JRRD Volume 50, Number 6, 2013
Pages 821–834

Interaction effects between rehabilitation and discharge destination on inpatients' functional abilities

Fase Badriah, MPH;[1] Takeru Abe, PhD;[1] Hidekazu Miyamoto, PhD;[1] Megumi Moriya, MS;[2] Akira Babazono, MD, PhD;[3] Akihito Hagihara, DMSc, MPH[1,3*]

[1]Kyushu University Graduate School of Medicine, Department of Health Services, Management and Policy, Fukuoka, Japan; [2]Kyushu University Graduate School of Human Environment Studies, Department of Behavioral and Health Sciences, Exercise and Sports Science Course, Fukuoka, Japan; [3]Kyushu University Graduate School of Medicine, Department of Health Care Administration and Management, Fukuoka, Japan

Abstract—A patient's functional ability after hospital discharge may be influenced by in-hospital rehabilitation and discharge destination. However, we know very little about how in-hospital rehabilitation intervention interacts with the type of discharge destination or how this interaction influences patients' functional abilities. Thus, how an interaction between in-hospital rehabilitation and discharge destination influences a patient's subsequent functional ability was examined. This was a cross-sectional study whose participants were inpatients who underwent rehabilitation between February 2008 and December 2010 at a hospital in Japan (n = 835). Participants were categorized into three condition groups (i.e., stroke, orthopedic, disuse syndrome). Then, interaction effects between the rehabilitation therapy and the type of discharge destination on a patient's subsequent functional ability were estimated by hierarchical linear regression analysis in each of the three subgroups. In models where the dependent variable was Functional Independence Measure (FIM) score at 3 mo after hospital discharge, a significant interaction between rehabilitation potential (a measure based on the FIM effectiveness measure) and discharge destination (home or other) was observed in the stroke and orthopedic patients (both $p < 0.001$). These findings may be useful in deciding on discharge destinations for patients.

Key words: diagnosis, discharge destination, disuse syndrome, functional abilities, Functional Independence Measure, in-hospital, orthopedic, rehabilitation, stroke, therapy.

INTRODUCTION

Although a rehabilitation patient's functional abilities after hospital discharge can be influenced by rehabilitation during the hospital stay and by the discharge destination, no studies have evaluated how such functional abilities following discharge are influenced by these two factors. Findings concerning associations among in-hospital rehabilitation, discharge destination, and functional ability after hospital discharge are very important because, in view of these findings, rehabilitation patients can choose discharge destinations that best fit them. To begin, we will briefly review previous findings related to rehabilitation outcomes, discharge destination, and patients' subsequent functional abilities. Factors related to effective rehabilitation interventions

Abbreviations: ADL = activities of daily living, FIM = Functional Independence Measure, LOS = length of stay, OT = occupational therapist, PT = physical therapist, SD = standard deviation, ST = speech therapist.

***Address all correspondence to Akihito Hagihara, DMSc, MPH; Kyushu University Graduate School of Medicine, Department of Health Services, Management and Policy, 3-1-1 Maidashi, Higashi-ku, Fukuoka 812-8582, Japan; +81-92-642-6950; fax: +81-92-642-6961.**
Email: hagihara@hsmp.med.kyushu-u.ac.jp
http://dx.doi.org/10.1682/JRRD.2012.08.0153

during a patient's hospital stay have been examined previously. Associations of effective rehabilitation have been reported with time from injury to rehabilitation admission, motor score on the Functional Independence Measure (FIM), total FIM score, length of stay (LOS) in hospital rehabilitation, and medical cost [1]. These findings indicate that the shorter the time is from injury to the initiation of rehabilitation, the better the rehabilitation outcome will be. Intensity of therapy has been defined as the level of rehabilitation intensity, calculated as the total hours of therapy divided by LOS [2–3]. Jette et al. reported that therapy intensity was related to shorter LOS and improved functional independence [2]. Hu et al. reported that, after adjusting for the effects of initial severity, intensity of therapy predicted the Barthel Index score and walking ability at discharge. Additionally, patients with severe stroke benefited more than those with moderate stroke from increased rehabilitation intensity [3]. Other factors, such as more time spent per day in higher-level rehabilitation activities, higher-level activities early in the rehabilitation process, tube feeding, and newer medications, were also associated with better stroke rehabilitation outcomes [4]. Patients receiving care in comprehensive rehabilitation programs showed measurable functional improvement, and a high percentage of patients were then discharged to community-based settings [5].

Rehabilitation outcome has been shown to be related to discharge destination. Patients with low FIM scores at admission or discharge were likely to be discharged to a facility, and those with high FIM scores at admission or discharge almost always returned home. Those with midrange scores at admission were more likely to return from rehabilitation unit to home (62%) than those with similar scores at discharge (33%) [6]. In addition, stroke patients in stroke units with a lower ability to transfer at discharge are more likely to be discharged to nursing homes [7]. Stroke patients in inpatient rehabilitation facilities are more likely to undergo community-based discharge [8]. For inpatients in acute hospitals, predictors of discharge to a nursing home were older age, longer LOS, and injury caused by falling [9]. For geriatric rehabilitation inpatients in a rehabilitation unit, younger age (<80), a key person's discharge destination preference being home, having no dementia, and route taken to hospitalization (i.e., not transferred from other acute hospital to the rehabilitation unit) were more likely to predict discharge to the patients' home [10]. An inpatient's discharge destination has also been reported to influence the patient's functional abilities [11–12]. Specifically, because osteoarthritis inpatients discharged to their homes did not receive home care after discharge, the mortality rate of osteoarthritis patients without home care was higher than that of osteoarthritis patients with home care [11]. At 6 mo postfracture, compared with long-term care unit residents, community-dwelling residents regained more prefracture function and residential status was significantly associated with risk-adjusted functional recovery [12].

In-hospital rehabilitation can influence a patient's functional ability at and after hospital discharge because a patient's functional ability after hospital discharge is closely related to functional ability at hospital discharge. In view of findings on rehabilitation and outcome [3–5] and the association between discharge destination and a patient's subsequent functional ability [11–12], a patient's functional ability after hospital discharge may be influenced by in-hospital rehabilitation and discharge destination. However, we know very little about how in-hospital rehabilitation intervention interacts with the type of discharge destination or how this interaction influences patients' functional abilities. Thus, using data from inpatients who were transferred from other acute hospitals to the rehabilitation unit and underwent rehabilitation at the rehabilitation unit, we examined the effects of the interactions between rehabilitation and the type of discharge destination on a patient's subsequent daily activity.

MATERIALS AND METHODS

Participants

The participants were all consecutive patients who underwent rehabilitation at the rehabilitation unit of "H" Hospital (full name is not given to protect patient privacy) in Fukuoka City, Japan, between February 2008 and December 2010. The patients were transferred from other acute hospitals, from the acute unit of H Hospital, or from nursing facilities. Specifically, patients who were admitted to the rehabilitation unit of the hospital, had completed the rehabilitation program, were discharged from the hospital during the study period, and were contacted 3 mo after hospital discharge were studied (n = 902). Because 67 patients had missing data, the remaining patients without missing data were used for analysis (n = 835). The age range of the study subjects was 21–100 yr. Patients were categorized into three condition groups: stroke, orthopedic disease, and disuse syndrome. The stroke group included patients with subarachnoid hemorrhage, subdural hemorrhage, cerebral infarction, or intracranial hemorrhage. The orthopedic disease group included patients with muscle injury, pelvic fracture, vertebral compression fracture, femoral fracture, or neuromuscular disease. The disuse syndrome group included patients with rheumatoid arthritis, muscle injury, respiratory disease, gastrointestinal disease, cardiac disease, neuromuscular disease, or other conditions. In view of the purpose of the study, patients who were admitted to the hospital from nursing facilities and patients who were of very advanced age (85 yr or older) were not excluded.

The hospital is a mixed-care medical institution with a general ward, a ward for long-term care, and a convalescence/rehabilitation ward. The professional staff includes 31 physical therapists (PTs), 21 occupational therapists (OTs), 9 speech therapists (STs), and 6 social workers.

Study Variables

There were eight independent variables, including an interaction term, and one dependent variable (**Table 1**). Specifically, the following information was ascertained before and during each patient's hospital stay at the rehabilitation unit of H Hospital: personal attributes such as age, sex, and previous history of disability. The patient's age was entered into an analysis model as a continuous variable. Previous history of disability was evaluated using a patient's physical capacity with respect to standing up, sitting, rolling over, walking, maintaining a standing position, eating, and sphincter control. Previous history of disability was determined based on either the patient's self-perception when no cognitive problems were present or the family's or others' judgment when a cognitive problem was present. The PTs and OTs assigned to take care of a patient ascertained each patient's functional independence level at the beginning of the rehabilitation program. Additionally, each patient's functional independence level was measured at the time of hospital discharge and 3 mo after hospital discharge. Thus, in summary, each patient's functional level was measured three times by the PTs or OTs in charge: at

Table 1.
Patient characteristics categorized by type of disease. Data presented as either mean ± standard deviation or frequency (%).

Characteristic	Stroke (n = 205)	Orthopedic (n = 441)	Disuse Syndrome (n = 189)	p-Value
Independent Variables				
Age (yr)	76.49 ± 13.76	78.87 ± 12.52	79.17 ± 13.44	0.06
Sex (female)	119 (58.09)	361 (81.50)	114 (60.32)	<0.001
Previous Disability History (yes)	112 (54.63)	248 (55.98)	110 (58.20)	0.77
Discharge Destination (home)	100 (48.78)	280 (63.21)	92 (48.68)	<0.001
Intensity of Therapy*	1.50 ± 0.71	0.96 ± 0.42	1.07 ± 0.57	<0.001
LOS (d)	112.99 ± 60.48	76.98 ± 39.47	79.03 ± 39.71	<0.001
Total Hours				
Total Therapy	140.69 ± 103.04	72.04 ± 45.21	80.46 ± 62.37	<0.001
Physical Therapy	68.77 ± 41.93	58.73 ± 30.79	49.65 ± 31.28	<0.001
Occupational Therapy	43.88 ± 48.00	12.39 ± 27.00	22.11 ± 32.58	<0.001
Speech Therapy	28.03 ± 40.51	0.92 ± 6.15	8.70 ± 20.72	<0.001
Rehabilitation Potential†	0.32 ± 0.22	0.41 ± 0.02	0.33 ± 0.02	<0.001
FIM Score				
At Beginning of Therapy	67.63 ± 32.84	86.89 ± 26.24	72.35 ± 32.49	<0.001
At Hospital Discharge	79.29 ± 34.72	96.94 ± 25.55	80.31 ± 33.37	<0.001
Dependent Variable				
FIM 3 mo after Hospital Discharge	74.39 ± 35.61	92.88 ± 28.03	74.25 ± 35.09	<0.001

Note: One-way analysis of variance for continuous variables and chi-square test for categorical variables.
*Intensity of therapy = (total hours of total therapy)/(LOS in days).
†Rehabilitation potential = (change in FIM total scores between beginning of rehabilitation therapy and hospital discharge)/(FIM total maximum score [i.e., 126] – FIM total score at beginning of rehabilitation).
FIM = Functional Independence Measure, LOS = length of stay.

the beginning of the rehabilitation program, at hospital discharge, and 3 mo after hospital discharge. Functional independence was assessed using the FIM [13]. The FIM consists of two parts that evaluate functional ability in the cognitive and motor domains. FIM motor includes four subcategories: self-care, locomotion, transfer, and sphincter control. FIM cognitive includes cognition and communication [13]. In this study, the total of these subcategory scores was used for analysis. Intensity of therapy was calculated by the total hours of therapy divided by the LOS at the rehabilitation unit of H Hospital in days [2–3]. The total therapy was the total amount of therapy provided by PTs, OTs, and STs. Five types of facilities comprised discharge destinations other than the patient's home: (1) nursing facilities that offer long-term care, (2) healthcare facilities that offer long-term care, (3) designated sanatorium-type medical care facilities for those requiring care, (4) group homes for those with dementia that offer daily life care in a communal living environment, and (5) nursing care centers and private senior citizens' homes that offer care services for designated facility residents. Of these five types of facilities, the first three are quite similar in terms of care services provided to residents. And the number of patients in the fourth and fifth was very small (1.8%). Thus, in the analysis, discharge destinations were categorized into the two groups: "home" and "others," the latter of which included the above-mentioned five types of facilities.

FIM effectiveness is the difference between FIM scores at hospital discharge and at the beginning of therapy at the rehabilitation unit [14–15]. It is quite difficult to increase the FIM score when the score at the beginning of therapy is high, whereas it is relatively easy to increase the FIM score when the score at the beginning of therapy is low. When evaluating the effectiveness of intervention, FIM effectiveness simply calculates the difference between FIM scores at two points and does not consider whether the baseline FIM score (i.e., the FIM score at the beginning of rehabilitation) is high. Thus, to remedy this and to evaluate the effectiveness of rehabilitation therapy more adequately, we devised a rehabilitation potential measure based on a FIM effectiveness measure [14–16]. The rehabilitation potential measure was calculated by dividing the change in FIM total score at the beginning of rehabilitation therapy and hospital discharge by the FIM total score target, which is the FIM total maximum score (i.e., 126) minus the FIM total score at the beginning of rehabilitation [17–19]. As a dependent variable, the FIM score 3 mo after hospital discharge was used.

Statistical Analyses

To analyze the data in diagnostic groups, we divided patients into three groups based on the following diagnoses: stroke, orthopedic disorders, and disuse syndrome. Disuse syndrome is a type of hypoactivity with musculoskeletal inactivity, which results in depletion of body systems and is typically associated with mechanical or prescribed immobilization, severe pain, and/or an altered level of consciousness [20].

In the analysis, following the models suggested by Harrell, we used models in which the dependent variable was FIM score at 3 mo after hospital discharge, not the difference between FIM scores at hospital discharge and at 3 mo after hospital discharge [21]. Because the aim of the study was to evaluate interaction effects between rehabilitation effectiveness and the type of discharge destination on a patient's subsequent functional ability level, hierarchical regression analyses were performed in the three patients groups. Specifically, one type of multiple regression analysis was performed using FIM scores 3 mo after hospital discharge as a dependent variable and factors related to patients and therapy, as well as the effectiveness of therapy and discharge destination, as independent variables (**Table 1**). In the hierarchical regression analyses, a group of variables was entered into the analysis model sequentially. In each step of the regression analyses, variance inflation factor showed no problems with respect to multicollinearity. In order to accurately evaluate the effect of an interaction term between two variables (i.e., unstandardized partial coefficient), centering is recommended in hierarchical regression analyses [22]. Thus, before constructing the interaction terms, we centered rehabilitation potential by subtracting the mean score of the sample from each individual's score for the variable [22]. To determine the significance of each interaction, post hoc analyses were conducted; p-values less than 0.05 were considered to indicate statistical significance. For the final model, to confirm the validity of the regression analysis, we performed regression diagnostics, which include checking of residuals, multicollinearity, outliers, and influential observations.

Finally, to obtain information that might be useful in interpreting the results of hierarchical regression analyses, we calculated correlation coefficients among study variables. For comparisons among the three groups, we performed chi-square tests and one-way analyses of variance. These analyses were performed using SPSS software (version 19, IMB Corp; Armonk, New York).

RESULTS

Description of Patient Groups

Table 1 shows a description of the study variables among the three patients groups. There was no significant difference in mean age among the groups of disuse syndrome patients (mean age = 79.17 ± 13.44 yr), orthopedic patients (mean age = 78.87 ± 12.52 yr), and stroke patients (mean age = 76.49 ± 13.76 yr) ($p = 0.06$). The percentage of females was lowest among stroke patients (58.09%) and was highest among orthopedic patients (81.50%) ($p < 0.001$). The percentage of patients whose discharge destination was home was lowest among stroke patients (48.78%) and highest among orthopedic patients (63.21%) ($p < 0.001$). Intensity of therapy also differed among the groups ($p < 0.001$); it was highest among stroke patients (1.50 ± 0.71) and lowest among orthopedic patients (0.96 ± 0.42), implying that the most intensive therapy was performed with the stroke patients. The intensity of therapy was calculated as the total hours of total therapy divided by the LOS at the rehabilitation unit of H Hospital in days. Thus, although these variables were not used in the analysis, LOS and total hours of occupational, physical, and speech therapy are listed in **Table 1**. A significant difference was observed among the three diagnostic groups with respect to these variables. There was also a significant difference among the three patient groups with respect to FIM score at the beginning of therapy and FIM score 3 mo after hospital discharge (both $p < 0.001$).

Associations Among Study Variables by Patient Group

Table 2 shows correlation coefficients of study variables among the three condition groups. There was a similar trend with respect to associations among study variables in the three groups. In particular, for discharge destination, those with a previous history of disability were less likely to be transferred to home ($p < 0.001$ for stroke patients and orthopedic patients and $p < 0.01$ for disuse syndrome patients). Discharge destination was also related to FIM score at the beginning of therapy ($p <$ 0.01 and 0.05 in stroke patients and orthopedic patients, respectively), intensity of therapy (all $p < 0.01$), effectiveness of therapy (all $p < 0.01$), and FIM scores 3 mo after hospital discharge (all $p < 0.01$) in the three patient groups (**Table 2**).

Rehabilitation potential was related to previous history of disability in the three patient groups (all $p <$ 0.001) and to age among orthopedic patients ($p < 0.001$) and stroke patients ($p < 0.001$) (**Table 2**). Several notable points are as follows. A previous history of disability was correlated with age and sex among orthopedic patients, while such a correlation was not observed among stroke and disuse syndrome patients. Intensity of therapy was correlated with FIM scores at the beginning of therapy among orthopedic patients, while such correlation was not observed among stroke and disuse syndrome patients.

Multiple Regressions

Tables 3–5 show the results of hierarchical regression analyses, in which the dependent variable was FIM

Table 2.
Correlation coefficients among study variables.

Variable	Stroke Patients (n = 205)							Orthopedic Patients (n = 441)							Disuse Syndrome Patients (n = 189)						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1. Age (yr)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Sex (female)	0.28*	—	—	—	—	—	—	0.46*	—	—	—	—	—	—	0.15†	—	—	—	—	—	—
3. Previous Disability History (yes)	0.08	0.04	—	—	—	—	—	0.19*	0.12†	—	—	—	—	—	–0.09	0.08	—	—	—	—	—
4. Discharge Destination (home)	–0.12	–0.04	–0.25*	—	—	—	—	–0.20*	–0.09	–0.28*	—	—	—	—	–0.10	–0.05	–0.21‡	—	—	—	—
5. FIM at Therapy Beginning	–0.35*	–0.10	–0.01	0.21‡	—	—	—	–0.23*	–0.18*	0.00	0.16*	—	—	—	–0.38*	–0.04	0.19‡	0.05	—	—	—
6. Therapy Intensity	–0.27*	–0.09	–0.24*	0.50*	0.04	—	—	–0.40*	–0.16*	–0.36*	0.50*	0.11†	—	—	–0.18†	0.10	–0.30*	0.42*	0.13	—	—
7. Rehabilitation Potential	–0.28*	–0.05	–0.23*	0.51*	0.23*	0.47*	—	–0.22*	–0.02	–0.22*	0.34*	0.05	0.25*	—	–0.08	–0.07	–0.32*	0.37*	–0.10	0.30*	—
8. FIM 3 mo after Hospital Discharge	–0.35	–0.13	–0.28*	0.60*	0.24*	0.88*	0.73*	–0.37*	–0.12‡	–0.40	0.59*	0.13*	0.86*	0.54*	–0.15†	0.05	–0.34*	0.55*	0.12	0.88*	0.59*

*$p < 0.001$.
†$p < 0.05$.
‡$p < 0.01$.
FIM = Functional Independence Measure.

Table 3.
Hierarchical regression analysis of factors related to Functional Independence Measure (FIM) scores at 3 mo after hospital discharge among stroke patients (*n* = 205).

Variable	b	*p*-Value	R^2 Change	*p*-Value
Step 1: Patients' Characteristics			**0.7982**	**<0.001**
Age	**–0.31**	**<0.001**		
Sex (female)	**–1.18**	**0.62**		
Previous History of Disability (yes)	**–4.97**	**0.03**		
FIM Scores at Beginning of Therapy	**0.90**	**<0.001**		
Step 2: Living Status			**0.0304**	**<0.001**
Age	–0.32	<0.001		
Sex (female)	–1.25	0.57		
Previous History of Disability (yes)	–2.96	0.18		
FIM Scores at Beginning of Therapy	0.80	<0.001		
Discharge Destination (home)	**14.47**	**<0.001**		
Step 3: Therapy Information			**0.0959**	**<0.001**
Age	–0.05	0.40		
Sex (female)	–2.11	0.15		
Previous History of Disability (yes)	–1.47	0.32		
FIM Scores at Beginning of Therapy	0.74	<0.001		
Discharge Destination (home)	3.58	0.04		
Intensity of Therapy	**6.01**	**<0.001**		
Rehabilitation Potential	**38.67**	**<0.001**		
Step 4: Interaction Terms			**0.0058**	**<0.001**
Age	–0.07	0.22		
Sex (female)	–2.40	0.09		
Previous History of Disability (yes)	–1.14	0.42		
FIM Scores at Beginning of Therapy	0.74	<0.001		
Discharge Destination (home)	2.72	0.12		
Intensity of Therapy	5.30	<0.001		
Rehabilitation Potential	52.99	<0.001		
Interaction Term Discharge Destination × Rehabilitation Potential	**–21.37**	**<0.001**		
R^2 Total			0.9303	<0.001
Adjusted R^2			0.9275	

Note: Bolded numbers represent newly added variables after previous step in hierarchical regression analysis model.

score at 3 mo after hospital discharge. Individual hierarchical regression analyses were performed in each of the three groups. Interaction terms between living status after hospital discharge and effectiveness of therapy were significant in the three groups. Specifically, in stroke patients, as shown in **Table 3**, age, sex, previous history of disability, and FIM score at the beginning of therapy, which were included in step 1 of the model, explained a significant portion of the variance ($p < 0.001$) in the equation. Age, previous history of disability, and FIM score at the beginning of therapy were related to the FIM score, indicating that FIM score was lower in older than in younger stroke patients ($p < 0.001$). It is also indicated that the FIM score was lower in patients with a previous history of disability compared with those without ($p < 0.03$) and in patients with low FIM scores at the beginning of therapy compared with patients with high FIM scores at the beginning of therapy ($p < 0.001$). Discharge destination, included in step 2 of the regression model, contributed significantly to variance in the FIM score ($p < 0.001$). This finding indicates that a home discharge destination was associated with a higher FIM score. A

Table 4.
Hierarchical regression analysis of factors related to Functional Independence Measure (FIM) scores at 3 mo after hospital discharge among orthopedic patients (n = 441).

Variable	b	*p*-Value	R^2 Change	*p*-Value
Step 1: Patients' Characteristics			**0.7523**	**<0.001**
Age	**–0.09**	**0.15**		
Sex (female)	**2.87**	**0.14**		
Previous History of Disability (yes)	**–5.70**	**<0.001**		
FIM Scores at Beginning of Therapy	**0.87**	**<0.001**		
Step 2: Living Status			**0.0295**	**<0.001**
Age	–0.10	0.10		
Sex (female)	2.94	0.11		
Previous History of Disability (yes)	–4.38	0.001		
FIM Scores at Beginning of Therapy	0.77	<0.001		
Discharge Destination (home)	**11.61**	**<0.001**		
Step 3: Therapy Information			**0.0842**	**<0.001**
Age	0.04	0.37		
Sex (female)	0.57	0.69		
Previous History of Disability (yes)	–2.51	0.02		
FIM Scores at Beginning of Therapy	0.77	<0.001		
Discharge Destination (home)	6.50	<0.001		
Intensity of Therapy	**1.57**	**0.20**		
Rehabilitation Potential	**21.76**	**<0.001**		
Step 4: Interaction Terms			**0.0334**	**<0.001**
Age	–0.00	0.96		
Sex (female)	0.36	0.77		
Previous History of Disability (yes)	–2.58	0.006		
FIM Scores at Beginning of Therapy	0.77	<0.001		
Discharge Destination (home)	1.69	0.14		
Intensity of Therapy	0.51	0.63		
Rehabilitation Potential	51.00	<0.001		
Interaction Term	**–35.69**	**<0.001**		
Discharge Destination × Rehabilitation Potential				
R^2 Total			0.8994	<0.001
Adjusted R^2			0.8976	

Note: Bolded numbers represent newly added variables after previous step in hierarchical regression analysis model.

block of therapy variables included in step 3 of the regression equation further contributed to the variance in the FIM score ($p < 0.001$). Specifically, both the intensity of total therapy and effectiveness of therapy were related to an increase in the FIM score (both $p < 0.001$). Inclusion of an interaction term between discharge destination and rehabilitation potential in step 4 led to a significant increase in FIM score variance ($p < 0.001$). The interaction between the two variables was significantly related to a decrease in FIM score at 3 mo after hospital discharge ($p < 0.001$). **Figure 1** displays the relationships between the effectiveness of therapy and FIM score 3 mo after hospital discharge as mediated by living status after hospital discharge. As shown in the figure legends, the slopes of the two lines in **Figures 1–3** were calculated using the partial regression coefficients of the interaction term, discharge destination, and rehabilitation potential [22]. The simple slope for the discharge destination being facilities other than home indicated a stronger association with the FIM score than did the slope for the discharge destination being home when the level of rehabilitation potential was the mean + 1 standard deviation (SD) ($p < 0.001$).

In orthopedic patients in **Table 4**, age, sex, previous history of disability, and FIM score at the beginning of therapy, which were included in step 1 of the model,

Table 5.
Hierarchical regression analysis of factors related to Functional Independence Measure (FIM) scores at 3 mo after hospital discharge among disuse syndrome patients (n = 189).

Variable	b	p-Value	R^2 Change	p-Value
Step 1: Patients' Characteristics			**0.7799**	**<0.001**
Age	**0.00**	**0.96**		
Sex (female)	**–2.17**	**0.40**		
Previous History of Disability (yes)	**–5.73**	**0.03**		
FIM Scores at Beginning of Therapy	**0.93**	**<0.001**		
Step 2: Living Status			**0.0366**	**<0.001**
Age	0.02	0.83		
Sex (female)	–0.92	0.70		
Previous History of Disability (yes)	–4.52	0.06		
FIM Scores at Beginning of Therapy	0.84	<0.001		
Discharge Destination (home)	**14.85**	**<0.001**		
Step 3: Therapy Information			**0.0869**	**<0.001**
Age	0.12	0.08		
Sex (female)	0.02	0.99		
Previous History of Disability (yes)	0.17	0.93		
FIM Scores at Beginning of Therapy	0.79	<0.001		
Discharge Destination (home)	8.39	<0.001		
Intensity of Therapy	**3.94**	**0.01**		
Rehabilitation Potential	**35.64**	**<0.001**		
Step 4: Interaction Terms			**0.0037**	**0.05**
Age	0.09	0.16		
Sex (female)	0.02	0.99		
Previous History of Disability (yes)	–0.11	0.95		
FIM Scores at Beginning of Therapy	0.79	<0.001		
Discharge Destination (home)	8.09	<0.001		
Intensity of Therapy	3.41	0.03		
Rehabilitation Potential	43.64	<0.001		
Interaction Term Discharge Destination × Rehabilitation Potential	**–14.38**	**0.008**		
R^2 Total			0.9071	<0.001
Adjusted R^2			0.9030	

Note: Bolded numbers represent newly added variables after previous step in hierarchical regression analysis model.

explained a significant portion of the variance ($p < 0.001$). Previous history of disability and FIM score at the beginning of therapy were related to the FIM score, indicating that FIM score at 3 mo after hospital discharge was lower in patients with a previous history of disability compared with those without ($p < 0.001$) and in patients with low FIM scores at the beginning of therapy compared with patients with high FIM scores at the beginning of therapy ($p < 0.001$). Discharge destination, included in step 2 of the regression model, contributed significantly to the variance of the FIM score ($p < 0.001$). This finding indicates that the discharge destination being home was associated with a higher FIM score at 3 mo after hospital discharge. A block of therapy variables, included in step 3 of the regression equation, accounted for significant increases in the variance of the FIM score ($p < 0.001$). Rehabilitation potential was related to the FIM score ($p < 0.001$). Inclusion of an interaction term between discharge destination and rehabilitation potential in step 4

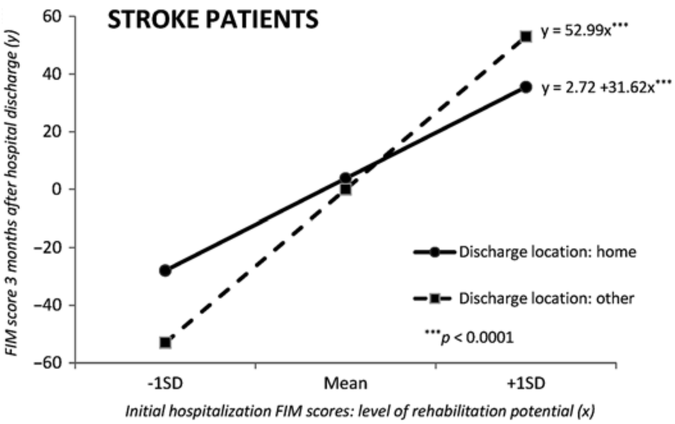

Figure 1.
Effect of interaction between discharge location and rehabilitation potential on Functional Independence Measure (FIM) scores at 3 mo after hospital discharge among stroke patients. SD = standard deviation.

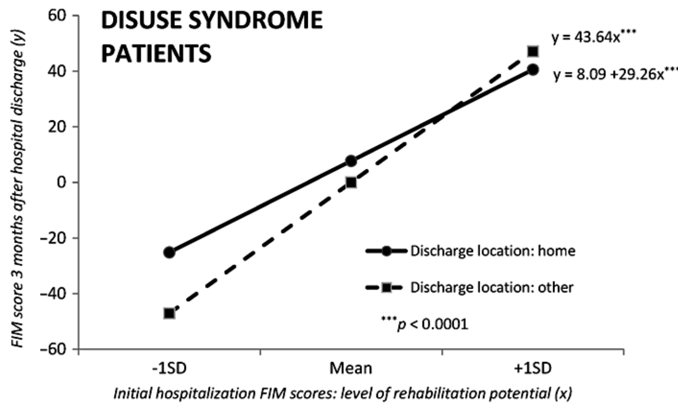

Figure 3.
Effect of interaction between discharge location and rehabilitation potential on Functional Independence Measure (FIM) scores at 3 mo after hospital discharge among disuse syndrome patients. SD = standard deviation.

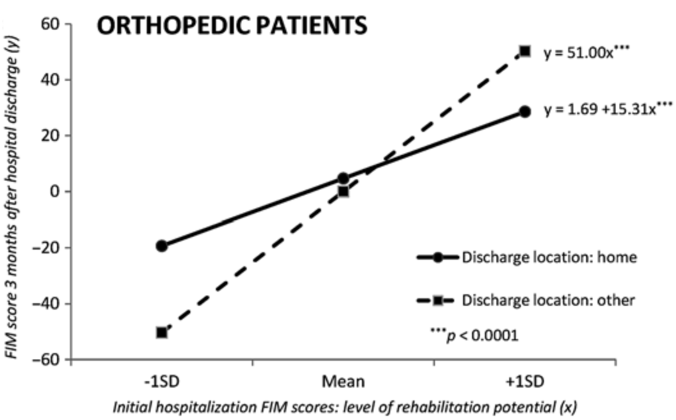

Figure 2.
Effect of interaction between discharge location and rehabilitation potential on Functional Independence Measure (FIM) scores at 3 mo after hospital discharge among orthopedic patients. SD = standard deviation.

led to a significant increase in FIM score variance ($p < 0.001$). The interaction between the two variables was significantly related to a lower FIM score at 3 mo after hospital discharge ($p < 0.001$). **Figure 2** displays the relationships between effectiveness of therapy and FIM score 3 mo after hospital discharge as mediated by living status after hospital discharge. The simple slope for the discharge destination being facilities other than home was associated with a significantly greater increase in FIM scores than was the slope for the discharge destination being home when the level of rehabilitation potential was the mean + 1 SD ($p < 0.001$).

In disuse syndrome patients in **Table 5**, age, sex, previous history of disability and FIM score at the beginning of therapy, which were included in step 1 of the model, explained a significant portion of the variance ($p < 0.001$) in the equation. Previous history of disability and FIM score at the beginning of therapy were related to the FIM score at 3 mo after hospital discharge, which was lower in patients with a previous history of disability compared with those without ($p = 0.03$) and in patients with low FIM scores at the beginning of therapy compared with patients with high FIM scores at the beginning of therapy ($p < 0.001$). Discharge destination, included in step 2 of the regression model, accounted for significant increases in variance of the FIM score ($p < 0.001$). This finding indicated that a discharge destination being home was associated with higher FIM scores. A block of therapy variables, included in step 3 of the regression equation, contributed significantly to the variance of the FIM score ($p < 0.001$). Specifically, intensity of total therapy and effectiveness of therapy were related to the FIM score, and both intensity of total therapy and effectiveness of therapy were related to higher FIM scores ($p = 0.01$ and < 0.001, respectively). An interaction term between discharge destination and effectiveness of therapy, included in step 4, did not account for a significant increase in the variance of the FIM score ($p = 0.05$). However, the interaction between the two variables was significantly related to a lower FIM score at 3 mo after hospital discharge (p = 0.008). **Figure 3** displays the relationships between effectiveness of therapy and FIM score 3 mo after hospital discharge as mediated by living status after hospital discharge. The simple slope for the discharge destination being facilities other than home indicated a greater increase in FIM scores than did the slope for the discharge destination being home when the level of rehabilitation potential was the mean + 1 SD (p < 0.001).

DISCUSSION

In the study, we examined how the interaction between in-hospital rehabilitation and discharge destination influenced a patient's functional ability 3 mo after hospital discharge among patients categorized by disease type. Several notable findings were made in the study. First, among stroke patients, the effectiveness of therapy and discharge destination interacted to influence a patient's subsequent functional ability (**Table 3**, **Figure 1**). Among stroke patients who were discharged to facilities other than home, the FIM score at 3 mo after hospital discharge was higher when rehabilitation potential was higher than the mean by +1 SD than when rehabilitation potential was lower than the mean by –1 SD. Similarly, among stroke patients who were discharged to home, the FIM score at 3 mo after hospital discharge was also higher when rehabilitation potential was higher than the mean by +1 SD than when rehabilitation potential was lower than the mean by –1 SD. However, the increase in FIM score was larger when the discharge destination was facilities other than home than when the discharge destination was home (**Figure 1**). Second, among orthopedic patients, the effectiveness of therapy and discharge destination interacted to influence patients' subsequent functional ability (**Table 4**). When rehabilitation potential was higher than the mean by +1 SD, versus when rehabilitation potential was lower than the mean by –1 SD, FIM score at 3 mo after hospital discharge increased more among orthopedic patients who were discharged to home and among orthopedic patients who were discharged to facilities other than home (**Figure 2**). However, the increase in FIM scores was larger when the discharge destination was facilities other than home than when the discharge destination was home. A previous study from Japan reported that patients discharged to their homes showed a gradual decline in activities of daily living (ADL) over time, and overprotection by family members was an attributable cause of the decline in ADL [23]. Stroke patients discharged to home have been reported to use daycare services or day services often [24]. However, patients discharged to their homes tend to seek healthcare services in terms of price and convenience factors (distance, drive time, etc.), not in terms of the necessity of service. On the other hand, OTs and PTs, not only nurses, are engaged in rehabilitation with stroke patients who are admitted to facilities other than their homes and who have paralysis due to damage to the central nervous system. The ratio of women to men and the FIM score at hospital discharge were highest in the orthopedic patient group (**Table 1**). Female orthopedic patients in their late 70s tend to have osteoporosis and to have no aftereffect of the disease, such as pressure fractures. Rehabilitation therapy for orthopedic patients who are discharged to long-term care facilities probably works well because patients have no paralysis due to central nervous system damage. Additionally, currently, there is no transition-support program for rehabilitation patients who are discharged to their homes in Japan [25–27]. These might be reasons why the increase in FIM scores was larger when the discharge destination was facilities other than home than when the discharge destination was home.

These are new findings based on Japanese data. These findings have practice and policy implications. Practically, these findings indicate that facilities other than home should be considered as the discharge destination for patients who have had a stroke or who have orthopedic diseases and have received effective rehabilitation. As for policy implications, the present findings imply the necessity of a transition-support program for rehabilitation patients who are discharged to their homes. Many stroke patients discharged to their homes reportedly use daycare services or day services, and the criteria for their choice are price and convenience factors (e.g., distance, drive time), not the necessity of service [24]. The present findings empirically support this hypothesis. Information is needed on the types of rehabilitation and the therapist fit for the needs of rehabilitation patients discharged to their homes through a transition-support program.

Among disuse syndrome patients, an interaction between effectiveness of therapy and discharge destination did not explain a significant portion of the variance (**Table 5**). When rehabilitation potential was higher than the mean by +1 SD, versus when rehabilitation potential was lower than the mean by −1 SD, FIM score at 3 mo after hospital discharge increased equally among disuse syndrome patients who were discharged to facilities other than home and those who were discharged to home (**Figure 3**). This finding indicates that long-term care facilities and homes should be considered as discharge destinations for disuse syndrome patients who received effective rehabilitation. The disuse syndrome patients have disability due to a loss of muscle strength. Thus, to maintain the level of a patient's functional abilities, OTs or PTs are not necessarily needed in the rehabilitation for disuse syndrome patients; rehabilitation by nurses at the facilities or the use of daycare services or day services at home may be equally effective.

Notable findings were obtained in the correlation analysis (**Table 2**). First, a previous history of disability was correlated with age and sex only among orthopedic patients. The ratio of females was highest in the orthopedic group (**Table 1**). Female patients in the orthopedic group probably tended to have decreased bone density and osteoporosis as they became older. Thus, a previous history of disability was correlated with age and sex only among orthopedic patients. Second, although the intensity of therapy was correlated with FIM scores at the beginning of therapy among orthopedic patients, such correlation was not observed among stroke and disuse syndrome patients. The orthopedic patients had musculoskeletal disorders and did not have other disorders, such as cardiovascular diseases, muscular atrophy, depression, and cognitive diseases. Thus, one assumes that intense rehabilitation was delivered to patients with higher FIM scores at the beginning of therapy only among the orthopedic patients.

We first revealed that rehabilitation during hospital stay at the rehabilitation unit and discharge destination interacted to influence patients' functional ability after hospital discharge among stroke and orthopedic patients. Although many studies have addressed related topics, most previous studies focused on (1) whether patient attributes (age, sex, income, type of residence, family, manner of living), type of disease, and functional ability were related to the type of discharge destination after rehabilitation at a hospital [1–9] and (2) the association between the type of discharge destination and patient outcome [9–11]. To our knowledge, no reported study has analyzed the effect of an interaction between rehabilitation during hospital stay at the rehabilitation unit and the type of discharge destination on a patient's subsequent functional ability. Thus, we believe that the present study reports novel findings. There are several caveats and limitations to the present study. First, the medical care delivery system peculiar to Japan might have influenced the findings. Specifically, interaction effects between rehabilitation during hospital stay at the rehabilitation unit and discharge destination after hospital stay on a patient's subsequent functional ability among stroke patients or among orthopedic patients 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 nursing care insurance system. Thus, we need to be cautious about the external validity of the findings. Second, the data were collected at a single hospital. Because factors other than those used as explanatory variables in this study might also potentially influence the dependent variable, additional studies including more variables in other settings with different healthcare delivery systems are necessary.

CONCLUSIONS

We demonstrated that rehabilitation during hospital stay at the rehabilitation unit and discharge destination interacted to influence patients' functional ability after hospital discharge in stroke patients and orthopedic patients. The present findings may be useful in deciding the discharge destination for patients. A transition-support program for rehabilitation patients who are discharged to their homes should be considered.

ACKNOWLEDGMENTS

Author Contributions:

Study conception and design: F. Badriah, T. Abe, A. Hagihara.

Acquisition of data: F. Badriah, T. Abe, A. Hagihara.

Analysis and interpretation of data: H. Miyamoto, M. Moriya, A. Babazono.

Drafting of article: F. Badriah, T. Abe, A. Hagihara.

Critical revision of article for important intellectual content: H. Miyamoto, M. Moriya, A. Babazono.

Final approval of article: F. Badriah, T. Abe, A. Hagihara, H. Miyamoto, M. Moriya, A. Babazono.

Financial Disclosures: The authors have declared that no competing interests exist.

Funding/Support: This material was unfunded at the time of manuscript preparation.

Institutional Review: This study was approved by the ethics committee at H Hospital in 2008.

Participant Follow-Up: The authors do not plan to inform participants of the publication of this study because contact information is unavailable.

REFERENCES

1. Kunik CL, Flowers L, Kazanjian T. Time to rehabilitation admission and associated outcomes for patients with traumatic brain injury. Arch Phys Med Rehabil. 2006;87(12): 1590–96. [PMID:17141638] http://dx.doi.org/10.1016/j.apmr.2006.09.001
2. Jette DU, Warren RL, Wirtalla C. The relation between therapy intensity and outcomes of rehabilitation in skilled nursing facilities. Arch Phys Med Rehabil. 2005;86(3): 373–79. [PMID:15759214] http://dx.doi.org/10.1016/j.apmr.2004.10.018
3. Hu MH, Hsu SS, Yip PK, Jeng JS, Wang YH. Early and intensive rehabilitation predicts good functional outcomes in patients admitted to the stroke intensive care unit. Disabil Rehabil. 2010;32(15):1251–59. [PMID:20131942] http://dx.doi.org/10.3109/09638280903464448
4. 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(12 Suppl 2):S101–14. [PMID:16373145] http://dx.doi.org/10.1016/j.apmr.2005.09.016
5. Deutsch A, Fiedler RC, Granger CV, 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(2):133–42. [PMID:11807350] http://dx.doi.org/10.1097/00002060-200202000-00010
6. Bottemiller KL, Bieber PL, Basford JR, Harris M. FIM score, FIM efficiency, and discharge disposition following inpatient stroke rehabilitation. Rehabil Nurs. 2006;31(1): 22–25. [PMID:16422041] http://dx.doi.org/10.1002/j.2048-7940.2006.tb00006.x
7. Lutz BJ. Determinants of discharge destination for stroke patients. Rehabil Nurs. 2004;29(5):154–63. [PMID:15468740] http://dx.doi.org/10.1002/j.2048-7940.2004.tb00338.x
8. Deutsch A, Granger CV, Heinemann AW, Fiedler RC, DeJong G, Kane RL, Ottenbacher KJ, Naughton JP, Trevisan M. Poststroke rehabilitation: outcomes and reimbursement of inpatient rehabilitation facilities and subacute rehabilitation programs. Stroke. 2006;37(6):1477–82. [PMID:16627797] http://dx.doi.org/10.1161/01.STR.0000221172.99375.5a
9. Aitken LM, Burmeister E, Lang J, Chaboyer W, Richmond TS. Characteristics and outcomes of injured older adults after hospital admission. J Am Geriatr Soc. 2010;58(3): 442–49. [PMID:20163484] http://dx.doi.org/10.1111/j.1532-5415.2010.02728.x
10. Miyamoto H, Hagihara A, Nobutomo K. Predicting the discharge destination of rehabilitation patients using a signal detection approach. J Rehabil Med. 2008;40(4):261–68. [PMID:18382821] http://dx.doi.org/10.2340/16501977-0161
11. Rahme E, Kahn SR, Dasgupta K, Burman M, Bernatsky S, Habel Y, Berry G. Short-term mortality associated with failure to receive home care after hemiarthroplasty. CMAJ. 2010;182(13):1421–26. [PMID:20713576]
12. Beaupre LA, Cinats JG, Jones CA, Scharfenberger AV, William C Johnston D, Senthilselvan A, Saunders LD. Does functional recovery in elderly hip fracture patients differ between patients admitted from long-term care and the community? J Gerontol A Biol Sci Med Sci. 2007;62(10): 1127–33. [PMID:17921426] http://dx.doi.org/10.1093/gerona/62.10.1127
13. Data Management Service. Guide for use of Uniform Data Set for medical rehabilitation. New York (NY): The Buffalo Hospital/State University of New York at Buffalo; 1991.
14. Prvu Bettger JA, Stineman MG. Effectiveness of multidisciplinary rehabilitation services in postacute care: state-of-the-science. A review. Arch Phys Med Rehabil. 2007; 88(11):1526–34. [PMID:17964900] http://dx.doi.org/10.1016/j.apmr.2007.06.768
15. Karges J, Smallfied 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(1):E1–10. [PMID:19753406]
16. Woo J, Chan SY, Sum MW, Wong E, Chui YP. In patient stroke rehabilitation efficiency: influence of organization of service delivery and staff numbers. BMC Health Serv Res. 2008;8:86. [PMID:18416858] http://dx.doi.org/10.1186/1472-6963-8-86
17. Shah S, Vanclay F, Cooper B. Efficiency, effectiveness, and duration of stroke rehabilitation. Stroke. 1990;21(2):241–46. [PMID:2305399] http://dx.doi.org/10.1161/01.STR.21.2.241
18. Paolucci S, Antonucci G, Pratesi L, Traballesi M, Lubich S, Grasso MG. Functional outcome in stroke inpatient rehabilitation: predicting no, low and high response patients. Cerebrovasc Dis. 1998;8(4):228–34. [PMID:9684063] http://dx.doi.org/10.1159/000015856
19. Paolucci S, Antonucci G, Grasso MG, Bragoni M, Coiro P, De Angelis D, Fusco FR, Morelli D, Venturiero V, Troisi E, Pratesi L. Functional outcome of ischemic and hemorrhagic stroke patients after inpatient rehabilitation: a

matched comparison. Stroke. 2003;34(12):2861–65. [PMID:14615613] http://dx.doi.org/10.1161/01.STR.0000102902.39759.D3
20. Okazaki T, Nara S, Hachisuka K. Prevention of disuse syndrome in acute stroke patients. Sogo Rinsho. 2002;51(12): 3189–95.
21. Harrell EF. Regression modeling strategies: With applications to linear models, logistic regression, and survival analysis. New York (NY): Springer; 2001. p. 1–9.
22. Aiken LS, West SG. Multiple regression: Testing and interpreting interactions. Thousand Oaks (CA): Sage; 1996. p. 116–26.
23. 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. Orthop Traumatol. 2002;51:84–88. http://dx.doi.org/10.5035/nishiseisai.51.84
24. Japan Association of Rehabilitation Hospital and Institution. [A study on effective rehabilitation: analysis on smooth transition from medical insurance to health care insurance.] Tokyo (Japan): Japan Association of Rehabilitation Hospital and Institution; 2007. Japanese.
25. Yamanaga H, Nojiri S, Nakanishi R, Katsura K, Watanabe S, Yonemitsu H. Rehabilitation of poststroke patients under long-term care insurance. Japanese J Rehabil Med. 2005; 42:58–71. http://dx.doi.org/10.2490/jjrm1963.42.58
26. Ministry of Health, Labour and Welfare. Heisei 22 nendo kaigo kyuufu-hi jittai-tyousa no gaiyou [A summary of the study on the long-term health care insurance benefit expenses in 2010]. Tokyo (Japan): Ministry of Health, Labour and Welfare; 2011. Japanese.
27. An official notice from the Ministry of Health, Labour and Welfare, Health Insurance Bureau, No. 0328001 [Internet]. Tokyo (Japan): Ministry of Health, Labour and Welfare; 28 Mar 2008 [cited 26 Mar 2012]. Available from: http://www.mhlw.go.jp/topics/2008/03/dl/tp0305-1ay_0001.pdf

Submitted for publication August 23, 2012. Accepted in revised form December 20, 2012.

This article and any supplemental materials should be cited as follows:
Badriah F, Abe T, Miyamoto H, Moriya M, Babazono A, Hagihara A. Interaction effects between rehabilitation and discharge destination on inpatients' functional abilities. J Rehabil Res Dev. 2013;50(6):821–34.
http://dx.doi.org/10.1682/JRRD.2012.08.0153

ResearcherID/ORCID: Akihito Hagihara, DMSc, MPH: G-4718-2012