9.80)	(-9.80)		(8.80)	(-8.80)		(14.89)	(-14.89)	
Non-improving group	379	202		117	464		42	539		27	554		10	571		3	578		3	578	
	(20.64)	(-20.64)		(6.46)	(-6.46)		(-1.01)	(1.01)		(-3.80)	(3.80)		(-9.80)	(9.80)		(-8.80)	(8.80)		(-14.89)	(14.89)	
5-d: Stairs																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ^2	Leve 2	Other level	χ^2	Leve 3	Other level	χ^2	Leve 4	Other level	χ^2	Leve 5	Other level	χ^2	Leve 6	Other level	χ^2	Leve 7	Other level	χ^2
Improving group	260	317	313.98**	36	541	5.00*	49	528	24.33**	61	516	49.01**	120	457	123.30**	40	537	36.79**	11	566	9.25**
	(-17.78)	(17.78)		(2.37)	(-2.37)		(5.07)	(-5.07)		(7.13)	(-7.13)		(11.20)	(-11.20)		(6.22)	(-6.22)		(3.34)	(-3.34)	
Non-improving group	542	39		19	562		11	570		5	576		3	578		1	580		0	581	
	(17.78)	(-17.78)		(-2.37)	(2.37)		(-5.07)	(5.07)		(-7.13)	(7.13)		(-11.20)	(11.20)		(-6.22)	(6.22)		(-3.34)	(3.34)	

*p<0.05, **p<0.01
(), adjusted standardized residuals

Table 5: Contingency Table and Chi Square Tests to each FIM levels at discharge in Group 2 (50 ≤ mFIM at admission < 70)

6-a: Toileting																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ ²	Leve 2	Other level	χ ²	Leve 3	Other level	χ ²	Leve 4	Other level	χ ²	Leve 5	Other level	χ ²	Leve 6	Other level	χ ²	Leve 7	Other level	χ ²
Improving group	9	1286	301.20**	23	1272	88.74**	59	1236	3.81	86	1209	0.00	182	1113	16.84**	385	910	5.69*	551	744	152.19**
	(-17.42)	(17.42)		(-9.51)	(9.51)		(-2.04)	(2.04)		(0.11)	(-0.11)		(4.17)	(-4.17)		(2.43)	(-2.43)		(12.38)	(-12.38)	
Non-improving group	260	874		125	1009		73	1061		74	1060		98	1036		287	847		217	917	
	(17.42)	(-17.42)		(9.51)	(-9.51)		(2.04)	(-2.04)		(-0.11)	(0.11)		(-4.17)	(4.17)		(-2.43)	(2.43)		(-12.38)	(12.38)	

6-b: Blader management																					
	Level 1			Level 2			Level 3			Level 4			Level 5			Level 6			Level 7		
	Level 1	Other level	χ ²	Leve 2	Other level	χ ²	Leve 3	Other level	χ ²	Leve 4	Other level	χ ²	Leve 5	Other level	χ ²	Leve 6	Other level	χ ²	Leve 7	Other level	χ ²
Improving group	30	1265	242.33**	38	1257	62.91**	48	1247	8.44**	73	1222	0.04	167	1128	11.83**	160	1135	8.84**	779	516	132.31**
	(-15.63)	(15.63)		(-8.01)	(8.01)		(-2.30)	(2.30)		(-0.29)	(0.29)		(3.51)	(-3.51)		(3.04)	(-3.04)		(11.54)	(-11.54)	
Non-improving group	260	874		126	1008		72	1062		67	1067		96	1038		97	1037		416	718	
	(15.63)	(-15.63)		(8.01)	(-8.01)		(2.30)	(-2.30)		(0.29)	(-0.29)		(-3.51)	(3.51)		(-3.04)	(3.04)		(-11.54)	(11.54)	

*p<0.05, **p<0.01
(), adjusted standardized residuals

Table 6: Contingency Table and Chi Square Tests to each FIM levels at discharge in Group 3 (70 ≤ mFIM at admission).

Discussion

According to literature review, previous studies focused on the relationship between FIM and mFIM item difficulties. However, few reports have investigated the contribution of individual mFIM items. This study indicated the contribution of mFIM items and minimum requested level in stroke patients with improved mFIM based on the three groups identified at admission. Gait training is an effective approach for stroke rehabilitation. Gait is a sub-item of locomotion, i.e., walking/wheelchair and stairs.

The range of mFIM in groups 1 and 2 was set in the severe-to-moderate assistance group based on mFIM at admission. The recovery pattern of gait in these stages was rapid [3,5,6,8,16]. Stairs is more difficult than gait and is influenced not only by gait but by multiple factors, such as standing balance and state of paralysis [17,18]. Moreover, the distribution of Stairs showed bias comprising 60-70% of the frequency in level 1 in the improving group. Therefore, it was strongly effective with little improvement.

Conversely, the OR was minimal in the logistic regression model in both groups. According to the OR value in the logistic regression model, the Stairs item did not have an adequate effect on the two groups (improving or non-improving) compared with the other items. As previously reported, Stairs is the most difficult activity, and gaps were identified between their capability and performance of ADL at discharge. Therefore, Stairs cannot reflect performance capability, and improving ability in Stairs is assumed to effectively contribute to the capability but not performance of patients recovering from stroke. Hence, the OR was low despite the high contribution rank.

The Mann-Whitney U test showed that the difference between the non-improving and improving groups in group 3 was not significant, which possibly improved gait based on Stairs-related activity. Group 3 was defined as >70 points of mFIM at admission. In cases with >70 points of mFIM, the walking/wheelchair (gait) FIM level was reported to be almost unchanged at admission and discharge [16]. Therefore, the Stairs contribution was lower in group 3 than in groups 1 and 2. Moreover, results of previous studies showed levels 2.8 (capability ADL) and 2.2 (performance ADL) [19]. The results of the Chi-squared test showed that levels higher than 3 significantly improved ADL in the improving group compared with those in the non-improving group.

Therefore, Stairs-related items require more effort and advanced activity, which were considered to influence FIM improvement by improving other activities and performances, indicating its lower

possibility of FIM improvement than with the other items. Thus, the contribution to the FIM level of the Stairs was defined as at least higher than level 3 in groups 1 and 2. Then, Self-care was also considered as a contribution item in groups 1 and 2. The OR of group 2 was higher than that of group 1. It was shown that the recovery process of Bathing, Dressing lower body, and Bladder was more evidently improving between 40 and 70 mFIM score. Therefore, these items did not change in rank, but were more effective in group 2.

In Bathing, the gaps between the capability and performance are reported to be low, and the agreement score was 90.2% at discharge although the level of difficulty was high [19,20]. Therefore, Bathing highly reflects the performance capacity, which was assumed to be more effective in improving mFIM than other items. However, improved FIM score of Bathing was not changed much after the 70-point FIM, and the Mann-Whitney U test showed that the difference was not significant between the non-improving and improving groups in group 3. Therefore, Bathing did not affect mFIM gain improvement in group 3. The results of the Chi-squared test showed that the improving group had higher than the non-improving group after level 3. As previously reported, the average levels were 3.3 (capability ADL) and 3.1 (performance ADL) [19]. Moreover, the final level reached in Bathing was level 3 [5]. Therefore, with regard to Bathing, the level of Stairs as a contribution item was defined as higher than level 3.

In the Dressing lower body item, the rank of contribution remained unchanged and showed a similar trend in the LR model in each group. Moreover, the agreement score was reported to be 84.3% and was lower than that of the Bathing item [19]. Moreover, the Dressing lower body gain showed no change in all groups. It was assumed that it did not impact the mFIM gain improvement when compared with Bathing. Moreover, unlike with the Bathing item, the recovery pattern of Dressing lower body tends to sharply improve after patients reach 60 mFIM points. Therefore, the result showed that the OR of Bathing was the most significant and mainly effective in group 2. The results of the Chi-squared test showed that group 1 had over level 4 and group 2 had level 3, which was significant in the improving group. The average level was 3.9 (capability ADL) and 3.7 (performance ADL), as previously reported [19]. Moreover, the recovery process pattern increased sharply from level 2 to 5 between the mFIM of 60 and 70 points [5,20]. Therefore, the level of Dressing lower body as a contribution item was defined as higher than at least level 3.

Among these extracted items, only the rank of the Bladder item increased. After stroke, symptoms of overactive bladder (OAB) such

as urinary frequency, urinary urgency, and urge incontinence are prominently observed in the recovery ward [21]. In case of cognitive impairment or gait disturbance, functional urinary incontinence may be observed. Pelvic floor muscle (PFM) training has been shown to be an effective method [22] and was significantly related to gait [23,24].

In other words, improving gait influences PFM improvement, which then improves OAB. The median of the walking/wheelchair item was significantly different between the non-improving and improving groups in groups 1 and 2. Thus, gait disturbance was presumably improved in the improving group compared to the non-improving group, as was the functional urinary incontinence caused by gait disturbance. Moreover, Toileting as a contribution item was found in group 3, i.e., Toileting with moderate difficulty and Bladder-related activity. Therefore, its level can possibly be improved in a wide range of FIM, although the mFIM score at admission was >70 points. Thus, Bladder rank was expected to increase due to the synergistic effect of two activities, although walking/wheelchair was not significantly different between the non-improving and improving subgroups in group 3. Moreover, Bladder was more easily observed than Bathing and Dressing lower body, and gaps between ADL capability and performance were lower than those of other items. In addition, the recovery process in Bladder management rapidly increased, ranging from an mFIM score of 50 to 70 points [5]. Moreover, most stroke patients with mFIM of >70 points possibly reached level 7 [5]. Therefore, Bladder rank was assumed to increase. The results of the Chi-squared test were significant in the improving group compared with those in the non-improving group: level 5 (group 1), level 4 (group 2), and level 5 (group 3). In previous studies, the average Bladder score was 4.3 (capability ADL) and 4.2 (performance ADL) [19]. Our results were consistent with these previous studies. Therefore, the level of Stairs as a contribution item was defined to be higher than at least level 5.

Finally, Toileting was found only in group 3. Toileting requires moderate activity compared with other items. It consists of component activities, such as "taking off pants," "wiping the buttocks," and "cutting the toilet paper." Among these movements, pulling the lower garments up and down were the most difficult, followed by toilet transfer [25-27]. In cases with mFIM of >70 points, the major Bladder level was nearly level 7 and Toileting transfer was higher than level 5 [5]. The recovery process of Toileting transfer was improved after or overlapped with walking recovery [5,28]. Our results showed level 6 in both the Bladder and Toileting transfer. These factors were presumably influenced by Toileting contribution for mFIM gain. Moreover, recovery process of Dressing lower showed improved mFIM with 70 points at admission [5,20]. In addition, upper extremity function recovery was improved after lower extremity recovery. Upper extremity function recovery has an effect on required upper extremity activities of Toileting. For the reason, it was assumed that the most difficult movement, pulling the lower garments up and down were improved by upper extremity function recovery. Toileting was reportedly correlated with Dressing lower body [29-32]. In short, necessary activities for Toileting were sharply improved above FIM <70 points, and Toileting was assumed to highly contribute in group 3 only [33]. Hence, Toileting was considered to have a contribution on mFIM gain even in group 3. The Chi-squared test results were significant at level 5 in the improving group compared with those in the non-improving group, with an average score of 4.1 (capability ADL) and 4.0 (performance ADL).

Therefore, the level of Toileting as a contribution item was defined to be higher than at least level 5.

One limitation of this study was that FIM improvement was

investigated based on mFIM items as the major factor. As mentioned in previous studies, FIM improvement has several related factors such as cognitive FIM and age. Investigation including these factors should be conducted in the future.

Conclusion

This study suggests that FIM items related to self-care and sphincter control after stroke each minimally required modified dependence (items related with self-care) and supervision or set-up level (items related with sphincter control) based on JRD data. Therefore, this study showed that a more effective intervention for recovery after stroke should consider not only the difficulty but also the minimally required level and contribution of mFIM gain. Moreover, the results suggested that it is important to reduce the gaps between the capacity and performance in Stairs during rehabilitation.

Conflict of Interest

The authors have no conflicts of interest to declare.

Acknowledgments

We greatly appreciate the special data management committee of the Japanese Association of Rehabilitation Medicine for creating the database that we used in this study. We acknowledge that the contents and conclusions of this study are not the views of the Japanese Association of Rehabilitation Medicine but are the author's own views.

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