



Original Article

The role of the functional independence measure score in predicting the home discharge of inpatients with cerebrovascular diseases in convalescent rehabilitation wards

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Abstract. [Purpose] To clarify the cutoff point of the Functional Independence Measure tool for predicting home discharge of patients in convalescent rehabilitation wards. [Participants and Methods] This retrospective observational study analyzed the data of 91 inpatients with cerebrovascular disease who received rehabilitation treatment at a convalescent rehabilitation ward. We categorized the participants into two groups: the home-discharged group and the non-home discharged group. We divided the outcome parameters in the two groups into different categories and compared them using the Mann-Whitney U test. To identify the relevant cutoff points in a clinical setting, we applied the receiver operating characteristic curve. [Results] In patients with cerebrovascular disease, the Functional Independence Measure motor, cognitive, and total scores were significantly higher in the home-discharged group than in the non-home discharged group. We statistically calculated the Functional Independence Measure motor score cutoff point that can predict home discharge, and the predicted Functional Independence Measure motor score at the time of hospitalization was 53.5–60.0 points. [Conclusion] It is important to start rehabilitation at an early stage and increase the amount of training to increase the likelihood of returning home.

Key words: Functional independent measure, Receiver operating characteristic curve, Convalescent rehabilitation ward

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INTRODUCTION

Medical rehabilitation in Japan is an intensive therapy conducted in the recovery phase ward. According to a national survey¹⁾, there are 1,313 hospitals in Japan with recovery phase rehabilitation wards (1,678 wards and 74,817 beds), and this number is increasing annually. According to the Stroke Guidelines²⁾, rehabilitation for stroke starts at the bedside, from the acute phase immediately after onset. Continuing to the acute phase rehabilitation, the guidelines report the importance of the implementation of intensive and comprehensive rehabilitation in the recovery phase using a team-based approach¹⁾.

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Functional Independence Measure (FIM) scoring is used widely in the recovery phase rehabilitation wards as among the outcomes. The FIM score improves with the length of time spent in rehabilitation training for cerebrovascular disease groups, including stroke patients. Hence, it is important to implement intensive rehabilitation during the recovery period. In the national survey¹⁾, cerebrovascular diseases, which accounted for 47.3% of the cases, were the most common causative diseases of patients admitted to the recovery phase rehabilitation wards. Japan is already becoming a super-aging society with the baby boomer generation (1947–1949) reaching old age (≥ 65 years)³⁾. In the 2016 survey, the number of the elderly population was 34,590,000, accounting for 27.3% of the total population (aging rate)⁴⁾. Such increase makes the implementation of intensive rehabilitation during the recovery phase and return of patients to their homes and communities, important tasks. Previous studies using a large database⁵⁾ predict discharge FIM from many parameters. However, it is important not to determine the FIM score at discharge, but to predict whether it will be possible to be discharged home at admission. The purpose of this study was to clarify the cut-off point of the FIM score for predicting discharge to home of cerebrovascular disease patients in the convalescent rehabilitation ward.

PARTICIPANTS AND METHODS

The target participants were 91 patients with cerebrovascular disease who were admitted to the convalescent rehabilitation ward of Sakuragaoka Central Hospital in Kanagawa between July 2015 and June 2016 to undergo rehabilitation training (Table 1). We categorized participants into discharged home groups (N=71) and non-discharged home groups (N=20).

We evaluated the participants' age, disease, period until hospitalization, number of hospitalization days, ability to perform activities of daily living (ADL), balance ability, and cognitive function. FIM was used to evaluate the ability to perform ADL⁶⁾, and the FIM motor score (FIM-M score), FIM cognitive score (FIM-C score), and FIM total score (FIM-T score) were calculated. The FIM score change indices, which refer to the difference in the FIM score at admission subtracted from the FIM score at discharge, were calculated as FIM-M score gain, FIM-C score gain, and FIM-T score gain. The daily improvement rate in the FIM score, which was calculated by dividing the FIM score gain by the number of hospitalization days, was set as FIM efficiency, and as FIM-M-E, FIM-C-E, and FIM-T-E, respectively. Half standing (HS), Functional Reach Test (FRT)⁷⁾, Berg balance scale (BBS)⁸⁾, and the 10-meter walking test (10MW) were used to evaluate the balance and walking abilities of the patients⁹⁾. The Mini-Mental State Examination (MMSE)¹⁰⁾ and the Hasegawa dementia rating scale-revised (HDS-R)¹¹⁾ were used to evaluate the cognitive function. The Fujishima scale was used to assess the swallowing function (Fujishima scale).

The receiver operating characteristic curve (ROC curve) was applied in this research to identify the relevant cut-off point in clinical setting and to evaluate the effectiveness and accuracy of the measurement method used¹²⁾. The ROC curve was used retrospectively to statistically calculate the cutoff point for FIM-M score¹³⁾ for patients who were discharged home. Factors found to have a statistically significant correlation were selected to elucidate those relating to the ability to be discharged home. A multiple logistic regression analysis was conducted on the effect of each factor, with the discharge destination (discharged home group/non-discharged home group) as the dependent variable. The group that was discharged to home from the recovery phase rehabilitation ward was set as the discharged home group, and the group discharged to a facility other than their own home was set as the non-discharged home group.

The outcome parameters in the two groups (discharged home group/non-discharged home group) were divided into different categories and compared using the Mann-Whitney U test. We used a ROC curve for the FIM score at admission along with its sensitivity and specificity to determine the cut-off point of the FIM score at admission to predict discharge to home in patients with cerebrovascular.

Data were analyzed using SPSS version 23.0 (IBM Japan, Tokyo, Japan) for Windows statistical software. Significance was accepted for values of $p < 0.05$.

This study was implemented with the approval of the ethical review board of Kanagawa University of Human Services (Approval number 10-37) and with the consent of the Sakuragaoka Central Hospital. Written informed consent was obtained from all patients before enrolment.

Table 1. Cerebrovascular disease (n=91)

Diagnosis	Home discharge group (n=71)	Non-home discharge group (n=20)
Cerebral hemorrhage	19	3
Cerebral infarction	39	13
Subarachnoid hemorrhage	5	3
Subdural hematoma	1	0
Cerebellum hemorrhage	2	0
Brain tumor	1	1
Polyneuropathy, schwannoma, postresuscitation encephalopathy, internal carotid aneurysm	4	0

RESULTS

Ninety-one patients with cerebrovascular disease were analyzed. The discharged home group (n=71) was significantly younger than the non-discharged home group (p<0.05). The number of hospitalization days was significantly shorter in the discharged home group (p<0.05). The period until hospitalization in the recovery phase ward was also shorter in the discharged home group than in the non-discharged home group, but the difference was not significant (Table 2). The BBS score, which was used to evaluate balance ability, was significantly higher in the discharged home group (p<0.05). Similarly, the cognitive function evaluation HDS-R score (p<0.05) and the swallowing function evaluation score (p<0.05) were also higher in this group. There was no significant difference in HS, FRT, 10MW, and MMSE between the groups. In patients with cerebrovascular diseases, the FIM-M score (p=0.001), FIM-C score (p=0.001), and FIM-T score (p=0.001) were all significantly higher in the discharged home group. There was no significant difference in the FIM-M score gain, FIM-C score gain, and FIM-T score gain (NS) between the groups. The discharged home group had a significantly higher FIM-M-E (p<0.05) (Table 3).

The ROC curve with the false positive rate and true positive rate plotted as the horizontal and vertical axes, respectively, is shown in the figure. When we statistically calculated the FIM-M score cutoff point that can predict discharge to home for patients with cerebrovascular disease, with the area under the curve (AUC) of 0.832 (p<0.001). A positive rate of 60.6–69.0%, and false positive rate of 5–15.0%, the predicted FIM-M score at the time of hospitalization would be 53.5–60.0 points (Fig. 1). Performed multiple logistic regression analysis with BBS score, FIM-M score, FIM-C score, 10 m walking (number of steps), and Fujishima scale at admission as independent variables and discharged home group or non-discharged home group as dependent variables. As a result, the BBS score at admission was selected in step 1. [multiple logistic regression analysis, odds ratio=1.088; 95% CI 1.008 to 1.175, p=0.03. positive discrimination rate=88.5. $y=(-1.04) + (\text{BBS score at admission}) \times 0.084$].

DISCUSSION

In this study, it was possible to predict discharge to home of patients with cerebrovascular diseases according to the differences in their ability to perform ADL and physical function at the time of admission. The cerebrovascular disease group

Table 2. Participant characteristics, physical function, cognitive function

	Home discharge group (n=71)		Non-home discharge group (n=20)		P
	Ave	SD	Ave	SD	
Gender (Males/Females)	42/29		7/13		
Age (years)	67.03	12.13	74.2	11.47	0.05
Onset of disease (days)	38.23	15.7	49.63	29.18	N.S.
Length of hospital stay (days)	81.24	45.24	109.35	49.6	0.05
Balance					
HS - Rt (sec)	8.92	12.29	4.02	7.86	N.S.
HS - Lt (sec)	10.36	22.3	2.84	6.59	N.S.
FRT (cm)	24.06	9.93	26.78	14.12	N.S.
BBS (points)	36.27	18.09	13.93	16.06	0.05
Gait					
10MW time (sec)	11.28	5.15	13.10	8.32	N.S.
10MW step (steps)	20.68	6.28	20.20	5.45	N.S.
Grip					
Power grip - Rt (kg)	20.58	10.07	14.09	10.68	N.S.
Power grip - Lt (kg)	22.24	11.79	18.80	7.85	N.S.
Cognitive function					
HDS-R (points)	23.59	6.71	18.00	5.95	0.05
MMSE (points)	24.05	6.04	21.11	4.73	N.S.
Swallowing function					
Fujishima scale (points)	8.47	2.01	6.47	2.95	0.05

Mann-Whitney U test.

HS: half standing; FRT: Functional Reach Test; BBS: Berg Balance Scale; 10MW: 10 m Walking test; HDS-R: Hasegawa dementia rating scale-revised; MMSE: Mini-Mental State Examination. Swallowing function: Fujishima scale.

Table 3. FIM score

FIM scores	Subcategories	Home discharge group (n=71)		Non-home discharge group (n=20)		p
		Ave	SD	Ave	SD	
Eating	Self-care	5.85	1.73	3.7	2.41	0.001
Grooming	Self-care	5.37	1.86	2.65	1.84	0.001
Bathing	Self-care	4.18	2.23	2.05	1.64	0.001
Dress upper body	Self-care	4.82	2.09	2.35	1.9	0.001
Dress lower body	Self-care	4.52	2.14	2.25	1.8	0.001
Toileting	Self-care	4.69	2.02	2.25	1.89	0.001
Bladder management	Sphincter control	5.17	2.56	2.5	2.26	0.001
Bowel management	Sphincter control	5.18	2.46	2.6	2.14	0.001
Bed/chair	Transfers (mobility)	4.93	1.76	2.8	1.85	0.001
Toilet	Transfers (mobility)	4.89	1.83	2.7	1.92	0.001
Tub/shower	Transfers (mobility)	4.07	2.07	1.8	1.36	0.001
Gait/wheelchair	Locomotion	3.92	2.35	1.8	1.74	0.001
Stairs locomotion	Locomotion	2.7	2.06	1.2	0.89	0.001
Comprehension	Communication	5.32	1.61	3.7	1.87	0.001
Expression	Communication	4.94	1.84	3.2	1.91	0.001
Social interaction	Social cognition	5.17	1.71	3.35	1.87	0.001
Problem-solving	Social cognition	4.28	2.13	2.1	1.37	0.001
Memory	Social cognition	4.55	1.96	2.65	1.42	0.001
FIM	Moter	60.38	23.31	30.65	21.18	0.001
	Cognitive	24.27	8.45	15	7.13	0.001
	Total	84.4	28.95	45.65	26.18	0.001
FIM gain	Moter	13.65	11.94	11.10	12.22	N.S.
	Cognitive	3.66	5.16	2.35	5.32	N.S.
	Total	17.31	14.22	13.45	16.29	N.S.
FIM efficiency	Moter	0.20	0.20	0.12	0.19	0.05
	Cognitive	0.06	0.09	0.01	0.10	N.S.
	Total	0.25	0.24	0.14	0.26	N.S.

Mann-Whitney U test.

had a high rate of patients who were discharged home (78%), demonstrating that the rehabilitation intervention is effective. Moreover, given that we were able to statistically calculate the FIM score at admission for the patients who were discharged home successfully, we proved that it is possible to predict the prognosis from the time of admission to the recovery phase rehabilitation ward.

In the previous study⁵⁾, many factors such as age, number of days from onset of stroke until admission, admission GCS, admission NIHSS, and admission FIM were involved in predicting FIM score at discharge. On the other hand, in this study, it is possible to predict the possibility of discharge to the home by the FIM score at admission, which is a new finding obtained in this study.

The patients in the discharged home group were younger and had a shorter number of hospitalization days than those in the non-discharged home group. The cognitive function of the discharged home group also exceeded the cutoff point, indicating that they still retained their cognitive function. The BBS score, which was a general evaluation of balance ability, was higher in the discharged home group, indicating that they still retained their balance function. The FIM-M, FIM-C, and FIM-T scores were significantly higher in the discharged home group, with the following values: FIM-M score, 66.35% (60.38/91 points); FIM-C score, 69.34% (24.27/35 points); and FIM-T score, 66.98% (84.4/126 points) for the ability to perform ADL. The FIM sub-items average score were over 4/7 points except for stairs and walking, indicating that patients obtaining this score has a moderate capability for self-care. There was also a significant difference in FIM-M-E, which is the index for FIM gain per day.

Based on the results of this study, we clarified that an increase of 0.2 points per day increases the possibility of being discharged home. Therefore, therapists are required to confirm the improvement in ADL of approximately 1 point every 5 days. Research related to the recovery phase rehabilitation wards in Japan has reported that FIM-M score at discharge can be predicted with high degree of precision with multivariate analysis using FIM motor effectiveness¹⁴⁾. In the previous study¹³⁾,

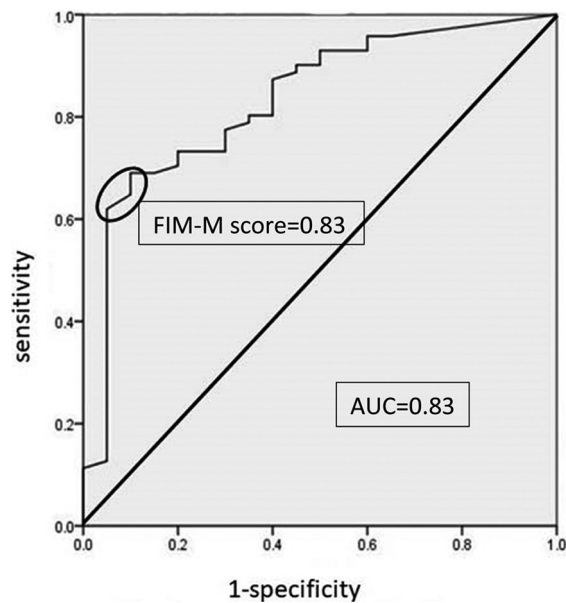


Fig. 1. Determination of the cut-off point of the Functional Independence Measure (FIM) using a receiver operating characteristic curve. The point with the larger Youden index, equal to sensitivity+specificity-1, was defined as the superior cut-off point. The ROC curve analysis showed that the cut-off point of the motor FIM (FIM-M) score at admission was 53.5–60.0 points in patients with cerebrovascular conditions. The area under the curve (AUC) AUC, sensitivity, and specificity were 0.83, 60.6 to 69.0%, and 90 to 95%, respectively.

the cut-off FIM-T score of 63/126 points is useful to discriminate patients with adverse events among those with acute stroke. In this study, the total FIM score was 84.4 points; thus, higher ability was needed for the patients to be discharged home. In this study, the FIM scores at admission and the overall balance evaluation (BBS) were the factors affecting a patient's chance of being discharged home, suggesting that balance training is an important rehabilitation intervention. Balance training includes programs that improve basic physical function and actual movement. Meanwhile, although not significant, there was a difference of approximately 10 days until admission to the recovery phase rehabilitation ward between the discharged and non-discharged home groups. Accordingly, it may be important to admit patients to the recovery phase rehabilitation ward as soon as possible and to start rehabilitation.

We clarified that it is possible to predict discharge to home using an ROC curve. In other words, we clarified that patients can be discharged home successfully if the FIM-M score at admission is 53.5–60.0 points for patients with cerebrovascular disease. In a previous study¹⁵⁾, the FIM sub-item scores or degrees of autonomy achievement and time to achieve autonomy had distinctive characteristics, depending on the type of ADL. Therefore, it is important to implement an intensive training that is in line with the severity at admission and the ADL ability with reduced function. It is important to provide an individualized approach for each ADL to achieve the FIM score that will enable the patient to be discharged home. Moreover, in the national survey¹⁾, it was reported that the FIM gain exceeds 20 points when the cumulative number of training units exceeds 700–800 in patients with cerebrovascular diseases and 500–600 in patients with orthopedic diseases. These findings suggest the importance of increasing the amount of training.

The main limitation of this study was that there was no detailed analysis of the previously reported factors affecting the possibility of a patient to be discharged home, which are as follows: 1) family structure and number of family members, and 2) living environment and financial situation.

Conflict of interest

The authors declare no potential conflicts of interest with respect to this research.

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