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Original Article

Formula for Predicting FIM Gain and Discharge FIM —Methods using Median Values of FIM Gain Stratified by Admission FIM, Age, Cognitive Function, and Transfer Interval—

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ABSTRACT

Tokunaga M, Sannomiya K, Nakashima Y, Nojiri S, Tokisato K, Katsura K, Watanabe S, Nakanishi R, Yamanaga H. Formula for Predicting FIM Gain and Discharge FIM —Methods using Median Values of FIM Gain Stratified by Admission FIM, Age, Cognitive Function, and Transfer Interval—. Jpn J Compr Rehabil Sci 2015; 6: 6−13.

Objective: To predict FIM gain and discharge FIM score by multiplying the standard value by influence coefficients for age, cognitive function, and transfer interval.

Methods: The subjects were 1,118 stroke patients admitted to a *Kaifukuki* rehabilitation ward of hospital A. The median value of motor FIM (mFIM) gain and discharge mFIM based on mFIM at the time of admission was used as the standard value. We then created a formula for predicting mFIM gain and discharge mFIM by multiplying the standard value by the influence coefficients for age, cognitive function, and transfer interval.

Results: The correlation coefficient between the actual and predicted values was 0.681 in the prediction of mFIM gain and 0.874 in the prediction of discharge mFIM. The residual of the subtraction of the predicted value from the actual value was 1.4±12.5 (median value: 0) in the prediction of mFIM gain, and 1.3±12.6 (median value: 0) in the prediction of discharge mFIM.

Conclusion: The correlation coefficient is comparable with those of reports that use multiple regression analysis. This new method clearly showed the relationship between factors and mFIM gain/discharge mFIM.

Key words: Functional Independence Measure, FIM gain, multiple regression analysis, formula, factors

Introduction

Multiple regression analysis is often used to analyze the outcome of stroke patients influenced by multiple factors. Regarding reports from *Kaifukuki* rehabilitation wards in Japan, there are 14 reports [2−15] that use a multiple regression analysis with Functional Independence Measure (FIM) [1] gain (discharge FIM − admission FIM) or discharge FIM as the objective variable.

The prediction formula for a multiple regression analysis is $y = aX_1 + bX_2 + cX_3$ (y: objective variable, X_1–X_3: explanatory variables, a–c: regression coefficients). This supposes that there is a linear relationship between the explanatory variables and the objective variable and adds the influence of the various factors together. However, there is not necessarily a linear relationship between the explanatory variables and the objective variable. For example, the relationship between admission FIM and FIM gain is not linear, but inverted V-shaped. FIM gain is smaller in the total assistance level because it includes numerous patients who have difficulty in recovering, and gains decrease due to the ceiling effect in the minimal assistance level [16]. Compared to this, there are numerous moderate-assistance patients with large gains [16]. It has been reported that FIM improvement decreases almost linearly in stroke patients after the age of 70, but remains constant for patients 69 and younger. In addition, it may be more suitable not to add the influence of each factor, but rather to perform multiplication by the influence coefficients after stratifying the influence of each factor.

Thus, we obtained the median (standard value) of

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the admission FIM-based FIM gain. We consider a new method in which the standard value is multiplied by the coefficient of the influence of age in order to obtain the predicted value of FIM gain that takes into consideration admission FIM and age.

The aim of this study is to create a formula for predicting FIM gain and discharge FIM by multiplying the medians of admission FIM-based FIM gain and discharge FIM (standard value) by the influence coefficients for age, cognitive function, and transfer interval.

Subjects and Methods

A total of 1,118 stroke patients who were admitted to the *Kaifukuki* rehabilitation ward in Hospital A between April 1, 2008 and July 16, 2013, after undergoing treatment at acute hospitals, were enrolled. The following patients were excluded: those with subarachnoid hemorrhage, those admitted within 7 days or more than 60 days after onset, those who spent less than 14 days or over 180 days in hospital, those who died in hospital, and those with motor FIM score on admission of 91 points. Table 1 shows the basic attributes of the 1,118 subjects. Other than a shorter period between onset and admission, the subjects were very similar to those recorded in the national survey of *Kaifukuki* rehabilitation wards [19].

Study 1: Standard Values of Admission mFIM-based FIM Gain and Discharge mFIM

The motor items of FIM at admission (admission mFIM) were split into 13 groups in 6-point increments (13−18, 19−24, 25−30, 31−36, 37−42, 43−48, 49−54, 55−60, 61−66, 67−72, 73−78, 79−84, and 85−90 points). We obtained the median for mFIM gain in each group and used that as the “standard value” for mFIM gain. The standard value of discharge mFIM was set as the sum of admission mFIM and the standard value of mFIM gain. Spearman’s rank correlation coefficient (significance level below 5%) was used to test whether there was a correlation between the actual and standard values. In addition, we calculated the “residual” of the actual value by subtracting the standard value from it. We used the median value instead of the mean value because it is more difficult for the median value to be influenced by outliers.

Study 2: Correcting the Standard Value for Age

For all patients, the numerical value (P) was obtained by dividing the “actual value of mFIM gain” by the “standard value of mFIM gain.” Similarly, the numerical value (Q) was obtained by dividing the “actual value of discharge mFIM” by the “standard value of discharge mFIM.” The ages were split into seven groups: 59 and below, 60−69, 70−74, 75−79, 80−84, 85−89, and 90 and above. We obtained the median values of P and Q in each of the age groups and set them as the “influence coefficient for age.” We multiplied the standard value of mFIM gain obtained in Study 1 by the “influence coefficient for age” and set it as the “predicted value of mFIM gain for which the standard value was corrected for age.” Similarly, we multiplied the standard value of discharge mFIM by the “age influence coefficient” and set it as the “predicted value of discharge mFIM for which the standard value was corrected for age.”

Study 3: Correcting for Cognitive FIM

We further corrected the standard value that had been corrected for age, for cognitive FIM. The

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

	This study	National survey [19]
Number of patients	1,118	14,254
Sex	Males 680, females 438	56.4% males, 43.6% females
Infarction, hemorrhage	Infarction 716, hemorrhage 402	−
Age	69.0±13.8 (72)	71.8
Duration from onset of stroke to admission	21.2±10.4 (18)	31.7±14.3
Length of hospital stay	81.0±39.9 (81)	89.1±50.0
Motor FIM score at admission	48.7±25.5 (48.5)	−
Cognitive FIM score at admission	22.8±9.3 (25)	−
Total FIM score at admission	71.5±32.9 (74)	68.9±31.7
Motor FIM score at discharge	67.4±24.4 (78)	−
Cognitive FIM score at discharge	26.4±8.4 (29)	−
Total FIM score at discharge	93.8±31.6 (107)	86.4±33.8
Motor FIM gain	18.7±15.4 (16)	−
Cognitive FIM gain	3.6±4.5 (2)	−
Total FIM gain	22.3±18.2 (19)	17.5±18.2

FIM, Functional Independence Measure.
Data for this study are expressed as number of patients, mean, or mean±standard deviation.

admission cognitive FIM was split into six groups: 5−9, 10−14, 15−19, 20−24, 25−29, and 30−35 points. The actual value/predicted value was taken to be the "influence coefficient for cognitive function." The "predicted value of mFIM gain/discharge mFIM for which the standard value was corrected for age and cognitive function" was obtained using the same method as in Study 2.

Study 4: Correcting for Number of Days between Onset and Hospital Admission

We further corrected the standard value that had been corrected by age and admission cognitive FIM by the number of days between onset and hospital admission. The number of days between onset and admission was split into seven groups: 13 days and below, 14−20, 21−27, 28−34, 35−41, 42−48, and 49 and above. The actual value/predicted value was taken to be the "influence coefficient for transfer interval." The "predicted value of motor FIM gain/discharge motor FIM for which the standard value was corrected for age, cognitive function, and transfer interval" was obtained using the same method as in Study 2. The correlation between the predicted and actual values as well as the residual of the actual value from which the predicted value was subtracted were calculated.

Results

In cases where the admission mFIM scores were between 13−18, 19−24, 25−30, 31−36, 37−42, 43−48, 49−54, 55−60, 61−66, 67−72, 73−78, 79−84, and 85−90 points, the median values of mFIM gain were 12, 23, 34, 35, 33, 29, 27, 22, 20.5, 15, 10, 7, and 2 points, respectively, and these values were taken to be the standard values for mFIM gain (Figure 1). There was a significant positive correlation between the standard values for mFIM gain and the actual mFIM gain (correlation coefficient 0.618, p<0.001) (Table 2a). The mean±standard deviation of the residual, which was obtained by subtracting the standard value of mFIM gain from the actual value of mFIM gain, was 0.3±12.8 (mean value: 0). There was a significant positive correlation between the standard values of the discharge mFIM and the actual values of the discharge mFIM (correlation coefficient 0.861, p<0.001). The residual of the actual value of discharge mFIM, which was obtained by subtracting the standard value of discharge mFIM from it, was 0.3±12.8 (mean value 0) points (Table 2a).

The influence coefficient for age in Study 2 (actual value/standard value) in the mFIM gain was high in young patients (the actual values were higher than the standard values in young patients) and low in older patients (the actual values were lower than the standard values in older patients) (Figure 2a). There was a similar trend also in the discharge mFIM; however, the influence of the difference in age was small (Figure 2b).

The influence coefficient for cognitive function (actual value/predicted value) in Study 3 was 0.386 for admission cognitive FIM scores between 5−9 points (the actual values are lower than the predicted values by the admission mFIM and age when the cognitive FIM is low) and 0.954 for admission cognitive FIM scores between 10–14 points, and was about 1.0 in the

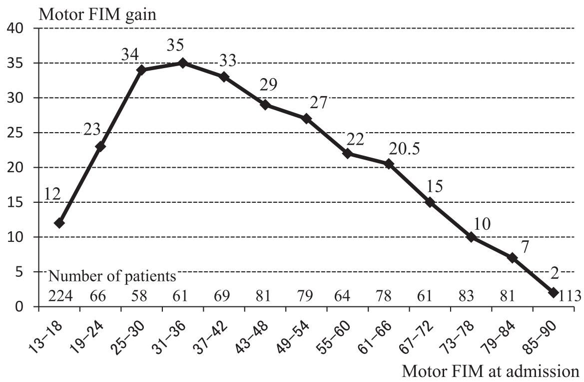

Figure 1. Relationship between motor FIM at admission and motor FIM gain.
Numerical value, median value.

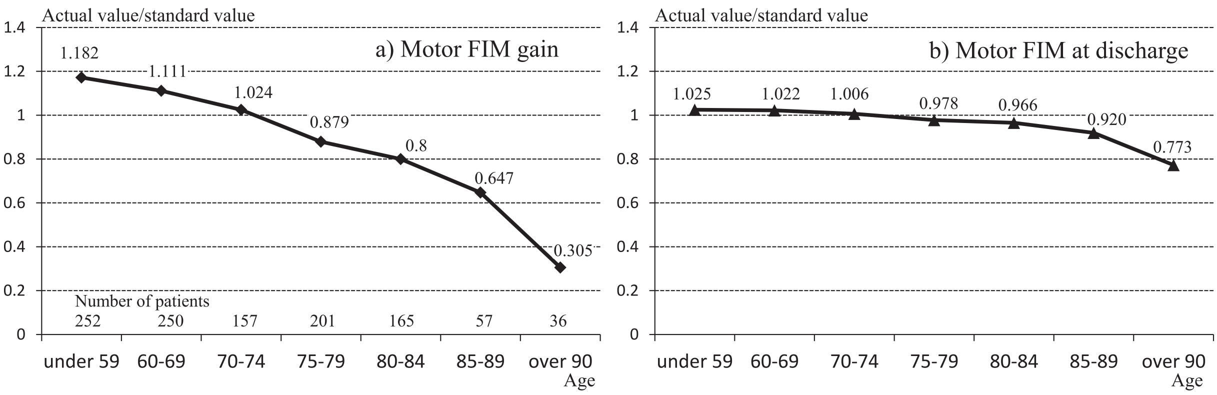

Figure 2. Influence coefficient for age.
Numerical value, median value.
Standard value, the median of FIM gain in 13 groups stratified by motor FIM at admission as shown in Figure 1 (Study 1).

Table 2. Correlation and the residual.

a) Study 1 (standard value)

A	B	Correlation between A and B	A−B (residual)
Motor FIM gain	Median of the motor FIM gain (standard value)	0.618 (p<0.001)	0.3±12.8 (0)
Motor FIM at discharge	Median of the motor FIM at discharge (standard value)	0.861 (p<0.001)	0.3±12.8 (0)

b) Study 2 (Correcting the standard value by age)

A	B	Correlation between A and B	A−B (residual)
Motor FIM gain	Predicted motor FIM gain for which the standard value was corrected for age	0.676 (p<0.001)	0.9±12.2 (0)
Motor FIM at discharge	Predicted motor FIM at discharge for which the standard value was corrected for age	0.874 (p<0.001)	0.7±12.4 (0)

c) Study 3 (Correcting the standard value by age and cognitive FIM)

A	B	Correlation between A and B	A−B (residual)
Motor FIM gain	Predicted motor FIM gain corrected for age and cognitive FIM	0.678 (p<0.001)	1.6±12.5 (0)
Motor FIM at discharge	Predicted motor FIM at discharge corrected for age and cognitive FIM	0.870 (p<0.001)	1.3±12.7 (0)

d) Study 4 (Correcting the standard value by age, cognitive FIM, and transfer interval)

A	B	Correlation between A and B	A−B (residual)
Motor FIM gain	Predicted motor FIM gain corrected for age, cognitive FIM, and transfer interval	0.681 (p<0.001)	1.4±12.5 (0)
Motor FIM at discharge	Predicted motor FIM at discharge corrected for age, cognitive FIM, and transfer interval	0.874 (p<0.001)	1.3±12.6 (0)

A, actual value; B, predicted value.
Residual value is expressed as mean±standard deviation (median).

four groups with admission cognitive FIM scores between 15–35 points (Figure 3a). There was a similar trend also in discharge mFIM; however, the influence of the difference in cognitive FIM was small (Figure 3b).

In the influence coefficient for transfer interval in Study 4, mFIM gain decreased as the number of days between onset and admission increased (Figure 4a). There was a similar trend also in discharge mFIM; however, the influence of the difference in transfer interval was small (Figure 4b). The predicted value of the mFIM gain score is 34 × 0.647 × 0.954 × 0.922 = 19.3, if for example, the admission mFIM score is 28, the age is 87, the admission cognitive FIM score is 12, and the number of days between onset and admission is 40. The correlation between the predicted value and actual value was 0.681 (p<0.001) in mFIM gain and 0.874 (p<0.001) in discharge mFIM (Table 2d). The residual was 1.4±12.5 (median value: 0) in mFIM gain and 1.3±12.6 (median value: 0) in discharge mFIM (Table 2d).

Discussion

In the present study, we predicted mFIM gain and discharge mFIM by multiplying the median value (standard value) of admission mFIM-based mFIM gain and discharge mFIM by the influence coefficients for age, cognitive function, and transfer interval. The correlation coefficient between the actual and predicted values was 0.681 in the prediction of mFIM gain and 0.874 in the prediction of discharge mFIM.

The correlation of the median value (standard value) of the admission mFIM-based discharge mFIM in Study 1 was 0.861 and the residual was 0.3±12.8 (Table 2a). We expected the correlation coefficient between the actual and predicted values of the

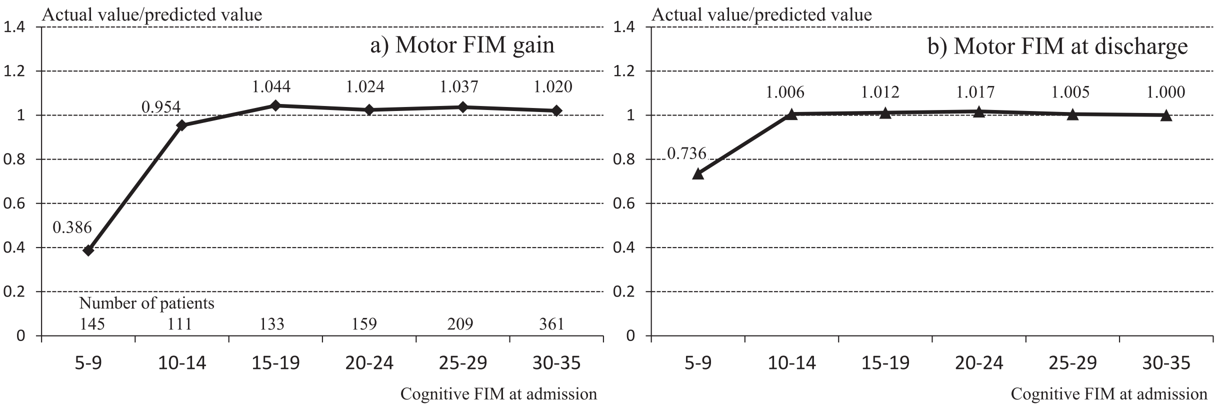

Figure 3. Influence coefficient for cognitive function.
Numerical value, median value.
Predicted value, the predicted value of motor FIM gain for which the standard value was corrected for age and cognitive function, using the method in Study 2.

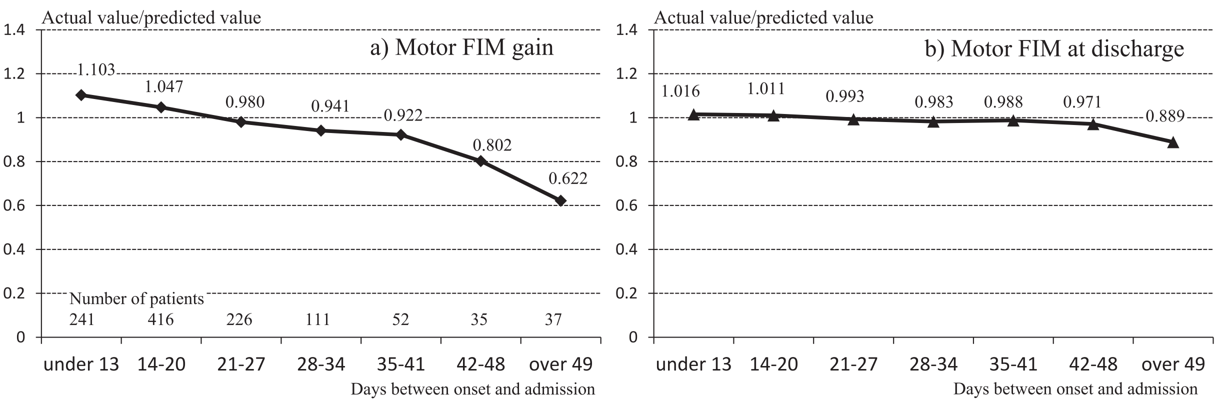

Figure 4. Influence coefficient for transfer interval.
Numerical value, median value.
Predicted value, the predicted value of motor FIM gain for which the standard value was corrected for age, cognitive function, and transfer interval, using the method in Study 3.

discharge mFIM to increase and the standard deviation of the residual to decrease by the multiplication by the influence coefficients for age, cognitive function, and transfer interval in Studies 2–4. The “actual value/predicted value” differs when stratified by age (Figure 2b), cognitive function (Figure 3b), or transfer interval (Figure 4b) and it was considered meaningful to correct their influence. However, the results showed that the correlation coefficient between the actual and predicted values of discharge mFIM was only raised by 0.013 (from 0.861 to 0.874) and the standard deviation of the residual was only lowered by 0.2 (from 12.8 to 12.6) (Tables 2a, 2d) even after the multiplication by the influence coefficients for these three factors. However, the effect of correcting the three factors was large in cases where the mFIM gain was predicted, and the correlation coefficient between the actual and predicted values was raised by 0.063 (from 0.618 to 0.681) and the standard deviation of the residual was lowered by 0.3 (from 12.8 to 12.5) (Tables 2a, 2d) when multiplied by the influence coefficients for these factors.

Multiple regression analyses that use discharge FIM as the objective variable have been reported in 10 articles from rehabilitation hospitals in Japan [2−11]; however, Jeong et al. [2] and Sonoda et al. [3] are the only two reports that recorded a correlation coefficient between the actual and predicted values.

Jeong et al. selected 941 stroke patients from *Kaifukuki* rehabilitation wards recorded in the Japan Rehabilitation Database as subjects, conducted a variable selection multiple regression analysis that used the total discharge FIM score as the objective variable, and selected seven of ten explanatory variables: admission mFIM, admission cognitive FIM, age, admission Glasgow coma scale (GCS) score, number of days from onset to admission, modified Rankin scale (mRS) score before onset, and presence of complications, and reported that the adjusted coefficient of determination (R^2) was 0.66. A high correlation between the predicted value of discharge FIM and the actual value was found (0.84) [2] when

Table 3. Multiple regression analysis to predict FIM at discharge or FIM gain.

Objective variable	Report	Correlation	Residual	R^2	Number of patients	Number of institutions	FIM
FIM at discharge	Jeong et al. [2]	0.84	−	0.66	941	multiple	total FIM
	Sonoda et al. [3]	0.88 0.89−0.93 (reciprocal)	8.06±6.29 (6.26) 6.19±5.04 (4.57)	−	87	one	motor FIM
	Liu et al. [4]	−	−	0.798	106	one	total FIM
	Iwai et al. [5]	−	−	0.719	482	multiple	total FIM
	Tokunaga et al. [6]	−	−	0.710	256	one	total FIM
	Jeong et al. [7]	−	−0.28±12.88	0.649	680	multiple	total FIM
	Tsuji et al. [8]	−	−	0.64	190	one	total FIM
	Inouye [9]	−	−	0.57 (over 80 years old), 0.76 (60−69 years old)	464	one	total FIM
	Hirano et al. [10]	−	−	0.5 (severe), 0.51 (moderate), 0.64 (mild)	482	one	total FIM
	Mutai et al. [11]	−	−	−	174	one	total FIM
	This study (new method)	0.874	1.3±12.6 (0)	−	1,118	one	motor FIM
FIM gain	Tokunaga et al. [6]	−	−	0.413 (severe), 0.723 (mild)	256	one	total FIM
	Imada et al. [12]	−	−	0.337 (severe), 0.693 (mild)	1,137	one	motor FIM
	Tokunaga et al. [13]	−	−	0.32 (severe), 0.51 (mild)	306	multiple	total FIM
	Shiraishi et al. [14]	−	−	0.5	68	one	total FIM
	Shiraishi et al. [15]	−	−	0.49	81	one	total FIM
	This study (new method)	0.681	1.4±12.5 (0)	−	1,118	one	motor FIM

Correlation, correlation between actual value and predicted value; residual, actual value−predicted value; R^2, coefficient of determination; FIM, Functional Independence Measure.
severe, severe patients; moderate, moderate patients; mild, mild patients.
Value of residual is expressed as mean±standard deviation (median); reciprocal, reciprocal of motor FIM at admission was input in multiple regression analysis.
This study (new method) does not use a multiple regression analysis; however, it is recorded in the table for comparison purposes.

the data for 999 subjects from the verification group was input into the prediction formula. Although there are differences between this study and their report, such as the fact that the results in this report are from a single institution, using the mFIM score and not the total FIM score, a prediction formula with only the four variables of admission mFIM, age, admission cognitive FIM, and transfer interval, and not establishing a verification group, our correlation coefficient between the actual and predicted values of discharge FIM (0.874) was larger than that reported by Jeong et al. [2] (0.84). R^2 (0.66) from the prediction formula in Jeong et al. [2] is the 4th−5th highest R^2 in the multiple regression analysis of eight reports [2, 4−10] (Table 3) that recorded the R^2.

Sonoda et al. conducted a multiple regression analysis with 87 stroke patients from one institution as subjects, using the same four explanatory variables as this study: admission mFIM, admission cognitive FIM, age, and number of days between onset and hospital admission, and used discharge mFIM as the objective variable. The results of that study showed a high correlation (0.88) between the predicted and actual values of discharge mFIM in both the 87 patients in the calculation group and the 44 patients in the verification group [3]. Moreover, the correlation between the predicted and actual values of discharge mFIM was 0.89 in the calculation group and 0.93 in the verification group when the reciprocal of the admission mFIM score was input instead of the ordinary admission mFIM score [3] (Table 3). The correlation coefficient of this study (0.874) is smaller than that reported by Sonoda et al. [3] (0.88 in the ordinary prediction and 0.89−0.93 in the reciprocal prediction).

The prediction of the discharge FIM through the methods in this report has the same level of accuracy when compared to the two multiple regression analysis reports [2, 3] above that recorded the correlation coefficient between the actual and predicted values.

The residual, which was calculated by subtracting the predicted value from the actual value, was not recorded in Jeong et al. [2]; however, in Sonoda et al. [3], the residual was 8.06±6.29 (median value: 6.26) in cases where admission mFIM was used as an explanatory variable, and 6.19±5.04 (median value: 4.57) in cases where the reciprocal of admission mFIM was used. In the present study, the residual was 1.3±12.6 (median value: 0), the mean and median values of the residual were smaller in the present report and the standard deviation of the residual was smaller in Sonoda et al. [3]. In another report by Jeong et al. [7], the residual was reported as −0.28±12.88 (Table 3), which was similar to that of the present report.

Sonoda et al. [3] used the reciprocal of admission mFIM to reduce the influence of the ceiling effect on the discharge mFIM (the fact that gains were smaller in the minimal-assistance level). The difference between the 13-point and 14-point score in admission FIM is 0.055 (difference between 1/13 and 1/14) if they are inverted and the difference between the 80-point and 81-point score in admission mFIM is 0.00015 (difference between 1/80 and 1/81) if they are inverted [3]. They were able to raise the precision of the prediction formula by reducing the influence of those patients with high admission mFIM scores (patients with a ceiling effect) on discharge mFIM by means of this operation. The method of the present study was able to correct not only the ceiling effect, but also the small mFIM gain in patients who had low admission mFIM. This led to the result that the median of residuals which were obtained by subtracting the predicted value from the actual value was 0.

In this study, the reason why the correlation between the predicted and actual values remained at 0.874 is considered to be that the influence of the pre-onset mRS and complications, as well as the influence of the number of training units and number of days in hospital as used in Jeong et al. [2], were not corrected. However, Sonoda et al. [3], which had high correlation coefficients (0.89−0.93), used the same four explanatory variables as in the present study; thus, we cannot say that having four explanatory variables was the major cause of this correlation value.

If the regression coefficient of age is −0.34 [2] in a multiple regression analysis, this implies that the discharge FIM lowers by 0.34 for every year that a person ages. In other words, we assume that there is a line-shaped relationship (linear relationship) between the objective variable and the explanatory variables. However, the influence of age on FIM gain and discharge FIM changes based on admission FIM [20−21]. In addition, the relationship that FIM gain and discharge FIM decrease in a linear fashion as age increases has not been shown to hold true for all ages [17, 18].

Since there is a correlation between the admission mFIM and the discharge mFIM in the first place, it was expected that the correlation coefficient that predicts discharge mFIM from admission mFIM would be larger than the correlation coefficient that predicts mFIM gain from admission mFIM (Table 2). In previous studies as well, R^2 in the multiple regression analyses that used FIM gain as the objective variable [6, 12−15] was smaller than R^2 in those that used discharge FIM as the objective variable [2, 4−10] (Table 3).

Advantages of multiple regression analysis are that it can analyze multiple factors simultaneously, that weighting of factors is shown as a numerical value of a standardized partial regression coefficient, that it can yield immediate results if using statistical software, and that it is an established method. Disadvantages of multiple regression analysis are that the prediction formula becomes unstable in cases where there is a strong correlation between factors (multicollinearity), that it assumes a linear relationship between the objective variable and the explanatory variables, and that it is difficult to visually comprehend results.

Advantages of the new method in this study are that a linear relationship between factors (explanatory variables) and objective variable is not required, and that it is possible to visually comprehend the relationship between factors and objective variable. Disadvantages of this method are that time and effort are required in order to produce results, that it is not an established method, that it is necessary to examine the influence of each factor individually, and that it cannot analyze multiple factors simultaneously.

This study has the following limitations. First, if a “standard value” is obtained using young patients with normal cognitive function and fast transfer intervals as subjects, the influence of age, cognitive function, and transfer interval can be shown as influence coefficients between 0−1. However, this method could not be carried out as the number of patients became too small. Second, the results are from one institution and the external validity has not been proven.

Despite these limitations, the new method described in this study for predicting FIM gain and discharge FIM by multiplying the median value (standard value) of admission FIM-based FIM gain by the influence coefficients for age, cognitive function, and transfer interval has the same degree of accuracy as multiple regression analysis and also is useful because it can clearly show the relationship between factors and FIM gain/discharge FIM.

References

1. Data management service of the Uniform Data System for Medical Rehabilitation and the Center for Functional Assessment Research (1990) Guide for use of the uniform data set for medical rehabilitation. version 3.0, State University of New York at Buffalo, Buffalo.
2. Jeong S, Inoue Y, Kondo K, Matsumoto D, Shiraishi N. Formula for predicting FIM for stroke patients at discharge from an acute ward or convalescent rehabilitation ward. Jpn J Compr Rehabil Sci 2014; 5: 19−25.
3. Sonoda S, Saitoh E, Nagai S, Okuyama Y, Suzuki T, Suzuki M. Stroke outcome prediction using reciprocal number of initial activities of daily living status. J Stroke Cerebrovasc Diseas 2005; 14: 8−11.
4. Liu M, Domen K, Chino N. Comorbidity measures for stroke outcome research. Arch Phys Med Rehabil 1997; 78: 166−72.
5. Iwai N, Aoyagi Y. Discharge index and prediction for stroke patients in the post-acute stage. Jpn J Compr Rehabil Sci 2012; 3: 37−41.
6. Tokunaga M, Fukunaga K, Sannomiya K, Imada Y, Hamasaki H, Noguchi D, et al. The difference between measured Nichijo-seikatsu-kino-hyokahyo (NSKH) score and predicted NSKH score derived from ADL is related to FIM gain. Jpn J Compr Rehabil Sci 2013; 4: 61−6.

7. Jeong S, Kondo K, Shiraishi N, Inoue Y. An evaluation of post-stroke rehabilitation in Japan. Clinical Audit 2010; 2: 59−66.
8. Tsuji T, Liu M, Sonoda S, Domen K, Chino N. The stroke impairment assessment set. Arch Phys Med Rehabil 2000; 81: 863−8.
9. Inouye M. Predicting models of outcome stratified by age after first stroke rehabilitation in Japan. Am J Phys Med Rehabil 2001; 80: 586−91.
10. Hirano Y, Okura Y, Takeuchi M. The influence of ADL severity at admission on ADL at discharge in convalescent stroke rehabilitation. Tohoku Rigaku-ryoho Kagaku 2011; 23: 32−7. Japanese.
11. 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.
12. Imada Y, Tokunaga M, Fukunaga K, Sannomiya K, Inoue R, Hamasaki H, et al. 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: 12−8.
13. Tokunaga M, Kondo K. Training time and FIM gain in patients with stroke in Kaifukuki rehabilitation hospitals. Sogo Rehabil 2014; 42: 245−52. Japanese.
14. Shiraishi N, Matsubayashi Y, Tanaka N, Iwamoto H. Changes in ADL of stroke patients in a convalescent rehabilitation ward. Rigakuryoho Kagaku 2005; 32: 361−7. Japanese.
15. Shiraishi N, Mizutani M, Menjho A, Deguchi K, Takase H, Hamaguchi Y, et al. Comparison of activities of daily living for a convalescent rehabilitation ward and general ward for strke patients. Jpn J Geriat 2004; 41: 646−52. Japanese.
16. Sonoda S, Nagai S, Saitoh E. A viewpoint and problem of the convalescent rehabilitation wards. Jpn J Rehabil Med 2005; 42: 614−7. Japanese.
17. Tokunaga M, Nakanishi R, Eguchi G, Kihara K, Tokisato K, Katsura K, et al. The influence of age on corrected motor FIM effectiveness. Jpn J Compr Rehabil Sci 2014; 5: 56−60.
18. Tokunaga M, Honda S, Uyama E, Mita S, Terasaki T, Hirata Y, et al. Difference of FIM improvement between subtypes of brain infarction. J Clin Rehabil 2014; 23: 1236−40. Japanese.
19. 2013 Annual Report from the Annual Survey Committee of Kaifukuki Rehabilitation Ward Association. February 2014. pp. 1−134. Japanese.
20. Black-Schaffer RM, Winston C. Age and functional outcome after stroke. Top Stroke Rehabil 2004; 11: 23−32.
21. 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.