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Comparison of Functional Independence Measure (FIM) Gain between Groups with Extreme Differences in FIM Score at Admission

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Abstract

Objective: There are several methods for inter-hospital comparison of the improvement in Functional Independence Measure (FIM). However, it is not known which method is most suitable. The purpose of this study was to elucidate which of 4 methods can most successfully compare the average improvement in motor FIM (mFIM) at each hospital with the least influenced by the difference of mFIM score at admission. For this purpose, we considered 3 groups divided based on motor FIM score at admission as 3 hospitals.

Methods: The subjects were 575 stroke patients hospitalized in a convalescent rehabilitation ward. We divided the subjects into 3 groups based on mFIM score at admission (13 to 38 points, 39 to 64 points, and 65 to 90 points) and investigated whether there were significant differences in the values derived from mFIM effectiveness, corrected mFIM effectiveness, deviation value of mFIM gain, and multiple regression analysis.

Result: Significant difference in the improvement in mFIM between 3 groups divided by mFIM at admission was not observed only for the use of the deviation value of mFIM gain.

Conclusion: Deviation value of mFIM gain, which is the least liable to the influence of differences in mFIM score at admission, is useful as a method to compare average improvement in mFIM among hospitals.

Keywords: Stroke; Functional Independence Measure; FIM gain; Ceiling effect

Introduction

The Functional Independence Measure (FIM) [1] is a technique used for evaluating activities of daily living (ADL). FIM evaluates ADL as 1-7 points each for 18 items. The scale consists of 13 motor items (mFIM) with a score range of 13-91 points, and 5 cognitive items (cFIM) with a score range of 5-35 points [1]. The results indicate to what extent an individual is capable of independent ADL. FIM gain (FIM score at discharge minus FIM score at admission) is commonly used to assess the degree of improvement in FIM. The mean FIM gain is greatest for patients requiring moderate assistance. On the other hand, patients with low FIM scores at admission exhibit little improvement, while those with high FIM scores at admission demonstrate a ceiling effect, and both groups display little gain in FIM [2]. When FIM at admission differs significantly between rehabilitation hospitals, simple comparison of FIM gain is impossible [2].

To overcome this problem, the following 5 methods were used when conducting inter-hospital comparisons of improvement in FIM: 1. Limitations of patients [3], 2. Case-control study that matches age and FIM score at admission [4], 3. Adjustment of FIM gain using a standard severity distribution [5], 4. Multiple linear regression analysis [6,7], 5. Corrected FIM effectiveness [8,9]. It may also be possible to use the following 3 methods: 6. FIM gain stratified by FIM score at admission, 7. FIM effectiveness [10], and 8. Deviation value of FIM gain [11]. However, it was not clear which of these 8 methods was best as a method for comparing the improvement in FIM between hospitals where FIM at admission differed [2]. Even when actual hospital data is used in an investigation, if the order of hospital's average improvement in FIM differs with each method, it is difficult to determine which result is accurate.

Therefore, the patients hospitalized in one hospital were divided into several groups based on mFIM score at admission (e.g. groups consisting of mFIM at admission of 13 to 38 points, 39 to 64 points, and 65 to 90 points). Then, we decided to conduct the study under the assumption that only patients with mFIM at admission scores of 13 to 38 were admitted to hospital A, only patients with scores of 39 to 64 were admitted to hospital B, and only patients with scores of 65 to 90 were admitted to hospital C. By investigating the improvement in mFIM based on the assumption that patients with such extreme differences in mFIM score at admission were hospitalized in the 3 hospitals, we believed we could elucidate which of the 8 methods was least likely to be influenced by mFIM score at admission, and could compare the average improvement in mFIM between hospitals. However, in this extreme condition, it was impossible to utilize methods 1, 2, 3, and 6, which meant that only methods 4, 5, 7, and 8 could be used. Investigation of methods 5, 7, and 8 (excluding method

4) by dividing the mFIM score at admission into 2 groups showed that methods 5 and 8 were less likely to be influenced by differences in mFIM score at admission than method 7 [11].

The purpose of this study was to elucidate which of 4 methods (corrected mFIM effectiveness, deviation value of mFIM gain, mFIM effectiveness, and multiple regression analysis) was best to compare the average improvement in mFIM with the least influenced by the differences in mFIM score at admission, by considering 3 groups divided by mFIM score at admission as 3 hospitals. In other words, the data from one hospital was divided into three groups with extremely different mean mFIM score at admission. And if mFIM improvement degree is the same among the three groups, we judged that this method was least influenced by the differences in mFIM score at admission, and suitable for comparison of improvement in FIM among hospitals.

Methods

This study is a retrospective design. A total of 770 stroke patients who were admitted to a convalescent rehabilitation ward in Hospital K between April 1, 2013 and June 17, 2016, after undergoing treatment at acute hospitals, were enrolled. The following patients were excluded: those with traumatic subarachnoid hemorrhage (3 cases), those aged younger than 40 years old (29 cases), those who died in the hospital (5 cases), those whose outcome was not recorded (7 cases), those admitted within 6 days or more than 60 days after onset (45 cases), those who spent less than 31 days in hospital (91 cases), those whose FIM score at admission or discharge was not recorded (2 cases), those whose mFIM score at admission was 91 points (4 cases), and those whose mFIM gain was less than 0 pint (9 cases). The remaining 575 patients were included in this study.

mFIM effectiveness

We calculated mFIM effectiveness as follows: mFIM gain/(91 pointsmFIM at admission). Since this shows the percentage of improvement among those who were able to improve, it was shown as a number from 0 to 1[10].

Corrected mFIM effectiveness

The corrected mFIM effectiveness=mFIM gain/(A-mFIM at admission), with the A score as 42 points, 64 points, 79 points, 83 points, 87 points, 89 points, and 91 points (when the mFIM at admission for the stroke patients was 13 to 18 points, 19 to 24 points, 25 to 30 points, 31 to 36 points, 37 to 42 points, 43 to 48 points, and 49 to 90 points, respectively) [8]. For example, the score of possible improvement in a patient whose mFIM score at admission was 13 points, was 78 points (91 minus 13 points), although the score at which actually possible improvement was smaller than that. Thus, we lowered the score of 91, which is the denominator for mFIM effectiveness.

Deviation value of mFIM gain

Deviation value of mFIM gain = {(mFIM gain-average) × 10/ standard deviation}+50 [11]. In this method, average was adjusted to 50 and the standard deviation was adjusted to 10. The averages and standard deviations for mFIM at admission divided into 13 groups are shown in Table 1.

Stratification of mFIM at admission	Average of mFIM gain	Standard deviation
13-18 points	19.73	19.96
19-24 points	35.45	17.47
25-30 points	25.26	16.40
31-36 points	30.45	15.61
37-42 points	30.95	11.71
43-48 points	29.45	10.03
49-54 points	25.28	9.76
55-60 points	25.00	7.23
61-66 points	18.14	7.05
67-72 points	15.86	3.92
73-78 points	11.77	3.21
79-84 points	8.61	2.35
85-90 points	2.38	1.81

Table 1: The averages and standard deviations for mFIM at admission divided into 13 groups. Deviation value of mFIM gain = {(mFIM gain-average) × 10/standard deviation}+50 [11]. In patient whose mFIM score at admsion is between 13 and 18 points and mFIM gain is 25 points, deviation value of mFIM gain is calculated as follows; (25-19.73) × 10/19.96+50=52.6.

Multiple linear regression analysis

We performed multiple linear regression analysis with mFIM at discharge as the dependent variable. The independent variables were age, gender, type of stroke (cerebral infarction, cerebral hemorrhage, subarachnoid hemorrhage), number of days from onset to admission, mFIM score at admission, cFIM score at admission, and number of days in hospital. We investigated the "measured/predicted ratio" obtained by dividing the measured value of mFIM score at discharge by the predicted value obtained using multiple regression analysis. In a review of 16 studies in which either FIM at discharge or FIM gain was predicted using multiple regression analysis on stroke patients hospitalized in convalescent rehabilitation wards in Japan, the independent variables that were used in at least 5 of these studies and that were found to be significant in at least half of those were age, number of days from onset to admission, mFIM at admission, cFIM at admission, and number of days in hospital [12]. We added gender and type of stroke to these 5, and the number of independent variables became 7.

Comparison of 3 groups divided by mFIM score at admission

We divided mFIM score at admission in 26-point increments (13 to 38 points, 39 to 64 points, and 65 to 90 points). These were designated as Group A, Group B, and Group C, and then we considered that only the patients who had those mFIM scores at admission hospitalized in hospitals A, B, and C. We compared the 3 groups using the following 9 items: age, cFIM at admission, number of days from onset to admission, number of days in hospital, mFIM gain, multiple regression analysis (measured/predicted ratio), mFIM effectiveness, corrected mFIM effectiveness, and deviation value of mFIM gain. Comparisons between the 3 groups were made using the Kruskal-Wallis test, and in cases in which significant difference was observed, multiple comparison was performed using Scheffé's method. The significance was set at under 5%.

This study complied with the regulations of the Clinical Research Ethics Committee of the authors' hospital. All personal data were processed so as not to identify any individuals. The statistics software we used was 4 Steps Excel Statistics [13].

Results

Table 2 shows the basic attributes of the 575 subjects. Other than a shorter period between onset and admission, the subjects were very similar to those recorded in the national survey of convalescent rehabilitation wards in Japan [14].

	This study	National survey [14]
Number of patients	575	9,031
Age	69.7 ± 12.1 (40-97,70)	73.3
Gender	Male 319, female 256	56.7%, 43.3%
Infarction, hemorrhage, SAH	336, 179, 60	
Number of days from onset to admission	18.3 ± 9.6 (7-59, 16)	29.6 ± 13.9
Number of days in hospital	90.9 ± 39.5 (31-283, 90)	81.3 ± 45.1
Motor FIM score at admission	45.6 ± 25.0 (13-90, 45)	
Cognitive FIM score at admission	22.0 ± 9.3 (5-35, 24)	
Total FIM score at admission	67.6 ± 32.5 (18-125, 70)	71.1 ± 31.3
Motor FIM score at discharge	20.8 ± 15.5 (0-77, 19)	
Cognitive FIM score at discharge	26.2 ± 8.5 (5-35, 29)	
Total FIM score at discharge	92.6 ± 32.3 (18-126, 106)	88.3 ± 33.6
Motor FIM gain	20.8 ± 15.5 (0-77, 19)	
Motor FIM effectiveness	0.556 ± 0.314 (0-1, 0.623)	
Corrected motor FIM effectiveness	0.698 ± 0.436 (0-2.920, 0.724)	
Deviation value of motor FIM gain	50.0 ± 9.9 (19.7-78.7, 50.7)	

Table 2: Clinical characteristics of subjects in this study.

The results of multiple regression analysis with mFIM at discharge used as the dependent variable are shown in Table 3. Among the independent variables, there were no correlations of 0.8 or above. The predictive formula was significant, and the coefficient of determination R^2 was 0.755.

	Coeff (B)	Std Coeff (β)	Sigificance (p)	95% CI of B	
				Lower	Upper
Independent variables					
Age	-0.339	-0.166	<0.001	-0.434	-0.243
Male 0, female 1	-2.491	-0.050	<0.05	-4.606	-0.375
Dummy variable for hemorhage	3.130	0.058	<0.05	0.699	5.562
Dummy variable for SAH	5.671	0.070	<0.01	2.019	9.323
Number of days from onset to admission	-0.225	-0.087	<0.001	-0.339	-0.111
Motor FIM at admission	0.569	0.574	<0.001	0.491	0.646
Cognitive FIM at admission	0.801	0.301	<0.001	0.634	0.969
Number of days in hospital	0.038	0.061	<0.05	0.002	0.075

Table 3: Multiple regression analysis (FIM: Functional Independence Measure; SAH: Subarachnoid hemorrhage; Coeff: Coefficient; Std Coeff: Standard coefficient; CI: Confidence interval; Dependent variable, Motor FIM at discharge; Constants: 46.595; Coefficient of determination (R^2): 0.755; p values: <0.001, Dummy variable for hemorhage, assign 1 for hemorrhage, 0 for other types of stroke, Predicted motor FIM score at discharge=-0.339 × Age-2.491 × Female+3.130 × Hemorhage-5.671 × SAH-0.225 × Days from onset to admission+0.569 × Motor FIM at admission+0.801 × Cognitive FIM at admission+0.038 × Number of days in hospital+46.595).

Comparison of the 3 groups divided by mFIM score at admission indicated that the lower the mFIM at admission, age was significantly higher (Figure 1a), cFIM score at admissions was significantly lower (Figure 1b), the number of days between onset and admission were significantly longer (Figure 1c), and number of days in hospital were significantly longer (Figure 1d). The mFIM gain was significantly smaller in Group C than in Groups A or B (Figure 1e). Measured/predicted ratio (multiple regression analysis) in Group B was significantly larger than those in Groups A or C (Figure 1f). mFIM effectiveness was significantly smaller as mFIM at admission became lower (Figure 1g). Corrected mFIM effectiveness was shown to be significant when subjected to the Kruskal-Wallis test, but multiple comparisons did not show a significant difference between the 3 groups (Figure 1h). The corrected mFIM effectiveness for Group A had a larger value of standard deviation. The deviation value of mFIM gain showed no significant differences in any of the 3 groups (Figure 1i).

Discussion

It was reported that corrected mFIM effectiveness and deviation value of mFIM gain are less susceptible to differences in mFIM score at admission than mFIM effectiveness [11]. In this study, only deviation value of mFIM gain does not show significant difference in mFIM improvement degree among 3 groups divided by mFIM score at admission. Therefore, the deviation value of mFIM gain was considered to be suitable for inter-hospital comparison of mFIM improvement degree rather than mFIM effectiveness, corrected mFIM effectiveness, and multiple regression analysis.

Comparison of the 3 groups divided by mFIM score at admission showed that as mFIM at admission became lower, age was significantly higher, cFIM at admission was significantly lower, there were significantly more days between onset and admission, and the hospital stay was longer. These factors indicate that the patient's condition is severe, so the improvement in mFIM should be small. Therefore, we believe that mFIM effectiveness is appropriate for the index of improvement in mFIM, which becomes smaller value as mFIM score at admission becomes lower.

However, the required condition for inter-hospital comparison of improvement in mFIM is completely different. The ordinary mFIM improvement index (mFIM gain and mFIM effectiveness), in which improvement in mFIM differs according to the mFIM score at admission, cannot be used to compare the improvement in mFIM between hospitals with different mFIM scores at admission. For that purpose, a method that uses mFIM gain stratified by mFIM score at admission (Method 6) is required, but stratification could not be applied to the extreme conditions as used in this study.

The mFIM improvement index, such as deviation value of mFIM gain and corrected mFIM effectiveness, that is used in inter-hospital comparisons, adjusted the improvement in mFIM of patients with low mFIM scores at admission so that it was the same as patients with high mFIM scores at admission. Doing this allowed comparison of improvement in mFIM among hospitals with any percentage of patients with low mFIM score at admission (these mFIM improvement indices are unlikely to be affected by mFIM score at admission).

The outcome is considered good in hospitals with large measured/predicted ratios in multiple regression analysis [7]. If the prediction of multiple regression analysis is completely correct, the measured/predicted ratios for all patients should be 1.0. However in the present study, which used the data from a single hospital (Hospital K), showed that the measured/predicted ratio was significantly larger in Group B than in Groups A and C. Currently, the predictive accuracy of multiple regression analysis is able to estimate trends in a population but cannot be used to make predictions regarding individual cases. Nevertheless, multiple regression analysis has the merit of allowing multiple factors to be considered, and therefore if its predictive accuracy can be improved, we believe it can become a useful method for inter-hospital comparisons of improvement in mFIM.

Figure 1.

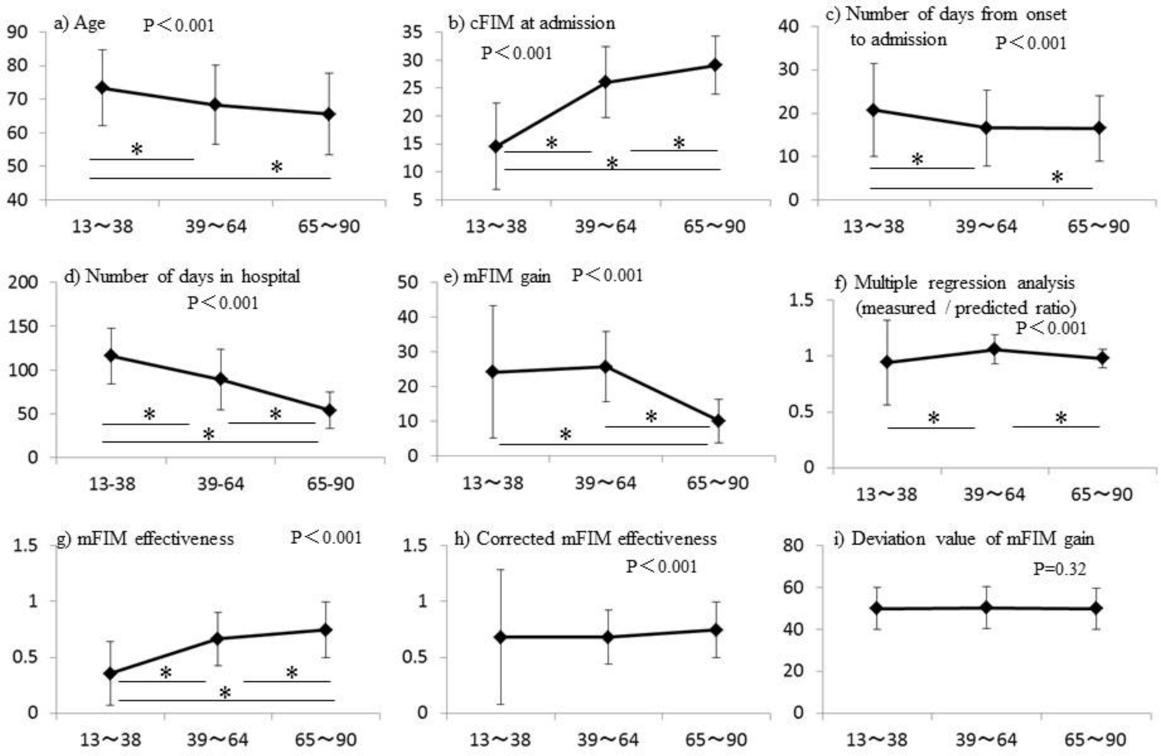

Figure 1: Comparison of 3 groups divided by mFIM score at admission. FIM: Functional Independence Measure; mFIM: mFIM; cFIM: cognitive FIM; *: Significant (p<0.05) using the multiple comparison (Scheffé's method); Horizontal axis: mFIM score at admission; Bar, Mean ± standard deviation; P value, Significance between the 3 groups divided by mFIM score at admission using the Kruskal-Wllis test).

This study had the following limitations. First is that it is not known whether the independent variables used in the present study was appropriate or not. In their review of multiple regression analysis performed on acute phase stroke patients, Meyer et al. [15] found that in 27 studies, 63 out of 126 factors used as independent variables were significant. However, the number of significant independent variables actually included in a single predictive formula was an average of no more than 4.1 (standard deviation of 2.5) [15]. And the coefficient of determination R^2, which means how well the explanatory variables can explain the objective variable, was on average 0.65 (minimum 0.35 to maximum 0.82) [15]. Second is the fact that we were only able to investigate 4 of the 8 methods of performing inter-hospital comparisons of improvement in mFIM.

It is hoped that the awareness of inter-hospital comparisons of the improvement in mFIM in stroke patients will increase, and that the deviation value of mFIM gain will be used in inter-hospital comparisons due to the fact that it is unlikely to be affected by mFIM score at admission.

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