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Original Article

Factors associated with the recovery of activities of daily living after hospitalization for acute medical illness: a prospective cohort study

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Abstract. [Purpose] This study investigated the factors associated with the recovery rate of activities of daily living of elderly patients hospitalized for acute medical illness. [Subjects and Methods] A total of 238 elderly patients were enrolled in this study. The main outcome measure was the functional independence measure score which was used as an assessment of activities of daily living. The participants were divided into 2 groups based on their activities of daily living before onset: the independent group and the partially dependent group. The participants of each group were further divided into 2 subgroups based on recovery rates of activities of daily living: the high-recovery group (80%) and the low-recovery group (<80%). The factors associated with the recovery rate were examined using multivariate logistic regression analysis. [Results] The factors associated with the recovery rate were: days of inactivity and cognitive status at the start of rehabilitation for the independent group, and days of inactivity and nutritional status at the start of rehabilitation for the partially dependent group. [Conclusion] The results of this study suggest that the important factors for return to normal activities of daily living are: days of inactivity and cognitive status for the independent group; and days of inactivity and management of nutrition for the partially dependent group.

Key words: Activities of daily living, Elderly, Hospitalization

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INTRODUCTION

Acute medical illness and prolonged inactivity are associated with a significant decline in functional ability known as "disuse syndrome". Disuse syndrome is caused by inactivity, immobility, and prolonged bed rest, and patients exhibit the following symptoms: musculoskeletal, cardiovascular and pulmonary, genitourinary and gastrointestinal, metabolic and endocrinal, and cognitive and behavioral[1)]. Furthermore, hospitalization caused by acute medical illness is stressful for elderly patients and is associated with a decline in activities of daily living (ADL)[2, 3)]. For elderly patients in particular, the decline in ADL during hospitalization is a large burden on both the patients themselves and their caregiver. Therefore, it is important to try to prevent the decline of ADL during hospitalization.

Previous studies have reported the factors related to prognosis of ADL in stroke and post-hip-fracture patients include: old age[4, 5)], cognitive impairment[4, 6)], and lower pre-rehabilitation functional status[6–8)]. Few reports have focused on the factors related to prognosis of ADL of elderly patients with acute medical illness[9)]. Furthermore, the majority of reports have examined the long-term prognosis (from 1 month to 1 year or more), while very few reports have examined short-term

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prognosis, such as the time of discharge. However, the factors related to ADL recovery and duration of hospitalization remain unclear. Clarifying these factors would be helpful for the development of prophylactic approaches to patient ADL recovery and for informing decisions regarding hospital discharge.

Therefore, the purpose of this study was to investigate the factors associated with ADL recovery of elderly patients with disuse syndrome who had undergone rehabilitation following acute medical illness.

SUBJECTS AND METHODS

This study enrolled patients of age 65 years old who were hospitalized at Tsukuba Memorial Hospital from August 1, 2012 to March 31, 2014, and who had undergone a rehabilitation program for disuse syndrome due to acute medical illness. Patients were excluded from this study for the following reasons: total dependence in ADL before onset (defined as<50 points of the motor functional independence measure [FIM])[10]; assessment difficulties during hospitalization; or absence of consent.

All the patients and their families read and signed the written informed consent documents. This study was conducted in accordance with the guidelines proposed in the Declaration of Helsinki. Furthermore, this study protocol was reviewed and approved by the Ethics Committee of the University of Tsukuba, Japan (631).

In order to elucidate the factors that are associated with the recovery rate of ADL during hospitalization, the various parameters that were collected within 72 hours from the start of rehabilitation (defined as the day when the instruction of rehabilitation was given by physician) were examined.

Each subject's main characteristics were collected from medical records, including: age, gender, and length of time from onset to start of rehabilitation (days of inactivity). In addition, length of stay (defined as length of hospitalization), amount of rehabilitation, and ADL were collected at discharge. ADL before onset was assessed in an interview of the patient or their caregivers at the start of rehabilitation. The following data was also evaluated: FIM score (total, motor, and cognitive); muscle strength (grip strength); range of motion (shoulder, hip, knee, and ankle); presence or absence of orthostatic hypotension, constipation, and urinary incontinence; malnutrition (Mini Nutritional Assessment [MNA])[11]; cognitive function (Mini-Mental State Examination [MMSE])[12]; depressive state (Geriatric Depression Scale [GDS])[13]; and balance (Functional Balance Scale [FBS])[14].

Functional disability was assessed using the FIM score, which can measure both physical and cognitive ability. FIM comprises 13 motor items, and 5 cognitive items. The items are scored on 7-point ordinal scales based on the amount of assistance required. The minimum score on the FIM is 18, which indicates a low level of functionality, while the maximum score is 126, which indicates a very high level of functionality[15].

Participants were classified into 2 groups: the independent group—those independent in ADL before onset (80 point of motor FIM score before onset); and the dependent group—those partially dependent in ADL before onset (<80 and 50 point of motor FIM score before onset)[10]. The recovery rate of the total FIM score for each of the groups was calculated as ([total FIM score at discharge minus total FIM score at the start of rehabilitation] divided by [total FIM score before onset minus total FIM score at the start of rehabilitation]). Patients with a recovery rate of FIM score 80% were categorized as the high recovery group (high group), and those with a recovery rate of FIM score<80% were categorized as the low recovery group (low group).

Student's *t*-test was used to compare the means of quantitative variables of the 2 groups. The χ^2 test was used to examine the significance of the association between qualitative variables of the two groups. Variables were removed if collinearity diagnostics showed correlation coefficients between variables of 0.7[16] or in cases where assessment of many patients was difficult. Multivariate logistic regression analysis was used to determine the factors associated with the recovery rate of the total FIM score. The level of statistical significance was chosen as $p<0.05$. All statistical analysis were performed using SPSS 21.0 software for Windows.

RESULTS

A total of 422 elderly patients received rehabilitation for disuse syndrome following acute medical illness. Among these patients, 194 patients were excluded from the study, 58 were difficult to assess, 45 did not provide consent, and 81 were totally dependent in ADL before onset. Of the remaining 238 patients, 130 (54.6%) were categorized as independent and 108 (45.4%) were categorized as dependent.

The average age (± SD) of the subjects was 81.3 ± 8.2 years (independent group: 83.9 ± 7.8 years, dependent group: 79.2 ± 7.8 years), and 58.4% were female (independent group: 50.8%, dependent group: 67.6%). Average days of inactivity was 4.4 ± 3.0 days (independent group: 4.3 ± 2.7 days, dependent group: 4.5 ± 3.3 days), and average length of stay was 20.5 ± 13.6 days (independent group: 20.0 ± 12.2 days, dependent group: 20.9 ± 14.5 days) (Table 1).

A comparison of the high group and low group of the independent group showed significant differences in days of activity, length of stay, cognitive FIM score at the start of rehabilitation, total FIM score at the start of rehabilitation, MNA, MMSE, and FBS (Table 2).

A comparison of the high group and low group of the dependent group showed significant differences in days of inactivity, motor FIM score at the start of rehabilitation, total FIM score at the start of rehabilitation, MNA, MMSE, and FBS (Table 2).

Table 1. Demographic and clinical characteristics of the patients

		Participants (n=238)	Recovery	Independent in ADL before onset (n=130)		Partial dependent in ADL before onset (n=108)	
				High group (n=52)	Low group (n=78)	High group (n=46)	Low group (n=62)
Age	(years)	81.3 ± 8.2		79.1 ± 7.3	79.2 ± 8.2	83.4 ± 7.9	84.3 ± 7.7
Gender							
Male		99 (41.6)		29 (55.8)	35 (44.9)	11 (23.9)	24 (38.7)
Female		139 (58.4)		23 (44.2)	43 (55.1)	35 (76.1)	38 (61.3)
Diagnosis (system)							
Digestive		103 (43.3)		30 (57.7)	31 (39.7)	20 (43.5)	22 (35.5)
Respiratory		78 (32.8)		12 (23.1)	26 (33.3)	17 (37.0)	23 (37.1)
Circulatory		20 (8.4)		2 (3.8)	6 (7.7)	4 (8.7)	8 (12.9)
Urinary		19 (8.0)		2 (3.8)	9 (11.5)	2 (4.3)	6 (9.7)
Metabolic		6 (2.5)		3 (5.8)	1 (1.3)	2 (4.3)	0 (0.0)
Other		12 (5.0)		3 (5.8)	5 (6.4)	1 (2.2)	3 (4.8)
Days of inactivity	(days)	4.4 ± 3.0		3.2 ± 2.8	5.4 ± 3.3*	3.3 ± 1.9	5.0 ± 2.9§
Length of stay	(days)	20.5 ± 13.6		17.7 ± 10.2	23.8 ± 17.0*	18.6 ± 10.9	21.1 ± 13.1
Amount of rehabilitation	(min/day)	57.4 ± 17.1		55.3 ± 17.0	58.0 ± 17.9	58.7 ± 16.1	57.4 ± 16.9

Mean ± SD, n (%).
Days of inactivity: length of time from onset to start of rehabilitation; ADL: activities of daily living; FIM: functional independence measure.
*p<0.05 (high group vs. low group in independent group)
§p<0.05 (high group vs. low group in dependent group)

The changes of FIM score at three time points are shown in Table 3.

In multivariate logistic regression analysis, the independent variables were the clinical variables that were found to have significant difference in univariate analysis of the two groups. In addition, age, gender, and amount of rehabilitation were included in the independent variables as adjusted variables. The dependent variable was the recovery rate of total FIM score. Cognitive FIM score of the independent group and motor FIM score of the dependent group were shown to have collinearity with the total FIM score. Therefore, cognitive FIM score of the independent group and motor FIM score of the dependent group were excluded from the logistic regression analysis. Logistic regression analysis revealed days of inactivity, and MMSE at the start of rehabilitation were significantly associated with the recovery rate of the total FIM score for the independent group (Table 4-1), and that days of inactivity, and MNA at the start of rehabilitation were significantly associated with the recovery rate of the total FIM score for the dependent group (Table 4-2).

DISCUSSION

In the independent and dependent groups, 52 patients (40%) and 46 patients (43%) achieved a recovery rate of FIM score 80%, respectively. In the multivariate analysis, factors associated with the recovery rate of FIM score for the independent group were days of inactivity, and MMSE at the start of rehabilitation. While for the dependent group the factors were days of inactivity, and MNA at the start of rehabilitation. Taken together these results indicate the important factors for the recovery rate of FIM score at discharge.

For both the independent group and dependent group, days of inactivity was found to be one of the important factors associated with the recovery rate of the FIM score. Hospitalization for acute medical illness is a stressful and potentially hazardous event for elderly patients[17, 18]. It is understood that muscle strength, endurance, and cognitive function are reduced by inactivity resulting from acute medical illness. A previous study investigated the effectiveness and feasibility of early physical rehabilitation, and its importance has been reported for patients with various diseases[19–21]. Furthermore, our previous study showed that early start of rehabilitation was an important factor for the recovery of ADL of elderly pneumonia patients[22]. In the present study, there was no significant difference in the total FIM score before onset between the high and low recovery groups of both the independent and dependent groups. However, there was a significant difference in the total FIM score at the start of rehabilitation. This strongly suggests that ADL is likely to decline in the period of hospitalization before the start of rehabilitation for the low groups. Since days of inactivity of the low groups was longer than that of the high groups, the results of this study led us to hypothesize that early rehabilitation prevents ADL decline, and early rehabilitation was one of the factors associated with the recovery rate of the FIM score.

Our results further revealed that cognitive function was also associated with the recovery rate of the FIM score, but only

Table 2. Comparison of the high and low recovery groups at the start of rehabilitation

			Independent in ADL before onset (n=130)		Partial dependent in ADL before onset (n=108)	
		Recovery	High group (n=52)	Low group (n=78)	High group (n=46)	Low group (n=62)
Muscle strength	(kg)					
Grip strength			20.6 ± 8.0	16.7 ± 8.7*	12.6 ± 8.4	11.5 ± 6.8
Range of motion	(°)					
Shoulder flexion			161.3 ± 22.3	154.4 ± 24.3	142.6 ± 30.9	139.9 ± 29.0
Shoulder extension			31.4 ± 12.2	29.8 ± 13.1	27.3 ± 14.2	30.0 ± 14.9
Hip flexion			116.4 ± 16.8	118.4 ± 9.5	114.1 ± 11.5	113.1 ± 13.4
Hip extension			7.1 ± 5.8	6.0 ± 6.9	0.2 ± 13.2	−2.1 ± 9.2
Knee flexion			132.2 ± 11.4	131.6 ± 12.5	129.1 ± 13.1	126.5 ± 13.3
Knee extension			−1.6 ± 3.7	−2.4 ± 3.8	−7.2 ± 10.0	−7.3 ± 10.7
Ankle flexion			47.8 ± 11.2	45.8 ± 12.2	41.9 ± 13.3	37.5 ± 12.8
Ankle extension			11.6 ± 6.8	9.5 ± 7.6	7.5 ± 8.3	8.1 ± 9.5
Orthostatic hypotension						
Yes			1 (1.9)	6 (7.7)	2 (4.3)	5 (8.1)
Constipation						
Yes			11 (21.2)	20 (25.6)	13 (28.3)	15 (24.2)
MNA	(points)		18.9 ± 4.1	14.4 ± 5.9*	16.3 ± 3.4	13.1 ± 5.2§
MMSE	(points)		25.1 ± 4.4	21.8 ± 6.1*	19.2 ± 5.2	16.8 ± 4.9§
GDS	(points)		4.0 ± 3.1	5.1 ± 3.7	3.5 ± 3.3	3.9 ± 2.4
FBS	(points)		37.2 ± 15.3	28.0 ± 16.9*	17.7 ± 11.8	12.3 ± 10.9§
Incontinence of urine						
Yes			9 (17.3)	10 (12.8)	10 (21.7)	19 (30.6)

Mean ± SD, n (%).
ADL: activities of daily living; FIM: functional independence measure; MNA: mini nutritional assessment; MMSE: mini mental status examination; GDS: geriatric depression scale; FBS: functional balance scale.
*p<0.05 (high group vs. low group in independent group)
§p<0.05 (high group vs. low group in dependent group)

in the independent group. Previous studies have shown that cognitive function is associated with rehabilitation effectiveness or relative functional gain[6, 23, 24]. Because many rehabilitation techniques require normal cognition and patient cooperation, cognitive status must be considered when determining the rehabilitation aims, establishing treatment strategies, and predicting outcomes[25]. Therefore, it is our opinion that the routine use of cognitive assessment for all patients at the start of rehabilitation is very important.

A previous study showed that malnutrition was associated with weaker muscle strength and future decline in muscle strength of the elderly[26]. Furthermore, the prognosis for ADL in rehabilitation was reported to be poor for cases with malnutrition[27–30]. In our study, nutritional status at the start of rehabilitation was one of the factors associated with the recovery rate of the FIM score for the dependent group. Therefore, management of nutrition from an early stage is likely to be important for elderly patients who are partially dependent in ADL before onset.

There were a number of limitations to this study. First, it included only patients who had undergone a rehabilitation program, and no adjustment was made for the severity of disease. Thus, there is a possibility of selection bias, because not all patients receive rehabilitation. However, the amount of rehabilitation did not differ between the high group and low group. Therefore, it is our opinion that this limitation had minimal effect on the results in this study. A second limitation of this study was its single-center design, meaning that only a limited number of results were obtained. A multi-center, larger sample size study is needed in order to confirm our results.

In this study days of inactivity and cognitive status for the independent group, and days of inactivity and management of nutritional status for the partially dependent group were found to be important factors for a patient's return to their former level of ADL following hospitalization. These findings are helpful when considering prophylactic approaches to patient ADL recovery and for making more informed decisions regarding hospital discharge.

Table 3. Changes of FIM score at three time points

		Before onset	Starting rehabilitation	Discharge
Participants (n=238)	(points)			
Motor		73.6 ± 18.9	44.8 ± 21.8	63.1 ± 20.8
Cognitive		28.1 ± 7.7	24.7 ± 9.2	26.0 ± 8.7
Total		101.7 ± 25.0	69.3 ± 28.6	88.9 ± 27.5
Independent in ADL before onset (n=130)				
• High group	(points)			
Motor		87.7 ± 3.7	54.3 ± 21.4	84.8 ± 6.0
Cognitive		33.7 ± 2.6	31.7 ± 4.9	33.3 ± 3.0
Total		121.4 ± 4.7	89.0 ± 24.5	117.9 ± 7.3
• Low group	(points)			
Motor		86.6 ± 3.5	52.6 ± 21.0	67.5 ± 16.2
Cognitive		33.1 ± 2.6	27.6 ± 8.4	28.2 ± 7.9
Total		119.7 ± 5.2	80.8 ± 26.5	95.5 ± 21.8
Partially dependent in ADL before onset (n=108)				
• High group	(points)			
Motor		60.6 ± 15.0	37.4 ± 17.8	59.4 ± 14.4
Cognitive		22.9 ± 6.9	20.2 ± 7.9	22.5 ± 7.1
Total		83.5 ± 19.2	57.8 ± 22.3	81.7 ± 18.6
• Low group	(points)			
Motor		55.2 ± 18.5	30.6 ± 15.0	42.1 ± 16.6
Cognitive		21.6 ± 7.6	18.7 ± 8.4	19.7 ± 8.0
Total		76.7 ± 22.2	48.2 ± 21.0	61.7 ± 21.5

Mean ± SD, n (%).
FIM: functional independence measure; ADL: activities of daily living

Table 4-1. Factors associated with the recovery rate of ADL of the independent group

	B	SE	Odds ratio	95% CI
Independent variables				
Days of inactivity*	−0.24	0.10	0.79	0.65–0.95
MMSE*	0.11	0.05	1.12	1.02–1.23
Constant	−2.24	1.21	0.11	

Adjusted variables include age, gender, amount of rehabilitaion, total FIM at start of rehabilitation, grip strength and MNA.
Days of inactivity: length of time between onset and start of rehabilitation; MMSE: mini-mental status examination; MNA: mini nutritional assessment; Independent group: independent in ADL before onset.
*$p<0.05$

Table 4-2. Factors associated with the recovery rate of ADL of the dependent group

	B	SE	Odds ratio	95% CI
Independent variables				
Days of inactivity§	−0.29	0.11	0.75	0.60–0.92
MNA§	0.14	0.05	1.15	1.04–1.27
Constant	−1.22	0.90	0.30	

Adjusted variables include age, gender, amount of rehabilitaion, total FIM at start of rehabilitation, and MMSE.
Days of inactivity: length of time between onset and start of rehabilitation; MNA: mini nutritional assessment; MMSE: mini-mental status examination; Dependent group: partial dependent in ADL before onset
§$p<0.05$

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