

ORIGINAL REPORT

INTERACTION EFFECTS OF IN-HOSPITAL REHABILITATION AND THE USE OF COMMUNITY-BASED SERVICES AFTER HOSPITAL DISCHARGE ON PATIENTS' SUBSEQUENT FUNCTIONAL ABILITIES

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Background: Patients' functional abilities after hospital discharge are influenced by rehabilitation during their hospital stay and their use of community-based services after hospital discharge. This study examined the interaction between rehabilitation during hospital stay, the use of community-based rehabilitation and non-rehabilitation services and their influence on patients' subsequent functional abilities.

Methods: This cohort study included 509 inpatients who underwent rehabilitation between 2008 and 2011 in Japan. Participants were categorized into 2 groups based on their condition: stroke and other. Interaction effects between the change in Functional Independence Measure (FIM) and the use of community-based rehabilitation and non-rehabilitation services on patients' subsequent functional abilities were estimated by sequential linear regression analyses in which the dependent variable was the FIM score 3 months after hospital discharge.

Results: A significant interaction between the change in FIM and the use of community-based rehabilitation or non-rehabilitation services after hospital discharge was observed among stroke and other patients.

Conclusion: Rehabilitation during hospital stay and the use of community-based rehabilitation or non-rehabilitation services interacted to influence the subsequent functional abilities of patients discharged home. These findings may be useful for maintaining patients' functional abilities after hospital discharge.

Key words: rehabilitation; service; interaction.

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INTRODUCTION

It is important for rehabilitation patients to maintain a high level of functional abilities after discharge from hospital to home (1). Functional ability after hospital discharge can be

influenced by various factors, including rehabilitation during the hospital stay, discharge destination, rehabilitation and use of community-based services after hospital discharge (2–7). Making use of the concept of the International Classification of Functioning, Disability and Health (ICF) by the World Health Organization (WHO), this paper summarizes findings concerning the functional ability of a rehabilitation patient who is discharged home (8). Specifically, the ICF framework consists of 2 parts: “Functioning and Disability” and “Contextual Factors”, in which “Functioning and Disability” includes “Body Functions and Structures” and “Activity and Participation”. “Contextual Factors” include “Environmental Factors” and “Personal Factors”. “Activities and Participation” is a key element of rehabilitation for patients who aim to be independent (9). A study related to “Activities and Participation” suggested that there was a beneficial effect on activities of daily living (ADL) when occupational therapists included instruction on functioning, the environment and education in elderly patients' pre-discharge home visits (10). One study showed that elderly stroke patients had an increased chance of participation 3 months after discharge home, and that walking and acknowledgment of the stroke and depression were the best predictors of increased participation levels (11). Prior studies regarding “Functioning and Disability” and “Individual Factors” reported that there was a relationship between social capital and cause-specific mortality in stroke (12), and that the mortality of in-hospital patients undergoing rehabilitation increased at 80–180 days after discharge despite a reduction in the length of hospital stay (1). A recent study reported that there was no significant difference between discharged patients with and without rehabilitation therapy (13). As for the findings related to “Environmental Factors”, compared with patients who receive home rehabilitation, patients who utilize day hospital rehabilitation were at increased risk of re-hospitalization (14).

Thus far, very little is known about the interaction between “Functioning and Disability” and “Contextual Factors” in the ICF. In other words, very little is known about how rehabilitation during a hospital stay interacts with the use of community-based services after hospital discharge, or how this interaction influences patients' functional abilities after hospital discharge.

We hypothesized that there would be interaction effects between rehabilitation in the hospital and the use of community-based services after hospital discharge on patients' subsequent functional abilities. Therefore, using data from inpatients transferred from other acute hospitals to a rehabilitation unit, we examined the interaction effects between rehabilitation during the hospital stay and the use of community-based rehabilitation or non-rehabilitation services after patients' hospital discharge home on subsequent daily activity by disease type (i.e. stroke and others). Because the purpose of this study was to evaluate interaction effects between rehabilitation during hospital stay and the use of rehabilitation or non-rehabilitation services after hospital discharge on patients' functional ability at 3 months after hospital discharge, the findings of this study will be useful for determining the type of community-based services that are necessary to maintain a patient's functional ability after discharge home.

MATERIAL AND METHODS

Subjects

The subjects were consecutive patients who underwent rehabilitation from 1 April 2008 to 30 November 2011, in the recovery phase rehabilitation ward at D hospital in Fukuoka City, Japan, and who were later discharged home. Because patients discharged to a facility cannot utilize community-based services in Japan, the subjects of this study were limited to patients discharged home.

A total of 1,651 patients were admitted to the rehabilitation wards of D hospital and completed the rehabilitation programme during the study period (1 April 2008 to 30 November 2011) (Fig. 1). Patients from D hospital who were discharged to the acute unit ($n=205$), to long-term care facilities ($n=539$) and to other facilities ($n=65$), as well as those who died during hospitalization ($n=35$) and who were lost-to-follow after discharge ($n=5$), were excluded. We attempted to contact patients discharged home ($n=802$) 3 months after hospital discharge by therapists, although we were unable to contact all of the patients, as some of them had moved ($n=271$). A total of 271 patients had missing data, and 22 patients were outliers with respect to the

standardized residuals (rather than 3 SD); therefore, the remaining patients with complete data were used in analysis ($n=509$). Based on their primary disease, patients were categorized into 2 groups: "stroke" and "other disease." The stroke group included patients with cerebral infarction, subarachnoid haemorrhage, subdural haemorrhage, or intracranial haemorrhage. The other disease group included patients with muscle injury, femoral fracture, vertebral compression fracture, pelvic fracture, neuromuscular disease, cardiac disease, gastrointestinal disease, rheumatoid arthritis, respiratory disease, or other conditions, which were typically associated with mechanical or prescribed immobilization, severe pain, and/or an altered level of consciousness (15). The protocol of this study was approved by the ethics committee of D hospital in 2008.

Study variables

The following information was ascertained during each patient's stay in the rehabilitation ward: personal attributes, such as age, gender, tax-exemption status, and dementia; the key person at hospital discharge; and the Functional Independence Measure (FIM) score at hospital discharge. The tax-exemption status category was used to evaluate whether a patient's household was tax-exempt and included the responses "yes" and "no." The "yes" response means that that patient has a right to pay no more than 15,000 Japanese-yen, which was equivalent to 140 US dollars in October 2014, for the use of long-term care services. The key person at hospital discharge had 2 categories: "spouse" and "other." Intensity of therapy was calculated as the total hours of therapy divided by the length of hospital stay (LOS) at the rehabilitation unit of D hospital in days (16, 17). The total therapy was the total amount of therapy provided by physiotherapists, occupational therapists, and speech therapists. The FIM score at the time of hospital discharge was measured by the physical and occupational therapists that were assigned to take care of the patient and was used to assess functional independence (18).

At the time of hospital discharge, the use of community-based rehabilitation and non-rehabilitation services and FIM change% were evaluated from medical charts. There are 6 types of community-based services available to patients discharged to their own homes: home-visit long-term care, home-visit nursing, home-visit rehabilitation, outpatient day long-term care, day service, and short stay (19). Home-visit long-term care includes assistance at home from a home-helper in bathing, toilet needs, eating, cooking, and cleaning. Home-visit nursing includes medical care and assistance from nurses at home following the physicians' orders when the patients are not capable of making hospital visits. Home visit rehabilitation service includes rehabilitation services at home with the assistance of physiotherapists, occupational therapists, and speech therapists per the physicians' orders. Outpatient day long-term care includes day-care assistance in day-to-day activities, such as eating, and rehabilitation services to sustain or improve vital functions that are provided at health service facilities for elderly people and at medical institutions. Day service includes assistance at day service centres in day-to-day activities, such as eating and bathing, and in the sustenance and improvement of functioning. Short stay services include assistance in day-to-day activities and functional training at welfare facilities. We counted the number of services that each patient used in the following 2 groups: the rehabilitation service use group (i.e. home-visit rehabilitation, and outpatient day long-term care) and the non-rehabilitation service use group (i.e. home-visit long-term care, home-visit nursing, day service, and short stay). Thus, in the rehabilitation service use group, the score takes on 1 of the following 3 values; "2", when using home-visit rehabilitation and outpatient day long-term care; "1", when 1 of the 2 services is used; and "0", when there is no service use. In the non-rehabilitation service use group, similar to the rehabilitation service use group, the score ranged between 0 and 4 depending on the number of services used. Therefore, the subjects of this study included patients who received both rehabilitation services and/or non-rehabilitation services.

To evaluate the effectiveness of rehabilitation during the hospital stay, we calculated FIM change% based on FIM effectiveness. FIM

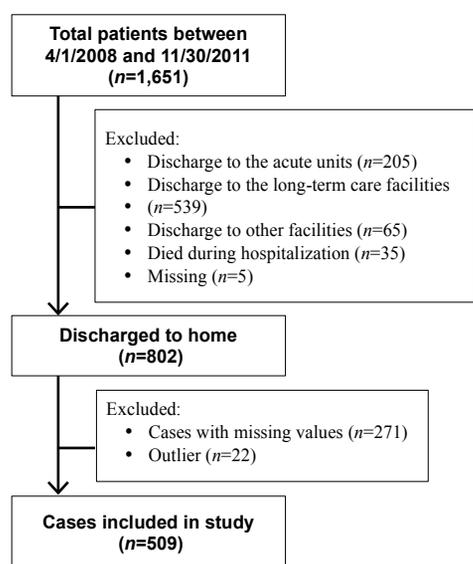


Fig. 1. Study participant selection.

effectiveness is the difference between FIM scores at the time of hospital admission and at the time of hospital discharge (20, 21). It is quite difficult to increase the FIM score when the score at hospital admission is high, whereas it is relatively easy to increase the FIM score when the score at hospital admission is low. When evaluating the effectiveness of rehabilitation during the hospital stay, FIM effectiveness simply calculates the difference between FIM scores at 2 time-points and does not consider whether the baseline FIM score (i.e. the FIM score at hospital admission) is high or low. Thus, to remedy this problem and to evaluate the effectiveness of rehabilitation during the hospital stay more adequately, we used FIM change% based on FIM effectiveness (20–22). The FIM change% was calculated by dividing the difference between the FIM scores at the time of hospital admission and hospital discharge by the FIM target score (i.e. the FIM maximum score: 126) minus the FIM score at the time of hospital admission (23–25).

Statistical procedures

Sequential regression analyses were performed for each patient group (26). In the analyses, following the models suggested by Harrell (27), models in which the dependent variable was the FIM score at 3 months after hospital discharge (rather than the difference between the FIM scores at the time of hospital discharge and at 3 months after hospital discharge) were used. In the last step, an interaction term between rehabilitation during hospital discharge and the use of community-based services was entered into a regression model. In each step of the regression analyses, the variance inflation factor (VIF) was calculated to check for multicollinearity. To test the assumptions of the multivariate analysis, we checked the normality and homoscedasticity of the residuals using scatter plots and a histogram of the residuals. In addition, we used 3 standardized residuals to detect outliers and defined cases that had greater than 3 standardized residuals as outliers, and these cases were excluded from the multivariate analysis. To accurately evaluate the effect of an interaction term between 2 variables, centring was performed before sequential regression analyses (28). Specifically, before constructing the interaction term, we centred FIM change% and the use of community-based services by subtracting the mean score of the sample from each individual's score (28). To determine the significance of each interaction, post hoc analyses were conducted. For the final model, to confirm the validity of the regression analyses, regression diagnostics, including checking the residuals, multicollinearity, outliers, and influential observations, were performed.

For comparisons between the 2 disease groups, based on whether the patient's condition was caused by damage to the central nervous system, we used the χ^2 test and Student's *t*-test. These analyses were performed using SPSSx Version 19 software, Chicago, IL, USA, and *p*-values < 0.05 were considered to indicate statistical significance.

RESULTS

Table I provides a description of the study variables in the 2 patient groups. There were 113 and 396 patients in the stroke

and other groups, respectively. There were no significant differences between the groups with respect to the means or proportions of the study variables.

Table II illustrates the FIM score at 3 months after hospital discharge and FIM change% in the rehabilitation or non-rehabilitation service use groups. There was a significant difference in the number of rehabilitation or non-rehabilitation service use groups, which implies that the amount of services used would be decided by the available services in accordance with the functional abilities of the patients in the long-term care insurance system.

Tables III and IV illustrate the results of the sequential regression analyses in the stroke patient group. In the analysis focusing on the interaction between FIM change% and the use of rehabilitation services after hospital discharge (Table III), the independent variables related to the patient attributes were included in step 1 of the analysis and explained a significant portion of the variance in the equation (*p* < 0.001). In step 2 of the analysis, FIM change% was entered into a regression model and was shown to contribute to a significant increase in explained variance of the FIM score (*p* < 0.001). In step 3 of the analysis, the use of rehabilitation services was entered into a regression model and was shown to contribute to a significant increase in explained variance of the FIM score (*p* < 0.001). However, the use of rehabilitation services was not related to the FIM score at 3 months after hospital discharge (*p* = 0.072). In step 4 of the analysis, an interaction term between FIM change% and the use of rehabilitation services was entered into a regression model and was shown to contribute to a significant increase in ex-

Table I. Patients' characteristics categorized by type of disease

	Stroke patients (<i>n</i> = 113)	Other disease patients (<i>n</i> = 396)	<i>p</i> -value
Age, years, mean (SD)	80 (11)	78 (13)	0.172
Gender, female, <i>n</i> (%)	72 (64)	277 (70)	0.208
Tax-exemption status, yes, <i>n</i> (%)	26 (23)	126 (32)	0.071
Dementia, yes, <i>n</i> (%)	24 (21)	106 (27)	0.235
Key person at hospital discharge, spouse, <i>n</i> (%)	34 (30)	127 (32)	0.689
Intensity of therapy, mean (SD)	1.6 (3.6)	1.6 (2.0)	0.962
Rehabilitation services use			
0 services	78 (69)	252 (64)	0.290
1 service	33 (29)	137 (34)	0.284
2 services	2 (2)	7 (2)	0.999
Non-rehabilitation services use			
0 services	64 (57)	254 (64)	0.146
1 service	35 (31)	106 (27)	0.378
2 services	12 (10)	33 (8)	0.450
3 services	2 (2)	3 (1)	0.336
4 services	0 (0)	0 (0)	–
FIM score at hospital admission, mean (SD)	96 (22)	95 (23)	0.635
FIM score at hospital discharge, mean (SD)	107 (18)	106 (20)	0.591
FIM change%, mean (SD)	42 (32)	43 (32)	0.925
FIM score at 3 months after hospital discharge, mean (SD)	105 (19)	104 (22)	0.551

$$\text{*FIM change \%} = \frac{(\text{the FIM score at hospital discharge}) - (\text{the FIM score at hospital admission})}{(\text{the FIM maximum score (i.e., 126)}) - (\text{the FIM score at hospital admission})} \times 100$$

Student's *t*-test for continuous variables and χ^2 test for categorical variables.

FIM: Functional Independence Measure.

Table II. Functional Independence Measure (FIM) change% and the FIM score at 3 months after hospital discharge in the rehabilitation and non-rehabilitation services use groups

	FIM change% ^a Mean (SD)	FIM score 3 months after hospital discharge Mean (SD)
Rehabilitation services use		
0 services (n=330)	45 (32)	106 (22)
1 service (n=170)	36 (28)	101 (20)
2 services (n=9)	33 (23)	97 (13)
	<i>p</i> =0.036	<i>p</i> <0.001
Non-rehabilitation services use		
0 services (n=318)	49 (33)	112 (16)
1 service (n=141)	29 (27)	94 (21)
2 services (n=45)	29 (23)	84 (26)
3 services (n=5)	29 (30)	72 (38)
4 services (n=0)	–	–
	<i>p</i> <0.001	<i>p</i> <0.001

$$^a\text{FIM change \%} = \frac{(\text{the FIM score at hospital discharge}) - (\text{the FIM score at hospital admission})}{(\text{the FIM maximum score (i.e., 126)}) - (\text{the FIM score at hospital admission})} \times 100$$

Kruskal-Wallis test. SD: standard deviation.

plained variance of the FIM score (*p* < 0.001). The interaction between the 2 variables was related to an increase in the FIM score at 3 months after hospital discharge (*B* = 12.094; *p* = 0.003). In the analysis focusing on the interaction between FIM change% and the use of non-rehabilitation services after hospital discharge (Table IV), independent variables were included in step 1 of the analysis and explained a significant portion of the variance in the equation (*p* < 0.001). In step 2 of the analysis, FIM change% was entered, and in step 3, the use of non-rehabilitation services

was entered into a regression model and both were shown to contribute to a significant increase in explained variance of the FIM score (*p* < 0.001 and *p* < 0.001, respectively). In step 4 of the analysis, an interaction term between FIM change% and the use of non-rehabilitation services was entered into a regression model and was shown to contribute to a significant increase in explained variance of the FIM score (*p* < 0.001). However, the interaction between the 2 variables was not related to the FIM score at 3 months after hospital discharge (*B* = 5.247; *p* = 0.075).

Figs 2 and 3 display the relationships between the use of rehabilitation or non-rehabilitation services and the FIM score at 3 months after hospital discharge, as mediated by FIM change% among stroke patients. The slopes of the 2 lines in Figs 2 and 3 were calculated by using the partial regression coefficients of the interaction term, FIM change%, and the use of rehabilitation or non-rehabilitation services (28). As shown in Fig. 2, the slope for the higher FIM change% (mean +1 SD) increases significantly when the level of rehabilitation services use moved from the mean –1 SD to +1 SD (*p* < 0.001), while the slope for the lower FIM change% (mean –1 SD) remained at the same level when the levels of rehabilitation services increased from the mean –1 SD to +1 SD (*p* = 0.74). As shown in Fig. 3, the slope for the higher FIM change% (mean +1 SD) remained at the same level irrespective of the level of non-rehabilitation services use (*p* = 0.35), while the slope for the lower FIM change% (mean –1 SD) decreased when the level of non-rehabilitation services use increased from the mean –1 SD to +1 SD (*p* < 0.01).

Tables V and VI show the results of the sequential regression analyses in the other patient group. In the analysis focusing on the interaction between FIM change% and the use of rehabilitation services after hospital discharge (Table V), which was step 4 of the analysis, an interaction term between FIM change% and the use of rehabilitation services was entered into

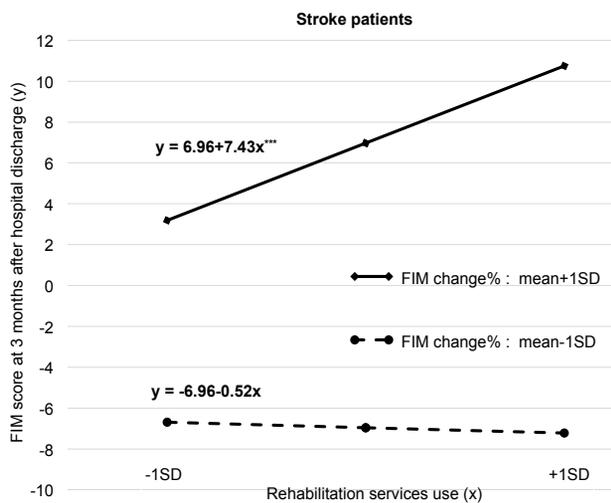


Fig. 2. Effect of interaction between rehabilitation potential and use of community-based rehabilitation services after hospital discharge on the Functional Independence Measure (FIM) scores at 3 months after hospital discharge among stroke patients discharged home. The slopes of the 2 lines are significantly different (*p* = 0.03). ****p* < 0.001.

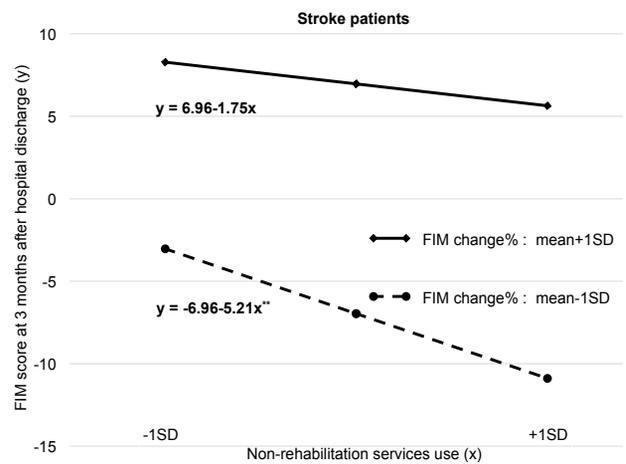


Fig. 3. Effect of interaction between rehabilitation potential and use of community-based non-rehabilitation services after hospital discharge on the Functional Independence Measure (FIM) scores at 3 months after hospital discharge among stroke patients who were discharged home. The slopes of the 2 lines are not significantly different (*p* = 0.08). ***p* < 0.01.

Table III. Sequential regression analysis of factors related to the Functional Independence Measure (FIM) score at 3 months after hospital discharge among the stroke patients: the interaction between FIM change% and the use of rehabilitation services (n = 113)

Variables	B	p-value	R ² change	p-value
Step 1: Patients' characteristics			0.807	<0.001
Age	0.039	0.604		
Gender, female	2.651	0.142		
Tax-exemption, yes	-2.922	0.139		
Dementia, yes	-11.225	<0.001		
Key person at hospital discharge, spouse	-1.009	0.592		
Intensity of therapy	1.163	<0.001		
Non-rehabilitation services use	-5.155	<0.001		
FIM score at hospital admission	0.622	<0.001		
Step 2: FIM change%			0.096	<0.001
Age	0.021	0.700		
Gender, female	0.695	0.592		
Tax-exemption, yes	-1.983	0.161		
Dementia, yes	-6.642	<0.001		
Key person at hospital discharge, spouse	-0.837	0.534		
Intensity of therapy	0.856	<0.001		
Non-rehabilitation services use	-3.957	<0.001		
FIM score at hospital admission	0.598	<0.001		
FIM change%	19.529	<0.001		
Step 3: Rehabilitation services use			0.003	<0.001
Age	0.006	0.917		
Gender, female	0.527	0.682		
Tax-exemption, yes	-2.344	0.098		
Dementia, yes	-6.044	0.001		
Key person at hospital discharge, spouse	-0.565	0.673		
Intensity of therapy	0.898	<0.001		
Non-rehabilitation services use	-3.491	<0.001		
FIM score at hospital admission	0.618	<0.001		
FIM change%	20.042	<0.001		
Rehabilitation services use	2.336	0.072		
Step 4: Interaction term			0.008	<0.001
Age	0.011	0.831		
Gender, female	0.216	0.862		
Tax-exemption, yes	-1.874	0.171		
Dementia, yes	-5.359	0.002		
Key person at hospital discharge, spouse	-0.296	0.819		
Intensity of therapy	0.975	<0.001		
Non-rehabilitation services use	-3.468	<0.001		
FIM score at hospital admission	0.648	<0.001		
FIM change%	21.149	<0.001		
Rehabilitation services use	3.457	0.009		
Interaction term				
Rehabilitation services use × FIM change%	12.094	0.003		
R ² total			0.913	<0.001
Adjusted R ²			0.904	

Bold texts represent variables entered into each step of the sequential regression model.

a regression model and was shown to contribute to a significant increase in explained variance of the FIM score ($p < 0.001$). The interaction between the 2 variables was related to an

Table IV. Sequential regression analysis of factors related to the Functional Independence Measure (FIM) score at 3 months after hospital discharge among the stroke patients: the interaction between FIM change% and the use of non-rehabilitation services (n = 113)

Variables	B	p-value	R ² Change	p-value
Step 1: Patients' characteristics			0.774	<0.001
Age	0.033	0.688		
Gender, female	2.855	0.144		
Tax-exemption, yes	-3.083	0.153		
Dementia, yes	-11.254	<0.001		
Key person at hospital discharge, spouse	0.395	0.845		
Intensity of therapy	1.193	<0.001		
Rehabilitation services use	2.480	0.188		
FIM score at hospital admission	0.690	<0.001		
Step 2: FIM change%			0.116	<0.001
Age	0.001	0.984		
Gender, female	0.532	0.699		
Tax-exemption, yes	-2.364	0.118		
Dementia, yes	-5.770	0.002		
Key person at hospital discharge, spouse	0.366	0.795		
Intensity of therapy	0.893	<0.001		
Rehabilitation services use	3.851	0.004		
FIM score at hospital admission	0.661	<0.001		
FIM change%	21.415	<0.001		
Step 3: Non-rehabilitation services use			0.015	<0.001
Age	0.006	0.917		
Gender, female	0.527	0.682		
Tax-exemption, yes	-2.344	0.098		
Dementia, yes	-6.044	0.001		
Key person at hospital discharge, spouse	-0.565	0.673		
Intensity of therapy	0.898	<0.001		
Rehabilitation services use	2.336	0.072		
FIM score at hospital admission	0.618	<0.001		
FIM change%	20.042	<0.001		
Non-rehabilitation services use	-3.491	<0.001		
Step 4: Interaction term			0.003	<0.001
Age	0.018	0.730		
Gender, female	0.273	0.831		
Tax-exemption, yes	-2.090	0.137		
Dementia, yes	-5.796	0.001		
Key person at hospital discharge, spouse	-0.118	0.930		
Intensity of therapy	0.823	<0.001		
Rehabilitation services use	1.760	0.182		
FIM score at hospital admission	0.601	<0.001		
FIM change %	21.147	<0.001		
Non-rehabilitation services use	-3.483	<0.001		
Interaction term				
Non-rehabilitation services use × FIM change%	5.247	0.075		
R ² total			0.909	<0.001
Adjusted R ²			0.899	

Bold texts represent variables entered into each step of the sequential regression model.

increase in the FIM score at 3 months after hospital discharge ($B = 12.557$; $p < 0.001$). In the analysis focusing on the interaction between FIM change% and the use of non-rehabilitation services after hospital discharge among other disease patients

Table V. Sequential regression analysis of factors related to the Functional Independence Measure (FIM) score 3 months after hospital discharge among the other disease patients: the interaction between FIM change% and the use of rehabilitation services (n = 396)

Variables	B	p-value	R ² Change	p-value
Step 1: Patients' characteristics			0.789	<0.001
Age	0.105	0.011		
Gender, female	1.206	0.308		
Tax-exemption, yes	-1.498	0.176		
Dementia, yes	-7.564	<0.001		
Key person at hospital discharge, spouse	-0.770	0.501		
Intensity of therapy	-0.207	0.414		
Non-rehabilitation services use	-4.631	<0.001		
FIM score at hospital admission	0.673	<0.001		
Step 2: FIM change%			0.116	<0.001
Age	0.011	0.698		
Gender, female	0.980	0.217		
Tax-exemption, yes	-0.997	0.180		
Dementia, yes	-3.064	0.002		
Key person at hospital discharge, spouse	-1.884	0.015		
Intensity of therapy	-0.064	0.707		
Non-rehabilitation services use	-2.758	<0.001		
FIM score at hospital admission	0.665	<0.001		
FIM change%	25.274	<0.001		
Step 3: Rehabilitation services use			0.005	<0.001
Age	0.003	0.913		
Gender, female	1.158	0.135		
Tax-exemption, yes	-1.215	0.095		
Dementia, yes	-2.777	0.004		
Key person at hospital discharge, spouse	-1.975	0.009		
Intensity of therapy	-0.161	0.337		
Non-rehabilitation services use	-2.013	0.001		
FIM score at hospital admission	0.689	<0.001		
FIM change%	26.152	<0.001		
Rehabilitation services use	3.186	<0.001		
Step 4: Interaction term			0.007	<0.001
Age	-0.001	0.963		
Gender, female	0.805	0.282		
Tax-exemption, yes	-0.912	0.193		
Dementia, yes	-3.013	0.001		
Key person at hospital discharge, spouse	-1.322	0.071		
Intensity of therapy	-0.154	0.340		
Non-rehabilitation services use	-2.034	0.001		
FIM score at hospital admission	0.695	<0.001		
FIM change%	27.079	<0.001		
Rehabilitation services use	3.561	<0.001		
Interaction term				
Rehabilitation services use × FIM change%	12.557	<0.001		
R ² total			0.917	<0.001
Adjusted R ²			0.915	

Bold texts represent variables entered into each step of the sequential regression model.

(Table VI), which was step 4 of the analysis, an interaction term between FIM change% and the use of non-rehabilitation services was entered into a regression model and was shown to contribute to a significant increase in explained variance of

Table VI. Sequential regression analysis of factors related to the FIM score 3 months after hospital discharge among the other disease patients: the interaction between FIM change% and the use of non-rehabilitation services (n = 396)

Variables	B	p-value	R ² change	p-value
Step 1: Patients' characteristics			0.776	<0.001
Age	0.110	0.010		
Gender, female	1.182	0.333		
Tax-exemption, yes	-1.800	0.116		
Dementia, yes	-9.556	<0.001		
Key person at hospital discharge, spouse	0.053	0.964		
Intensity of therapy	-0.252	0.339		
Rehabilitation services use	1.772	0.097		
FIM score at hospital admission	0.716	<0.001		
Step 2: FIM change%			0.132	<0.001
Age	0.003	0.914		
Gender, female	1.134	0.149		
Tax-exemption, yes	-1.322	0.073		
Dementia, yes	-3.513	<0.001		
Key person at hospital discharge, spouse	-1.651	0.029		
Intensity of therapy	-0.172	0.310		
Rehabilitation services use	3.824	<0.001		
FIM score at hospital admission	0.706	<0.001		
FIM change%	26.847	<0.001		
Step 3: Non-rehabilitation services use			0.003	<0.001
Age	0.003	0.913		
Gender, female	1.158	0.135		
Tax-exemption, yes	-1.215	0.095		
Dementia, yes	-2.777	0.004		
Key person at hospital discharge, spouse	-1.975	0.009		
Intensity of therapy	-0.161	0.337		
Rehabilitation services use	3.186	<0.001		
FIM score at hospital admission	0.689	<0.001		
FIM change%	26.152	<0.001		
Non-rehabilitation services use	-2.013	0.001		
Step 4: Interaction term			0.014	<0.001
Age	-0.008	0.747		
Gender, female	1.396	0.050		
Tax-exemption, yes	-0.849	0.204		
Dementia, yes	-2.040	0.022		
Key person at hospital discharge, spouse	-0.978	0.162		
Intensity of therapy	-0.138	0.368		
Rehabilitation services use	2.602	<0.001		
FIM score at hospital admission	0.683	<0.001		
FIM change%	28.510	<0.001		
Non-rehabilitation services use	-0.573	0.325		
Interaction term				
Non-rehabilitation services use × FIM change%	15.268	<0.001		
R ² total			0.925	<0.001
Adjusted R ²			0.923	

Bold texts represent variables entered into each step of the sequential regression model.

the FIM score ($p < 0.001$). Specifically, the interaction between the 2 variables was related to the FIM score at 3 months after hospital discharge ($B = 15.268$; $p < 0.001$).

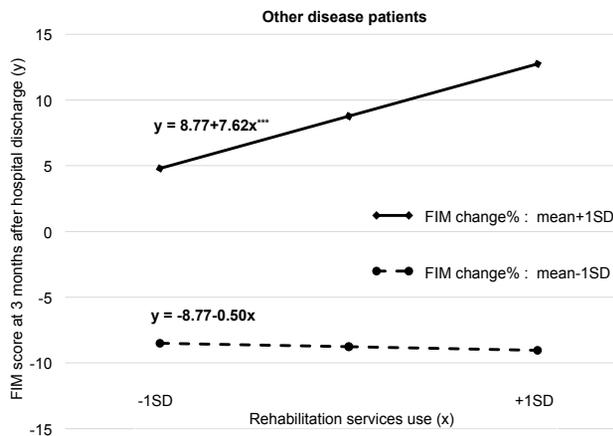


Fig. 4. Effect of interaction between rehabilitation potential and use of community-based rehabilitation services after hospital discharge on the Functional Independence Measure (FIM) scores at 3 months after hospital discharge among other disease patients discharged home. The slopes of the 2 lines are significantly different ($p < 0.001$). *** $p < 0.001$.

Figs 4 and 5 illustrate the relationship between the use of rehabilitation or non-rehabilitation services and the FIM score at 3 months after hospital discharge as mediated by FIM change% among other disease patients. As a sensitivity analysis, the difference in the FIM was entered into 4 regression models instead of FIM change%. None of the interactions between the 2 variables were related to the FIM score at 3 months after hospital discharge. This finding implies that FIM change% reflected the effectiveness of rehabilitation more accurately than did the simple amount of change, such as the difference in FIM.

DISCUSSION

There were several notable findings in this study. First, although community-based rehabilitation services were effective in improving or maintaining the functional ability of a stroke patient who is discharged home, community-based non-rehabilitation services were not. Secondly, although community-based rehabilitation services were effective in improving or maintaining the functional ability of other disease patients who were discharged home, the efficacy of community-based non-rehabilitation services was limited to those who had effective rehabilitation during their hospital stay.

Effectiveness of rehabilitation, limit to the total amount of services

Community-based rehabilitation services are provided by a rehabilitation therapist, while non-rehabilitation services are provided by caregivers other than a rehabilitation therapist. A rehabilitation therapist can evaluate a patient's rehabilitation needs individually and deliver necessary interventions to the patient in the rehabilitation service. A British study reported that patients whose rehabilitation needs were unmet were more dependent and less integrated 1 year after hospital discharge than those whose rehabilitation needs were met (29). Thus, in the present study, the subsequent FIM score of stroke patients

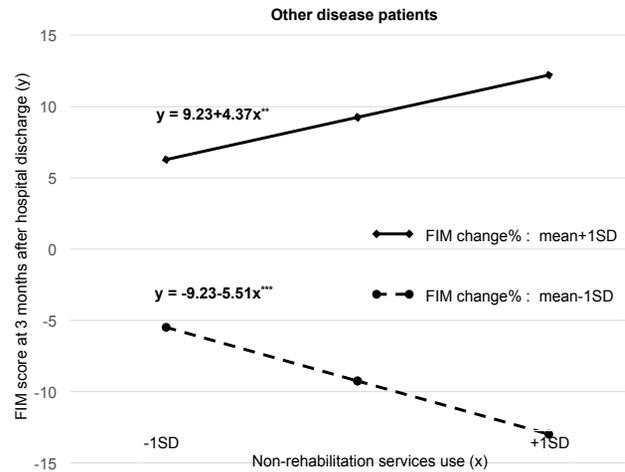


Fig. 5. Effect of interaction between rehabilitation potential and use of community-based non-rehabilitation services after hospital discharge on Functional Independence Measure (FIM) scores at 3 months after hospital discharge among other disease patients discharged home. The slopes of the 2 lines are significantly different ($p < 0.001$). ** $p < 0.01$, *** $p < 0.001$.

and other disease patients whose FIM change% were higher became larger when they received more community-based rehabilitation than when they received less community-based rehabilitation. Among stroke patients and other disease patients whose FIM change% were lower, the FIM score 3 months after hospital discharge remained at the same level irrespective of the quantity of community-based rehabilitation they received. In addition, among stroke patients and other disease patients who received both rehabilitation services and non-rehabilitation services, mean FIM score at 3 months after hospital discharge decreased from that at hospital discharge. Only one patient received 2 types of rehabilitation services, and her subsequent FIM score remained at the level of hospital discharge. Community-based non-rehabilitation services were effective in improving functional ability at 3 months after hospital discharge for other disease patients whose FIM change% were higher, but not for stroke patients whose FIM change% were higher. It is notable that stroke patients had damage to the central nervous system, while other disease patients had no such damage. In addition, non-rehabilitation services did not meet the needs of stroke patients. Among stroke patients and other disease patients whose FIM change% were lower, the FIM scores 3 months after hospital discharge decreased as the quantity of their community-based non-rehabilitation increased. Under long-term care insurance, there is a limit to the total amount of community-based services a patient can use. It is probable that the quantity of that community-based rehabilitation service that they receive might shrink when the quantity of non-rehabilitation use increases. Concomitantly, among the other disease patient group, the mean rehabilitation use scores were 0.43 (SD 0.54) in the lower non-rehabilitation service use group and 0.30 (SD 0.47) in the higher non-rehabilitation service use group. Among stroke patients, the mean rehabilitation use scores were 0.42 (SD 0.56) in the lower non-rehabilitation service use group and 0.20 (SD 0.41) in the

higher non-rehabilitation service use group. Under the long-term care insurance system in Japan, the total amount of usable services is limited by the functional abilities of the patients and by the fact that the price of rehabilitation services is higher than that of non-rehabilitation services. The decreased use of rehabilitation services among the higher non-rehabilitation service users might be attributable to this finding.

Practical implications

Maintaining functional ability after completing a rehabilitation programme during the hospital stay is extremely important for patient quality of life and for containing healthcare costs. Although Japanese patients discharged home have been reported to show a gradual decline in daily living activities over time (30), factors that support the maintenance of the functional ability of such patients have not been reported. Currently, there is no transition-support programme for rehabilitation patients who are discharged home in which a patient would be allowed to go back and forth between home and a facility to gradually adjust to the home environment without full recovery (31–33). Patients discharged home tend to seek healthcare services based on price and convenience (e.g., distance and driving time), rather than with regard to necessity (34). Most previous studies have examined the associations between patient attributes and the type of discharge destination after hospital rehabilitation (2–4, 16, 17, 35–37). Although some of these factors are related to the functional abilities of patients, the interactions between them have not been elucidated.

This is the first study to demonstrate that rehabilitation during hospital stay and the use of community-based rehabilitation or non-rehabilitation services interact to influence functional ability at 3 months after hospital discharge in stroke and other patients. Thus, the findings of this study are theoretically and practically important. The practical implications of the present findings are straightforward: (i) community-based rehabilitation services are recommended to maintain or improve the functional ability of patients who are discharged home from a rehabilitation unit; (ii) community-based non-rehabilitation services are recommended only to non-stroke patients who have received effective rehabilitation during their hospital stay and are discharged home; (iii) social capital has been shown to be related to mortality due to stroke (12). Thus, according to the present study, stroke patients might benefit from outpatient day long-term care that can provide rehabilitation services while simultaneously strengthening community support.

Study limitations

There are several caveats and limitations to the present study. First, the medical care delivery system unique to Japan might have influenced the findings. Specifically, it is probable that interaction effects between rehabilitation and the use of community-based services after hospital discharge and the subsequent functional abilities of patients discharged to their own homes may have been influenced by the Japanese medical care delivery system. Every Japanese citizen is insured under

the health insurance system, and elderly citizens can utilize nursing care under the long-term care insurance system. Thus, caution is warranted with regard to the external validity of this study's findings. Secondly, the data were collected at a single hospital. Because factors other than those used as explanatory variables in this study might also influence the dependent variable, additional studies including more variables in other settings with different healthcare delivery systems are necessary. Thirdly, the use of community-based services between hospital discharge and 3 months after hospital discharge was surveyed at the time of hospital discharge. The content of community-based services use might have changed during the 3 months of the study period. However, because the study period was short, we believe that any changes in the content of social services use might be negligible.

Conclusion

In conclusion, this study demonstrated that rehabilitation during a hospital stay and the use of community-based rehabilitation or non-rehabilitation services interacted to influence the functional abilities of patients who were discharged home. The present findings may be useful for maintaining patients' functional abilities after hospital discharge and could be utilized in a future transition-support programme for rehabilitation patients who are discharged home.

REFERENCES

1. Kenneth JO, Pam MS, Sandra BI, Richard TL, Glenn VO, Carl VG. Trends in length of stay, living setting, functional outcome, and mortality following medical rehabilitation. *JAMA* 2004; 292: 1687–1695.
2. Bottemiller KL, Bieber PL, Basford JR, Harris M. FIM score, FIM efficiency, and discharge disposition following inpatient stroke rehabilitation. *Rehabil Nurs* 2006; 31: 22–25.
3. Lutz BJ. Determinants of discharge destination for stroke patients. *Rehabil Nurs* 2004; 29: 154–163.
4. Deutsch A, Granger CV, Heinemann AW, Fiedler RC, DeJong G, Kane RL, et al. Poststroke rehabilitation outcomes and reimbursement of inpatient rehabilitation facilities and subacute rehabilitation programs. *Stroke* 2006; 37: 1477–1482.
5. Amy C, Vincy C, Brandon Z, Daria P, Angela C. Factors associated with living setting at discharge from inpatient rehabilitation after acquired brain injury in Ontario, Canada. *J Rehabil Med* 2014; 46: 144–152.
6. Richard JC, Katherine B, Ker-Ai L, Jeffrey WP, John PH, Paul S. Rehabilitation in home care is associated with functional improvement and preferred discharge. *Arch Phys Med Rehabil* 2013; 94: 1038–1047.
7. Outpatient service trialists. Therapy-based rehabilitation services for stroke patients at home. *Cochrane Database of Systematic Reviews* 2003; (1): CD002925.
8. World Health Organization. The International Classification of Functioning, Disability and Health – ICF. Geneva: WHO; 2001.
9. Kerstin BR, Kenneth A, Marianne S, Margareta P. Activity and participation in home rehabilitation: older people's and family members' perspectives. *J Rehabil Med* 2013; 45: 211–216.
10. Natasha AL, Lindy C, Annie M, Chung-Wei CL, Ian DC, Sarah B. Feasibility and results of a randomised pilot-study of pre-discharge occupational therapy home visits. *BMC Health Serv*

- Res 2007; 7: 42.
11. Desrosiers J, Demers L, Robichaud L, Vincent C, Belleville C, Ska B. Short-term changes in and predictors of participation of older adults after stroke following acute care or rehabilitation. *Neurorehabil Neural Repair* 2008; 22: 288–297.
 12. Sundquist K, Hamano T, Li X, Kawakami N, Shiwaku K, Sundquist J. Linking social capital and mortality in the elderly: a Swedish national cohort study. *Exp Gerontol* 2014; 55: 29–36.
 13. Makisako H, Abe T, Onuma T, Shimada H. Factors associated with continuous home care services and effects of home-visit rehabilitation service in older individuals requiring home care: a cluster randomized trial. *J Jpn Phys Ther Assoc* 2009; 36: 382–388.
 14. Crotty M, Gile CL, Halbert J, Harding J, Miller M. Home versus day rehabilitation: a randomised controlled trial. *Age Ageing* 2008; 37: 628–633.
 15. Okazaki T, Nara S, Hachisuka K. [Prevention of disuse syndrome in acute stroke patients.] *Sogo Rinsho* 2002; 51: 3189–3195 (in Japanese).
 16. Jette DU, Warren RL, Wirtalla C. The relation between therapy intensity and outcome of rehabilitation in skilled nursing facilities. *Arch Phys Med Rehabil* 2005; 86: 373–379.
 17. Hu MH, Hsu SS, Yip PK, Jeng JS, Wang YH. Early and intensive rehabilitation predicts good functional outcome in patients admitted to the stroke intensive care unit. *Disabil Rehabil* 2010; 32: 1251–1259.
 18. State University of New York at Buffalo. Guide for use of uniform data set for medical rehabilitation. New York: Research Foundation State University of New York; 1990.
 19. Fukuoka City Public Health & Welfare Bureau. Nursing Care Insurance Guidebook. Fukuoka (Japan): Fukuoka City Public Health & Welfare Bureau; 2014.
 20. Bettger JAP, Stineman MG. Effectiveness of multidisciplinary rehabilitation services in postacute care: state-of-the-science: a review. *Arch Phys Med Rehabil* 2007; 88: 1526–1534.
 21. Karges J, Smallfield S. A description of the outcomes, frequency, duration, and intensity of occupational, physical, and speech therapy in inpatient stroke rehabilitation. *J Allied Health* 2009; 38: e1–e10.
 22. Woo J, Chan SY, Sum MWC, Wong E, Chui YPM. In patient stroke rehabilitation efficiency: Influence of organizational of service delivery and staff numbers. *BMC Health Serv Res* 2008; 8: 86.
 23. Shah S, Vanclay F, Cooper B. Efficiency, effectiveness, and duration of stroke rehabilitation. *Stroke* 1990; 21: 241–246.
 24. Paolucci S, Antonucci G, Pratesi L, Traballese M, Lubich S, Grasso MG. Functional outcome in stroke inpatient rehabilitation: predicting no, low and high response patients. *Cerebrovasc Dis* 1998; 8: 228–234.
 25. Paolucci S, Antonucci G, Grasso MG, Bragoni M, Coiro P, Angelis DD, et al. Functional outcome of ischemic and hemorrhagic stroke patients after inpatient rehabilitation: a matched comparison. *Stroke* 2003; 34: 2861–2865.
 26. Barbara GT, Linda SF. Using multivariate statistics. 6th edn. New Jersey: Pearson Education; 2012.
 27. Harrell EF. Regression modeling strategies: with applications to linear models, logistic regression, and survival analysis. New York: Springer; 2001, p. 1–9.
 28. Aiken LS, West SG. Multiple regression: testing and interpreting interactions. Thousand Oaks: Sage; 1996, p. 116–126.
 29. Siegert RJ, Jackson DM, Playford ED, Fleminger S, Turner-Stokes L. A longitudinal, multicentre, cohort study of community rehabilitation service delivery in long-term neurological conditions. *BMJ Open* 2014; 4: e004231.
 30. Matsuoka A, Tabe R, Matsumoto Y, Toda M, Yano H. [Connection between social background and activities of daily Life (ADL) in elderly suffering from femoral neck fracture.] *Orthoped Traumatol* 2002; 51: 84–88 (in Japanese).
 31. Yamanaga H, Nojiri S, Nakanishi R, Katsura K, Watanabe S, Yonemitsu H. [Rehabilitation of poststroke patients under long-term care insurance.] *Jpn J Rehabil Med* 2005; 42: 58–71 (in Japanese).
 32. Ministry of Health, Labour and Welfare. [A summary of the study on the long-term health care insurance benefit expenses in 2010.] Tokyo: Ministry of Health, Labour and Welfare; 2011 (in Japanese).
 33. An official notice from the Ministry of Health, Labour and Welfare, Health Insurance Bureau, No.0328001, March 28, 2008 (in Japanese).
 34. Badriah F, Abe T, Miyamoto H, Moriya M, Babazono A, Hagihara A. Interaction effects between rehabilitation effectiveness and discharge destination upon a inpatient's subsequent functional abilities. *Rehabil Res Dev* 2013; 50: 821–834.
 35. Kunik CL, Floweres L, Kazanjian T. Time to rehabilitation admission and associated outcomes for patients with traumatic brain injury. *Arch Phys Med Rehabil* 2006; 87: 1590–1596.
 36. Horn SD, DeJong G, Smout RJ, Gassaway J, James R, Conroy B. Stroke rehabilitation patients, practice, and outcomes is earlier and more aggressive therapy better? *Arch Phys Med Rehabil* 2005; 86 Suppl 2: S101–S114.
 37. Deutsch A, Fiedler R, Granger C, Russell CF. The uniform data system for medical rehabilitation report of patients discharged from comprehensive medical rehabilitation programs in 1999. *Am J Phys Med Rehabil* 2002; 81: 133–142.