

*Original Article***Relationship between cognitive FIM score and motor FIM gain in patients with stroke in a *Kaifukuki* rehabilitation ward**

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**ABSTRACT**

Imada Y, Tokunaga M, Fukunaga K, Sannomiya K, Inoue R, Hamasaki H, Noguchi D, Nakashima Y, Watanabe S, Nakanishi R, Yamanaga H. Relationship between cognitive FIM score and motor FIM gain in patients with stroke in a *Kaifukuki* rehabilitation ward. *Jpn J Compr Rehabil Sci* 2014; 5: 12–18.

**Objective:** To clarify the relationship between cognitive Functional Independence Measure (FIM) and motor FIM gain.

**Methods:** We examined 1,137 patients with stroke in a *Kaifukuki* rehabilitation ward. Both motor and cognitive FIM scores at admission were divided into six separate groups (three groups per parameter), and we then compared these groups with motor FIM gain as the objective variable. We also performed a multiple regression analysis using motor FIM gain as the objective variable.

**Results:** In the groups where motor FIM scores at admission were 13–38 points and 39–64 points, motor FIM gain was significantly higher in individuals that had high cognitive FIM scores at admission. In the multiple regression analysis, we found that motor FIM gain increased by 0.889 points when cognitive FIM scores at admission increased by 1 point in patients whose motor FIM score at admission was between 13 and 34 points and whose cognitive FIM score at

admission was between 5 and 14 points.

**Conclusion:** This study clarified the relationship between cognitive FIM scores at admission and motor FIM gain in individuals with stroke.

**Key words:** cognitive FIM, motor FIM gain, multiple regression analysis, stratification

**Introduction**

During the rehabilitation process, it is imperative that patients affected by stroke understand instructions from the rehabilitation staff in order to properly perform certain operations. Often, the cognitive function of a patient will affect their rehabilitation outcome. Therefore, many studies have been dedicated to investigating the relationship between outcome and cognitive function [1]. Functional Independence Measure (FIM) gain (FIM score at discharge minus FIM score at admission) and the FIM efficiency (gain/length of hospital stay), as well as the Barthel index gain and Barthel index efficiency are the most widely used outcome measures in medical rehabilitation.

The FIM is an 18-item, 7-level scale that rates the ability of patients to perform independently in activities of daily living (ADL). A total score is obtained by summing the scores across all 18 items; the lower the score, the more dependent a patient is. Two sub-scales (motor and cognition) can be obtained by summing the 13 motor items (range, 13–91 points) and the five cognitive items (range, 5–35 points). Even if cognitive FIM at admission is positively correlated with motor FIM gain, there is a possibility that motor FIM at admission, rather than cognitive FIM, could affect motor FIM gain. In order to show that motor FIM gain is large enough to have an effect on cognitive function, a multivariate analysis or stratification is required. When investigating gain, one must be

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cautious of the ceiling effect since the gain becomes smaller when a patient's ADL is high at admission. For example, a patient with a motor FIM score of 90 points at admission would only be able to obtain a maximum gain of 1-point. Moreover, the previous reports that have concluded that motor FIM gain is large enough when cognitive function is good in patients with stroke were all conducted overseas [2–5] with the exception of one report [6] coming from a hospital in Japan. This is a problem because foreign countries differ in their health care systems when compared to the systems that are employed at rehabilitation hospitals in Japan. However, a group from Japan [7] recently used national data from *Kaifukuki* rehabilitation wards to show that patients with dementia receive significantly less rehabilitation and are significantly older in age when compared to patients without dementia. Interestingly, this group saw that there was no significant difference between the two groups in motor FIM gain [7].

Our study objective was to determine whether cognitive FIM score at admission could affect motor FIM gain in severely disabled patients in the *Kaifukuki* rehabilitation ward.

### Methods

In this retrospective epidemiological study, we examined 1,137 patients with stroke in the *Kaifukuki* rehabilitation ward of Hospital A; these patients had received prior treatment in acute phase hospitals. Patients were admitted between April 1, 2008 and July 16, 2013. Except for subarachnoid hemorrhage, patients were included in this study if they were admitted to the hospital after 7 days of stroke onset, but were excluded if they were admitted 60 days after

onset. Additionally, patients were included if their length of stay was more than 14 days, but were excluded if their stay exceeded 180 days. Patients who had died in the hospital were excluded from the current study. Table 1 shows the clinical characteristics of the 1,137 cases. All the data required for this study were submitted to the database without any missing values. With the exception of a shorter duration of stroke onset to admission, patients used in our study were similar to patients incorporated into the national survey of the *Kaifukuki* rehabilitation wards [8].

Personal information examined in this study was processed in a manner that no individuals were identifiable, and this study was conducted in accordance with the regulations of the Clinical Research Ethics Committee of the hospital.

#### *Study 1: Relationship between FIM at admission and FIM gain*

In order to assess the relationship between motor FIM score at admission and motor FIM gain, patients were divided into 20 groups based on their initial motor FIM scores at admission. Since motor FIM scores range from 13 to 91 points, we divided groups using increments of 4 for the first 1–19 groups (scores from 13 to 16 points, 17 to 20 points, 21 to 24 points, etc.) and used an increment of 3 for the last 3 groups (81–84 points, 85–88 points, and 89–91 points) (see Table 2a). In order to assess the relationship between cognitive FIM at admission and cognitive FIM gain, we divided patients into eight groups based on their cognitive FIM scores at admission. Since cognitive FIM scores range from 5 to 35 points, we used a similar method as described above and divided groups using increments of 4 for the first 7 groups (5–8 points, 9–12 points, etc.) and increments of 3 for the last group (33–35 points) (see Table 2b).

**Table 1.** Clinical characteristics of subjects in this study compared with national survey.

	This study	National survey [8]
Number of patients	1,137	14,011
Sex	Males 698, females 439	56.8% males, 43.2% females
Infarction, hemorrhage	728 cases, 409 cases	–
Age	68.7±14.0	72.0
Duration from onset of stroke to admission	21.2±10.4	36.6
Length of hospital stay	80.3±40.1	89.4
Motor FIM score at admission	49.4±25.9	–
Cognitive FIM score at admission	23.0±9.4	–
Total FIM score at admission	72.3±33.3	68.4
Motor FIM score at discharge	67.8±24.4	–
Cognitive FIM score at discharge	26.5±8.4	–
Total FIM score at discharge	94.3±32.7	85.8
Motor FIM gain	18.4±15.5	–
Cognitive FIM gain	3.5±4.5	–
Total FIM gain	22.0±18.3	17.4

FIM, Functional Independence Measure; number, mean ± standard deviation.

**Table 2.** Relationship between FIM gain and FIM at admission.**a Motor FIM gain**

Motor FIM score at admission	13-16	17-20	21-24	25-28	29-32	33-36	37-40	41-44	45-48	49-52	53-56	57-60	61-64	65-68	69-72	73-76	77-80	81-84	85-88	89-91
Number of patients	187	61	42	42	30	47	46	47	57	42	56	45	48	51	40	49	61	54	83	49
Mean	15.5	25.8	26.4	31.2	32.4	32.7	28.7	28.1	27.6	26.7	25.2	18.6	20.1	16.4	13.3	10.6	8.3	5.6	3.3	0.4
Standard deviation	17.8	16.5	20.7	18.9	16.3	14.4	15.9	12.4	11.2	9.9	7.4	10.5	5.8	5.6	5.0	4.2	2.7	2.7	1.7	0.7

**b Cognitive FIM gain**

Cognitive FIM score at admission	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-35
Number of patients	122	91	96	114	127	157	222	208
Mean	4.8	6.7	6.9	6.3	3.9	3.1	1.7	0.4
Standard deviation	5.1	6.6	5.6	4.5	4.1	3.1	2.0	1.0

*Study 2: Correlation detection*

The Spearman's rank correlation coefficient was used to examine the relationship between motor FIM score at admission and cognitive FIM score at admission. A significance level of less than 5% was adopted. We also investigated the relationship, between motor FIM score at admission and motor FIM gain, between cognitive FIM score at admission and cognitive FIM gain, and between cognitive FIM score at admission and motor FIM gain. From the results of Study 1, motor FIM gain was largest in the group where motor FIM at admission scores were 33–36 points. In order to further explore the relationship between motor FIM at admission and motor FIM gain, we divided motor FIM scores at admission into 2 groups: scores of 13–34 points (where a positive relationship between motor FIM at admission and motor FIM gain was expected) and scores of 35–91 points (where a negative relationship was expected). We also observed that cognitive FIM gain was the largest in the group where cognitive FIM at admission scores were 13–16 points. Therefore, in order to further investigate the relationship between cognitive FIM at admission and cognitive FM gain, we divided cognitive FIM at admission scores into two groups: 5–14 points and 15–35 points.

*Study 3: Motor FIM gain stratified into nine groups*

Motor FIM scores at admission were divided into three groups (13–38 points, 39–64 points, and 65–91 points). For the first two groups, we used increments of 26 points while the last group had an increment of 27 points. We also divided cognitive FIM scores at admission into three groups (5–14 points, 15–24 points, and 25–35 points). For these divisions, we used an increment of 10 for the first two groups and an increment of 11 for the last group. Using the Kruskal-Wallis test, we then wanted to explore whether there was a significant difference in motor FIM gain among the three groups of cognitive FIM at admission scores (5–14 points, 15–24 points, and 25–35 points) for patients with motor FIM scores at admission of 13–38

points (significance level was less than 5%). The same test was done for patients with motor FIM scores at admission of 39–64 points and 65–91 points.

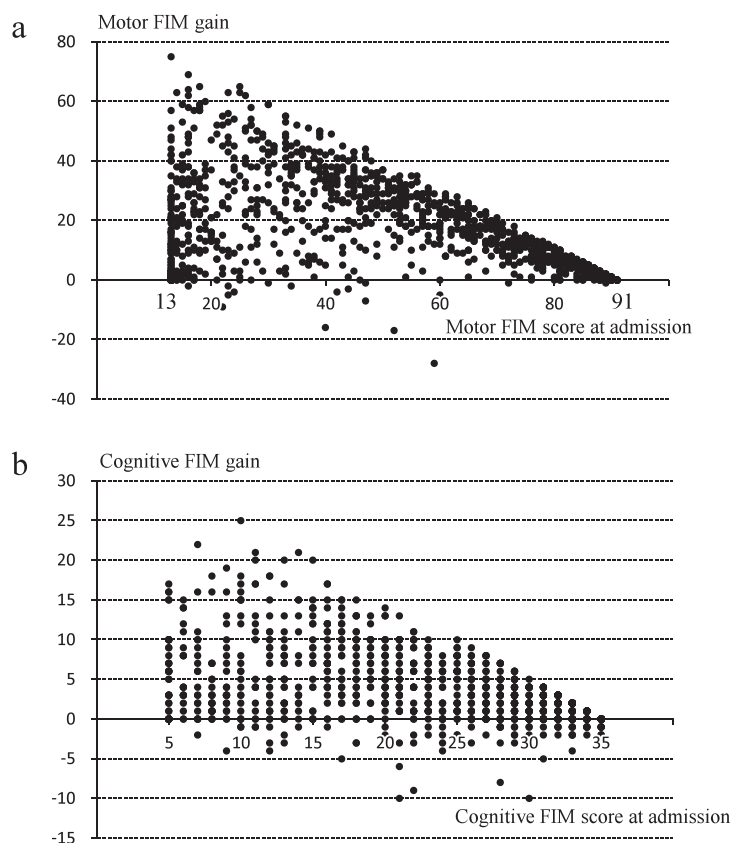
*Study 4: Multiple regression analysis for motor FIM gain*

We did a variable selection multiple regression analysis in order to exclude the effect of confounding factors. Age, duration from onset of stroke to admission, length of hospital stay, motor FIM score at admission, and cognitive FIM scores at admission were selected as the explanatory variables ( $F\text{-static} \geq 2$  was selected as a valid explanatory variable) while motor FIM gain was set as the objective variable. Similar to Study 2, a multiple regression analysis was performed separately on four groups; two groups of motor FIM scores at admission (5–14 points and 15–35 points) and two groups of cognitive FIM scores at admission (13–34 points and 35–91 points).

**Results**

We found a relationship between motor FIM at admission and motor FIM gain (Fig. 1a) that exhibited a mountain-shaped form, which was not linear. The average value of the motor FIM gain was the greatest (32.7 points) in the group of motor FIM scores at admission of 33–36 points (Table 2a). We also observed the mountain-shaped form between cognitive FIM at admission and cognitive FIM gain (Fig. 1b), where the mean value of cognitive FIM gain (6.9 points) was the greatest (6.9 points) in the group of cognitive FIM scores at admission of 13–16 points (Table 2b).

There was a strong relationship between cognitive FIM at admission and motor FIM at admission (correlation coefficient 0.714,  $p < 0.001$ ) (Table 3). When patients were divided into two groups based on FIM scores at admission to assess the relationships between motor FIM at admission and motor FIM gain and between cognitive FIM at admission and cognitive



**Figure 1a.** Relationship between motor FIM gain and motor FIM at admission.

**Figure 1b.** Relationship between cognitive FIM gain and cognitive FIM at admission.

●: each patient.

FIM gain, the correlation coefficient was negative in the group of patients where FIM scores at admission were low and positive in the group of patients where FIM scores at admission were high. When all patients were included in the analysis (i.e., no separation into groups), the correlation coefficient was negative (FIM gain was low when FIM at admission was high). The correlation coefficient between motor FIM scores at admission and motor FIM gain was greater than that between cognitive FIM scores at admission and cognitive FIM gain. We found no relationship between cognitive FIM scores at admission and motor FIM gain.

In the group where motor FIM scores at admission were 13–38 points, motor FIM gain among the three groups based on cognitive FIM scores at admission (5–14 points, 15–24 points, and 25–35 points) was significantly greater when cognitive FIM at admission was higher (Figure 2). Additionally, in the group where motor FIM scores at admission were 39–64 points, motor FIM gain was significantly higher when cognitive FIM at admission was high. However, when motor FIM scores at admission were 65–91 points, no significant difference in motor FIM gain was observed among the three groups based on cognitive FIM scores

at admission.

Table 4 shows the results of the variable selection regression analysis when motor FIM gain was used as the objective variable. In the groups where motor FIM scores at admission were 35–91 points and cognitive FIM scores at admission were 5–14 points, we could not perform a multiple regression analysis due to the small number of patients (only 26 cases). In the other three groups, we obtained negative regression coefficients with age (motor FIM gain was smaller when age was high) and duration from onset of stroke to admission (motor FIM gain was smaller when duration from onset of stroke to admission was longer). In contrast, we obtained a positive regression coefficient with length of stay (motor FIM gain was smaller when the length of stay was longer). The regression coefficient was also positive with motor FIM at admission scores of 13–34 points (motor FIM gain was greater when motor FIM score at admission was higher), but negative when motor FIM scores at admission were 35–91 points (motor FIM gain was smaller when motor FIM score at admission scores were higher). Lastly, we obtained a positive regression coefficient with cognitive FIM at admission (motor FIM gain increased by 0.237–0.889 points when

**Table 3.** Correlation detection.

A	B	Patient	Correlation coefficient	Significance
FIM score at admission	Cognitive FIM score at admission	All patients	0.714	$p < 0.001$
Motor FIM score at admission	Motor FIM gain	All patients	-0.343	$p < 0.001$
		Motor FIM score at admission 13-34	0.458	$p < 0.001$
		Motor FIM score at admission 35-91	-0.802	$p < 0.001$
Cognitive FIM score at admission	Cognitive FIM gain	All patients	-0.468	$p < 0.001$
		Cognitive FIM score at admission 5-14	0.111	n.s.
		Cognitive FIM score at admission 15-35	-0.582	$p < 0.001$
Cognitive FIM score at admission	Motor FIM gain	All patients	-0.039	n.s.

A, B: relationship between A and B; Significance, Spearman’s rank correlation coefficient; n.s, not significant.

**Table 4.** Variable selection regression analysis with motor FIM gain as the objective variable.

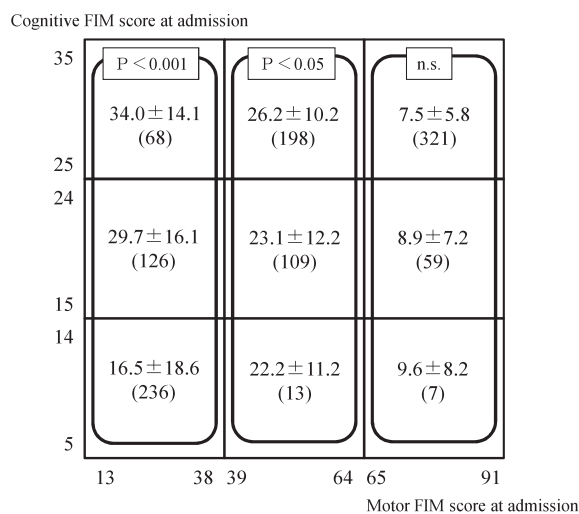
	Motor FIM score at admission	13-34 points		35-91points	
	Cognitive FIM score at admission	5-14 points	15-35 points	5-14 points	15-35 points
Number of patients		230	159	26	722
Explanatory variable	Age	-0.582 (40.5)	-0.499 (31.8)	/	-0.092 ( 23.5)
	Duration from onset of stroke to admission	-0.243 ( 7.0)	-0.210 ( 5.9)	/	-0.155 ( 30.4)
	Length of hospital stay	0.147 (28.0)	0.160 (26.0)	/	0.069 ( 44.0)
	Motor FIM score at admission	0.600 ( 8.2)	0.520 (11.1)	/	-0.551 (571.7)
	Cognitive FIM score at admission	0.889 ( 5.4)	-	/	0.237 ( 21.5)
	Constant		32.7	41.9	/
Adjusted R square		0.373	0.337	/	0.693

Number, Regression coefficient (F-static); -, not selected as an explanatory variable; /, multiple regression analysis could not be performed due to small number of patients.

cognitive FIM at admission increased by 1 point).

**Discussion**

Since there was a significant positive relationship between motor FIM at admission and cognitive FIM at admission, we stratified these two parameters into nine separate groups (three groups per parameter), and compared motor FIM gain in these groups . In patients with motor FIM scores at admission of 13-38 points and 39-64 points, motor FIM gain was significantly higher in the group that had high cognitive FIM scores at admission. We then did a variable selection multiple regression analysis in order to exclude the effect of confounding factors. In severe cases where motor FIM at admission scores were between 13 and 34 points and where cognitive FIM scores were between 5 and 14 points, we found that aside from age, duration from onset of stroke to admission, length of stay, and motor FIM at admission, cognitive FIM at admission affected



**Figure 2.** Motor FIM gain stratified into nine groups Numbers, FIM gain (mean ± standard deviation); P, Motor FIM gain among the three groups of cognitive FIM at admission (Kruskal-Wallis test).

motor FIM gain. More specifically, motor FIM gain was found to increase by 0.889 for each increase (by one) of cognitive FIM at admission.

The conclusion of Sogawa et al [7] differs from that of the present study. Specifically, the previous study analyzed national data from *Kaifukuki* rehabilitation wards in Japan and found there was no significant difference in motor FIM gain between the dementia group and the non-dementia group in patients with stroke. In this prior study, an attending physician determined the overall presence or absence of dementia using dementia tests like the Mini Mental State Examination (MMSE) or the Hasegawa intelligence evaluation scale revision (HDS-R). Although, among the 1,347 (70.5%) patients in the dementia group who received significantly less rehabilitation and were significantly older in age when compared to the 564 (29.5%) patients in the non-dementia group, there was no significant difference in motor FIM gain between the two groups. However, because FIM gain will be altered when FIM at admission varies, it is important to distinguish whether there is a significant difference in FIM scores at admission between dementia and non-dementia groups; this necessary measure was not mentioned by Sogawa et al. [7].

Only few studies have reported that cognitive functions of patients with stroke can affect motor FIM gain [2–6]. As mentioned earlier, these studies were all conducted overseas with the exception of one report coming from a hospital in Japan. The reasons why these studies are few in number could be explained by the relationship between motor FIM and cognitive “FIM” and “FIM gain is small in patients with high FIM scores at admission”.

Even if reports have proved that the motor FIM gain of patients with stroke is small in patients with low cognitive FIM scores at admission, the relationship between motor FIM and cognitive FIM would lead one to think that motor FIM, instead of cognitive FIM, affects motor FIM gain. This can be addressed by employing either a multiple regression analysis or stratification. However, stratification cannot correct the effects of confounding factors. For example, in patients with low cognitive FIM at admission there is a possibility that motor FIM gain becomes small because of the elderly patients included in the group. The multiple regression analysis also has limitations in that the relationship between motor FIM gain and explanatory variables, such as age [8, 9] and motor FIM at admission (Fig. 1a), are not linear. In previous reports, multiple regression analyses designated training time and total FIM scores at admission as explanatory variables and total FIM gain as the objective variable; multiple regression analyses were said to be separated into two groups based on total FIM score at admission [11]. In the present study, we classified cognitive and motor FIM scores at admission into four groups. If the multiple regression analysis

was performed using FIM gain as the objective variable in all patients [12], the regression coefficient of FIM at admission would become negative leading to a wrong conclusion that good ADL is related to poor outcome.

Lastly, the few reports [2–6] that concluded that motor FIM gain was large when cognitive function was good, used FIM effectiveness as a measure (motor FIM gain/(91 points-motor FIM at admission) [13]) instead of FIM gain. FIM effectiveness is expressed as a percentage that reflects the actually achieved improvement out of the total potential improvement.

The current study has several limitations that should be addressed. First, our results were derived from data obtained from one hospital, which might be considered as a drawback. However, one report [11] has stated that even if a study finds a positive correlation between training time and FIM gain in several hospitals, if the data from many hospitals with different rehabilitation programs are mixed, the association of training time and FIM gain become unclear. Thus, detailed examination in one hospital, such as the investigation in the current report, may be better than research conducted across multiple centers.

We did not study HDS-R and MMSE. However, it has been reported that cognitive FIM can be used for the evaluation of cognitive function in patients with stroke [14].

There is also a possibility that the results we observed may become different if the stratification of the groups were different. Using 4 increments in this study, we found that motor FIM gain was the largest in motor FIM scores at admission of 33–36 points; however, in a study by Sonoda et al. [15], motor FIM gain was the largest in patients with motor FIM scores of 30–40 points. We stratified our data differently for each study, but we are still not clear on what level of stratification is optimal.

Another point that remains unclear is the reason why the group with motor FIM scores at admission of 33–36 points had the maximum motor FIM gain.

We also did not take into consideration the presence or absence of hemispatial neglect and aphasia [16].

In the current study, FIM gain was used as an outcome measure instead of FIM efficiency. Since FIM efficiency reflects the speed of improvement, FIM efficiency is used more often than FIM gain [1]. However, FIM efficiency is susceptible to the length of stay. Therefore, FIM gain within a limited time (e.g., FIM gain over 2 months) may more properly reflect the speed of improvement [17].

Moreover, we were not able to exclude the effects of confounding factors, such as comorbidity and impairment, since it is difficult to perform a multiple regression analysis with all of the factors that may affect motor FIM gain included.

Lastly, it is not clear whether extending the length of stay and giving intensive training for patients with

low initial cognitive FIM scores makes cognitive and motor FIM gain high. All of these limitations should be addressed in future studies.

In conclusion, using a multiple regression analysis on motor FIM scores at admission of 13–34 points and cognitive FIM scores of 5–14 points clarified that motor FIM gain increases by 0.889 points as cognitive FIM at admission scores increase by 1 point. We believe that this method might be useful for evaluating the relationship between factors other than dementia and motor FIM gain.

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### References

1. Koh GCH, Chen CH, Petrellia R, Thind A. Rehabilitation impact indices and their independent predictors; a systematic review. *BMJ Open* 2013; 3(9): e003483.
2. Heruti RJ, Lusky A, Dankner R, Ring H, Dolgopiat M, Barell V, et al. Rehabilitation outcome of elderly patients after a first stroke; effect of cognitive status at admission on the functional outcome. *Arch Phys Med Rehabil* 2002; 83: 742–9.
3. Toglia J, Fitzgerald KA, O'Dell MW, Mastrogiovanni AR, Lin CD. The Mini-Mental State Examination and Montreal Cognitive Assessment in persons with mild subacute stroke, relationship to functional outcome. *Arch Phys Med Rehabil* 2011; 92: 792–8.
4. Denti L, Agosti M, Franceschini M. Outcome predictors of rehabilitation for first stroke in the elderly. *Eur J Phys Rehabil Med* 2008; 44: 3–11.
5. Koh GC, Chen C, Cheong A, Choo TB, Pui CK, Phoon FN, et al. Trade-offs between effectiveness and efficiency in stroke rehabilitation. *Int J Stroke* 2012; 7: 606–14.
6. Mutai H, Furukawa T, Araki K, Misawa K, Hanihara T. Factors associated with functional recovery and home discharge in stroke patients admitted to a convalescent rehabilitation ward. *Geriatr Gerontol Int* 2012; 12: 215–22.
7. Sogawa Y. Effectiveness of rehabilitation for activity of daily living, cognitive function and outcome after hospital discharge in dementia patients. *J Clin Rehabil* 2012; 21: 716–20. Japanese.
8. 2012 Annual Report from the Annual Survey Committee of *Kaifukuki* Rehabilitation Ward Association. February 2013. Japanese.
9. Black-Schaffer RM, Winston C. Age and functional outcome after stroke. *Top Stroke Rehabil* 2004; 11: 23–32.
10. Tokunaga M, Yonemura M, Inoue R, Sannomiya K, Nakashima Y, Watanabe S, et al. Effects of age on functional independence measure score gain in stroke patients in *Kaifukuki* rehabilitation ward. *Jpn J Compr Rehabil Sci* 2012; 3: 32–6.
11. Tokunaga M, Kondo K. Training time and FIM gain in patients with stroke in *Kaifukuki* rehabilitation hospitals. *Sogo Rehabil* (in press). Japanese.
12. Leung AWS, Cheng SKW, Mak AKY, Leung KK, Li LSW, Lee TMA. Functional gain in hemorrhagic stroke patients is predicted by functional level and cognitive abilities measured at hospital admission. *NeuroRehabilitation* 2010; 27: 351–8.
13. Heinemann AW, Roth EJ, Cichowski K, Betts HB. Multivariate analysis of improvement and outcome following stroke rehabilitation. *Arch Neurol* 1987; 44: 1167–72.
14. Zwecker M, Levenkrohn S, Fleisig Y, Zeilig G, Ohry A, Adunsky A. Mini-Mental State Examination, cognitive FIM instrument, and the Loewenstein Occupational Therapy Cognitive Assessment; relation to functional outcome of stroke patients. *Arch Phys Med Rehabil* 2002; 83: 342–5.
15. Sonoda S, Nagai S, Sakamoto R, Okuyama Y, Nobotachi N. Pass according to disease severity and the goal. In: *The Japanese Association of Rehabilitation Medicine*, editor. *Liaison path for stroke rehabilitation*. Tokyo: Igaku Shoin; 2007. p. 199–202. Japanese.
16. Gialanella B, Ferlucchi C. Functional outcome after stroke in patients with aphasia and neglect; assessment by the motor and cognitive Functional Independence Measure instrument. *Cerebrovasc Dis* 2010; 30: 440–7.
17. Tokunaga M, Watanabe S, Nakanishi R, Yamanaga H, Yonemitsu H, Kawano S, et al. Amount of training and FIM gain in 9 *Kaifukuki* rehabilitation hospitals participating in Kumamoto stroke liaison critical pathway. *J Clin Rehabil* 2012; 22: 208–13. Japanese.