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The Validity of FIM as a Predictor of Functional Independence of Stroke Patients: a Comparison between the Early and Late Elderly

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Abstract. [Purpose] This study examined the validity of admission FIM scores as predictors of functional independence, of "early" and "late" elderly patients with stroke in a post-acute rehabilitation unit. [Subjects] After excluding stroke patients with recurrence and complications, the remaining 286 (150 males and 136 females) patients aged 65 to 84 with stays of more than one month . [Methods] According to the level of ADL independence, based on motor and cognitive admission FIM scores, the patients were divided into 3 groups: completely dependent/maximal assistance; moderate/minimal assistance; and supervision/completely independent. Subsequently, time-dependent changes in FIM scores were analyzed to compare the "early" and "late" elderly, score-based groups, and measurements. [Results] Total motor and cognitive FIM scores on and after admission did not overlap among the three ADL independence groups, and showed linear time-dependent changes. Such changes were not observed in individual FIM item, while differences were shown in the period and degree of ADL improvement between the age-based groups. [Conclusion] Motor and cognitive FIM scores were shown to be valid as predictors of functional independence, regardless of age. Scores of individual items were shown to be generally inappropriate as predictors. As the period and degree of ADL improvement varied between the age-based groups, it may be important to continuously provide approaches not only for motor, but also cognitive functions over a long period of time, while considering the age and type of ADL, as well as the individual needs of each patient.
Key words: FIM, Stroke, Prediction

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INTRODUCTION

Although the number of stroke-related deaths has been decreasing year by year, the incidence of stroke is showing a tendency to increase, resulting in a steady increase in the number of patients admitted to the post-acute rehabilitation units. As the social attention has been focused on the importance of post-acute rehabilitation care with it has an enhanced public awareness, and rehabilitation specialists are required to fulfill their duties and demonstrate positive outcomes. Up to the present, several studies have examined the effect of establishing post-acute rehabilitation units. For example, Shiraishi and colleagues compared ADL performance between patients in the post-acute rehabilitation and general units. They reported a significant functional improvement in FIM scores of patients in the post-acute rehabilitation unit[1]. Similarly, Minari and colleagues reported similar improvement one month after admission and on discharge, in addition to an increased rate of returning home after discharge[2]. In both studies, a significant improvement in ADL independence was observed in the post-acute rehabilitation unit. According to a report by the All Japan Post-Acute Rehabilitation Unit Liaison (February 2011), the rate of returning home after discharge from the post-acute rehabilitation unit is 70.5%[3]; however, with the recent increase in the number of stroke patients, it is expected that elderly patients with difficulty in returning home will further increase.

The improvement in ADL independence is a key factor for returning home. In order to determine indicators of the timing of discharge and returning home, it is very important to share the results of ADL evaluations between acute and post-acute care staff through liaison critical pathways, and conduct continuous ADL evaluations in the post-acute

rehabilitation units[4]. The Functional Independence Measure (FIM) is one of the most used indices of ADL evaluation for stroke patients, especially for the evaluation of time-dependent changes in ADL independence, and its reliability and validity have been statistically verified[5].

As the structure of ADLs varies among countries, it has been pointed out that multi-national comparisons are necessary. For example, Chino and colleagues compared ADLs of stroke patients among countries, using the Barthel Index[6], while Tsuji and colleagues performed Rasch analysis, hypothesizing that different lifestyles and customs to be the reason for the difference in the structure of ADLs between the USA and Japan[7]. They also reported that there is a difference in cultural backgrounds and medical service systems between European countries and Japan, and, concluded that, it is significant to conduct multi-national comparisons[8]. In the USA, patients tend to be admitted to the rehabilitation unit in the early stages after the onset of stroke, when their FIM scores are still quite low, in order to receive intensive rehabilitation care aiming for early discharge and high FIM efficiency. In contrast, in Sweden and Japan, intensive rehabilitation care tends to be provided late, as late as around the period of discharge in the USA, and is continued until FIM scores reach sufficient levels for functional independence with lower FIM efficiency. The UK and Australia adopt an approach between these: patients are admitted to the rehabilitation unit later than in the USA, and are discharged earlier than in Sweden or Japan. These differences are, however, partly shaped by the health care systems of each country. For example, in the USA, where medical expenses are covered by private insurance, the FIM efficiency of inpatient rehabilitation care is constantly evaluated, and patients are discharged as soon as possible. Considering that the length of the stay in the rehabilitation unit after the onset until discharge and FIM efficiency varies widely among countries, it is not appropriate to apply the results of multi-national comparisons reflecting social differences to Japanese patients. Therefore, it is important to devise country-specific methods to examine the appropriate use of FIM for ADL evaluations.

Against this background, in Japan, a large number of studies have been conducted examining ADL evaluations using FIM, focusing on the discharge FIM, FIM gain (discharge FIM − admission FIM), and FIM efficiency[9–19]. Toshima[19] reported that it is important to provide rehabilitation care immediately after admission for one and a half months, as the highest care efficiency can be obtained within this period. FIM has been shown to be valid as an index for the evaluation of time-dependent changes in ADL independence in these studies. The recovery of motor skills and improvement in functional independence after stroke are observed within a certain period of time with some degree of variation. From a clinical viewpoint, the recovery levels vary among stroke patients, and not all can achieve independence. In terms of long-term prognosis, based on our clinical experience, recovery levels may be categorized as: practical walking, limited walking, sitting, or bedridden conditions. Therefore, an index which can predict the long-term improvement in ADL independence at a certain point in time may provide physical therapists with a long-term viewpoint in the early stages of rehabilitation. Accordingly, this study examined the use of FIM as a predictor, independent of time course, in addition to its use as a time-dependent evaluation index. We aimed to determine the possibility of typologically predicting the level of functional independence over a long period of time, based on FIM scores at the initiation of rehabilitation. To the best of our knowledge, FIM has mainly been examined as an evaluation index of time-dependent changes in ADLs, and no studies have been conducted examining its use as a predictor.

Age is an indispensable factor for the prediction of ADL independence. Suzuki defined geriatric syndrome as a cause of assistance-dependency, labeling the socially active and young elderly aged 65 to 74 in a favorable health condition as "the early elderly", and those aged 75 or over, whom mental, physical, and living functions steadily decline, as "the late elderly"[20]. The speed of aging in Japan is among the highest in the world. Particularly, the number of the late elderly is continuously increasing, and is expected to reach 17.67 million in 2020[21]. Preceding studies have mostly examined the early elderly[1, 2, 4, 11, 12, 15, 18], and few have focused on time-dependent changes in ADL independence of the late elderly with stroke. Against this background, this study focused on the late elderly with stroke, seeking to predict their prognosis through comparison with the early elderly, using FIM scores as a predictor.

SUBJECTS AND METHODS

Subjects

We excluded those with recurrence and complications from 438 stroke patients admitted and discharged within the period from April 1, 2009 to March 31, 2011, and recruited the remaining 286 (150 males and 136 females) patients aged 65 to 84 with stays of more than one month for this study.

The patients were divided into 3 groups, completely dependent/maximal assistance, moderate/minimal assistance, and supervision/completely independent, based on admission motor and cognitive FIM scores, and those for motor FIM sub-items, as follows: total motor scores: 13–26, 27–52, and 53–91; total cognitive scores: 5–10, 11–20, and 21–35; and scores for motor FIM sub-items: 1–2, 3–4, and 5–7, respectively. They were further divided into 2 age-based groups: the early (aged 65–74); and late elderly (75–84) (Table 1).

Methods

Measurements were performed to evaluate the level of ADL independence 30, 60, 90, and 120 days after admission to the post-acute rehabilitation unit, based on total motor scores (18 items), motor sub-scores, and total cognitive scores (5 items). The FIM evaluation was conducted by 44 experienced physical and occupational therapists. As an intra-class correlation coefficient of 0.7 or higher was obtained for all items in a previous verification of inter-

Table 1. Property

	Early elderly (age 65–74)						
FIM motor based on admission motor FIM scores	A (n=28)	B (n=44)	C (n=67)	A vs B	A vs C	B vs C	
age (years)	70.7 ± 3.3	70.7 ± 2.9	70.5 ± 3.2				†
sex (males/females)	17 / 11	31 / 13	34 / 33				††
crebral hemorrhage/cerebral infarction	16 / 12	21 / 23	30 / 37				††
Paralysis side (right/left)	16 / 12	15 / 29	31 / 36				††
mean length of stay (days)	50.5 ± 14.5	40.4 ± 16.4	36.4 ± 16.3	*	*		†
	Early elderly (age 65–74)						
FIM Cognative based on admission cognitive FIM scores	A (n=17)	B (n=39)	C (n=83)	A vs B	A vs C	B vs C	
age (years)	70 ± 3.6	71 ± 2.9	70 ± 3.0				†
sex (males/females)	11 / 6	22 / 17	47 / 36				††
crebral hemorrhage/cerebral infarction	12 / 5	16 / 23	41 / 42				††
Paralysis side (right/left)	10 / 7	14 / 25	24 / 59				††
mean length of stay (days)	55 ± 15.6	40 ± 14.2	37 ± 16.4	*	*		†
	Late elderly (age 75–84)						
FIM motor based on admission motor FIM scores	A (n=54)	B (n=44)	C (n=49)	A vs B	A vs C	B vs C	
age (years)	79.8 ± 2.5	80.0 ± 2.9	79.3 ± 3.0				†
sex (males/females)	25 / 29	23 / 21	20 / 29				††
crebral hemorrhage/cerebral infarction	25 / 29	16 / 28	19 / 30				††
Paralysis side (right/left)	26 / 28	23 / 21	23 / 26				††
mean length of stay (days)	47.5 ± 15.7	40.6 ± 16.6	34.7 ± 14.3		*		†
	Late elderly (age 75-84)						
FIM Cognative based on admission cognitive FIM scores	A (n=31)	B (n=46)	C (n=70)	A vs B	A vs C	B vs C	
age (years)	80 ± 2.3	80 ± 2.8	80 ± 3				†
sex (males/females)	12 / 19	28 / 18	28 / 42				††
crebral hemorrhage/cerebral infarction	14 / 17	17 / 29	29 / 41				††
Paralysis side (right/left)	14 / 17	27 / 19	28 / 42				††
mean length of stay (days)	49 ± 15.6	39 ± 13.9	39 ± 17.4	*	*		†

* $p<0.05$.
Completely dependent/maximal assistance groups (A), Moderate/minimal assistance groups (B), Supervision/completely indepdentce groups (C).
†：For comparison of means of 3 or more groups, one-way analysis of variance and the Tukey-Kramer test were conducted.
††：In addition, Fisher's exact test was performed to analyze differences in the sex, primary disease, and region of paralysis.

rater reliability, the measurements were considered to be performed under the same condition.

In statistical analysis, for the comparison of means of 3 or more groups, one-way analysis of variance and the Tukey-Kramer test were conducted. In addition, Fisher's exact test was performed to analyze differences in sex, primary disease, and region (side) of paralysis. The unpaired two sample t-test was conducted to examine the difference in the means of the early and late elderly. For analysis, JMP 9 for Mac was used. This study was conducted with the approval of the Ethics Committee for Epidemiological and Clinical Research of Fujita Health University (Approval Number: 09–041).

RESULTS

Subject attributes are shown in Table 1. No differences in sex, primary disease, or region of paralysis were observed between the three motor score-based groups (completely dependent/maximal assistance, moderate/minimal assistance, and supervision/completely independent) of the early or late elderly. No differences were observed in the cognitive score-based groups, either. Regarding post-onset improvement periods based on both total motor and cognitive scores, a difference of 10 to 15 days between the completely dependent/maximal assistance and moderate/minimal assistance groups, and that of 2 to 3 weeks between the completely dependent/maximal assistance and supervision/completely independent groups were observed in

Table 2. FIM Comparison of itemized independence and different times

FIM motor				
based on admission motor FIM scores		Group A	Group B	Group C
	days after admission	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)
Early elderly (age 65-74)	0	17.8 ± 4.2 (24)	39.4 ± 7.9 (42)	69.8 ± 10.2 (59)
	30	23.1 ± 8.5 (23)	47.6 ± 10.8 (42)	74.7 ± 9.4 (57)
	60	26.7 ± 11.6 (22)	52.0 ± 13.7 (37)	74.7 ± 8.4 (37)
	90	31.1 ± 12.5 (15)	54.6 ± 14.3 (27)	74.4 ± 6.9 (24)
	120	36.5 ± 16.8 (6)	53.2 ± 14.7 (11)	77.5 ± 6.4 (6)
In the comparison of total motor scores among the groups, except for between the completely dependent/maximal assistance and moderate/minimal assistance groups of the early elderly 120 days after admission, the 95% confidence intervals between the completely dependent/maximal assistance, moderate/minimal assistance, and supervision/completely independent groups of the early and late elderly did not overlap on any measurement, showing a significant differences among the groups during the period of measurement ($p<0.05$).				
based on admission motor FIM scores		Group A	Group B	Group C
	days after admission	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)
Late elderly (age 75-84)	0	17.1 ± 3.8 (54)	39.7 ± 7.6 (44)	68.0 ± 9.6 (49)
	30	20.1 ± 6.7 (52)	49.7 ± 11.4 (44)	73.8 ± 7.6 (46)
	60	22.7 ± 9.8 (51)	53.0 ± 11.6 (39)	73.2 ± 14.7 (27)
	90	25.6 ± 12.3 (45)	56.5 ± 10.3 (23)	74.7 ± 5.8 (9)
	120	27.0 ± 16.5 (23)	58.8 ± 9.1 (10)	
In the comparison of total motor scores of each group, total motor scores significantly improved 30 days after admission, compared to those on significant improvements were admission, in the moderate/minimal assistance and supervision/completely independent groups of the early elderly. Such an improvement was also observed on comparison between on and 60 days after admission, and 30 and 120 days after admission in the completely dependent/maximal assistance group of the early elderly ($p<0.05$). Similarly, in the late elderly, total motor scores of the moderate/minimal assistance and significant improvements were supervision/completely independent groups significantly improved 30 days after admission, compared to those on admission. Such an improvement was also observed on comparison between on and 60 days after admission, and 30 and 90 days after admission in the completely dependent/maximal assistance group ($p<0.05$).				
FIM Cognative				
based on admission cognitive FIM scores		Group A	Group B	Group C
	days after admission	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)
Early elderly (age 65-74)	0	7.6 ± 2.0 (16)	16.1 ± 2.4 (34)	29.2 ± 4.5 (75)
	30	8.5 ± 2.3 (15)	17.1 ± 3.1 (34)	29.7 ± 4.5 (73)
	60	9.4 ± 2.1 (14)	18.1 ± 3.9 (29)	29.4 ± 4.6 (53)
	90	10.5 ± 2.4 (8)	18.8 ± 5.1 (21)	28.9 ± 4.5 (37)
	120	8.7 ± 3.2 (3)	18.0 ± 4.7 (11)	31.0 ± 3.4 (9)
In the comparison of total cognitive scores among the groups, the 95% confidence intervals between the completely dependent/maximal assistance, moderate/minimal assistance, and supervision/completely independent groups did not overlap on any measurement, showing a significant differences among the groups during the period of measurement ($p<0.05$).				
based on admission cognitive FIM scores		Group A	Group B	Group C
	days after admission	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)	Average FIM Score ± SD (n)
Late elderly (age 75-84)	0	7.5 ± 1.5 (31)	14.8 ± 3.2 (46)	27.3 ± 3.8 (70)
	30	8.6 ± 2.8 (28)	16.5 ± 4.8 (46)	27.9 ± 3.8 (68)
	60	9.2 ± 4.2 (26)	17.5 ± 5.4 (42)	27.7 ± 3.8 (48)
	90	9.9 ± 4.9 (24)	18.6 ± 5.6 (28)	28.0 ± 3.5 (25)
	120	11.1 ± 7.2 (14)	17.7 ± 6.2 (10)	28.3 ± 3.9 (9)
In the comparison of total cognitive scores of each group, total cognitive scores significantly improved 90 after admission, significant improvements were compared to those on admission, in the completely dependent/maximal assistance group of the early elderly. In the late elderly, such an improvement was observed on comparison between on and 120 days after admission in the completely dependent/maximal assistance group, and on and 90 days after admission in the moderate/minimal assistance group ($p<0.05$). Completely dependent/maximal assistance groups (A), Moderate/minimal assistance groups (B), Supervision/completely independentce groups (C).				

the early elderly. The difference between the completely dependent/maximal assistance and supervision/completely independent groups of the late elderly was less than 2 weeks.

In the comparison of total motor scores among the groups, except for between the completely dependent/maximal assistance and moderate/minimal assistance groups of the early elderly 120 days after admission, the 95% confidence intervals between the completely dependent/maximal assistance, moderate/minimal assistance, and supervision/completely independent groups of the early and late elderly did not overlap for any measurement, and significant differences were found among the groups during the period of measurement ($p<0.05$). In the comparison of total cognitive scores among the groups, the 95% confidence intervals between the completely dependent/maximal assistance, moderate/minimal assistance, and supervision/completely independent groups did not overlap for any measurement, and significant differences were found among the groups during the period of measurement ($p<0.05$). In the comparison of total motor scores of each group, total motor scores significantly improved 30 days after admission, compared to those on admission, in the moderate/minimal assistance and supervision/completely independent groups of the early elderly. Significant improvements were also observed in the comparison between on and 60 days after admission, and 30 and 120 days after admission in the completely dependent/maximal assistance group of the early elderly ($p<0.05$). Similarly, in the late elderly, total motor scores of the moderate/minimal assistance and supervision/completely independent groups had significantly improved 30 days after admission, compared to those on admission. Significant improvements were also observed in the comparison between on and 60 days after admission, and 30 and 90 days after admission in the completely dependent/maximal assistance group ($p<0.05$). In the comparison of total cognitive scores of each group, total cognitive scores had significantly improved 90 days after admission, compared to those on admission, in the completely dependent/maximal assistance group of the early elderly. In the late elderly, significant improvements were observed in the comparison between on and 120 days after admission in the completely dependent/maximal assistance group, and on and 90 days after admission in the moderate/minimal assistance group ($p<0.05$). In the comparison of motor scores between the early and late elderly, a significant difference was observed 120 days after admission for the completely dependent/maximal assistance group based on motor items ($p<0.05$) (Table 2).

In the comparison among the groups, significant differences in bladder management were observed among the groups of the early elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 90 and 120 days after admission ($p<0.05$). Significant differences were also observed among the groups of the late elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 days after admission ($p<0.05$). Regarding bowel management, significant differences were observed among the groups of the early elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 days after admission ($p<0.05$). Significant differences were also observed among the groups of the late elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 60 days after admission, between the moderate/minimal assistance and completely dependent/maximal assistance groups 90 days after admission, and between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 days after admission ($p<0.05$).

In transfers (bed/toilet), significant differences in bed transfer were observed among the groups of the early elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 days after admission ($p<0.05$). Significant differences were also observed among the groups of the late elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 days after admission ($p<0.05$). Regarding toilet transfer, significant differences were observed among the groups of the early elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 120 days after admission ($p<0.05$). Significant differences were also observed among the groups of the late elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 90 and 120 days after admission ($p<0.05$).

For the early elderly, significant differences in toileting were observed among the groups for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 90 days after admission, and between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 days after admission ($p<0.05$). For the late elderly, significant differences were observed among the groups for all measurements ($p<0.05$).

In dressing (upper/lower body), for the early elderly, significant differences in upper-body dressing were observed among the groups for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 90 and 120 days after admission ($p<0.05$). Significant differences were also observed among the groups of the late elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 120 days after admission ($p<0.05$). Regarding lower-body dressing, significant differences were observed among the groups of the early elderly for all measurements, except for between the

moderate/minimal assistance and supervision/completely independent groups 60, 90, and 120 days after admission ($p<0.05$). For the late elderly, significant differences among the groups were observed for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 90 days after admission, and between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 after admission ($p<0.05$).

Significant differences in walking were observed among the groups of the early elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 60 days after admission, and between the moderate/minimal assistance and supervision/completely independent, and moderate/minimal assistance and completely dependent/maximal assistance groups 120 after admission ($p<0.05$). Significant differences were also observed among the groups of the late elderly for all measurements, except for between the moderate/minimal assistance and supervision/completely independent groups 60 and 90 days after admission ($p<0.05$).

Regarding time-dependent changes in each group, of the early elderly, a significant improvement in bladder management was observed between on and 60 days after admission, and between 30 and 90 days after admission in the moderate/minimal assistance group, and between on and 30 days after admission in the completely dependent/maximal assistance group ($p<0.05$), while no improvement was observed in the supervision/completely independent group. For the late elderly, a significant improvement was solely observed between on and 60 days after admission in the completely dependent/maximal assistance group ($p<0.05$). Regarding bowel management, a significant improvement was observed between on and 90 days after admission in the moderate/minimal assistance group, and between on and 30 days after admission in the completely dependent/maximal assistance group ($p<0.05$), while no improvement was observed in the supervision/completely independent group of the early elderly. For the late elderly, a significant improvement was solely observed between on and 30 days after admission in the completely dependent/maximal assistance group ($p<0.05$).

In transfers (bed/toilet), a significant improvement in bed transfer was observed between on and 60 days after admission, and 30 and 90 days after admission in the moderate/minimal assistance group, and between on and 30 days after admission in the completely dependent/maximal assistance group of the early elderly. For the late elderly, significant improvements were observed between on and 30 days after admission in the completely dependent/maximal assistance and moderate/minimal assistance groups ($p<0.05$). Regarding toilet transfer, significant improvements were observed between on and 30 days after admission, 30 and 60 days after admission, and 30 and 90 days after admission in the moderate/minimal assistance group, and between on and 60 days after admission in the completely dependent/maximal assistance group of the early elderly. For the late elderly, significant improvements were solely observed between on and 30 days after admission in the completely dependent/maximal assistance and moderate/minimal assistance groups ($p<0.05$).

Significant improvements in toileting were observed between on and 30 days after admission in the moderate/minimal assistance group, and between on and 60 days after admission, and 30 and 90 days after admission in the completely dependent/maximal assistance group of the early elderly. For the late elderly, significant improvements were observed between on and 30 days after admission in both the completely dependent/maximal assistance and moderate/minimal assistance groups ($p<0.05$).

Regarding dressing (upper/lower body), significant improvements in upper-body dressing were observed between on and 30 days after admission, and 30 and 60 days after admission in the moderate/minimal assistance group, and between on and 60 days after admission, and 30 and 120 days after admission in the completely dependent/maximal assistance group of the early elderly. For the late elderly, significant improvements were observed between on and 30 days after admission in the supervision/completely independent group, and between on and 60 days after admission in the moderate/minimal assistance and completely dependent/maximal assistance groups. Regarding lower-body dressing, significant improvements were observed between on and 30 days after admission, and 30 and 60 days after admission in the moderate/minimal assistance group, and between on and 60 days after admission, and 30 and 90 days after admission in the completely dependent/maximal assistance group of the early elderly. For the late elderly, significant improvements were observed between on and 30 days after admission in the supervision/completely independent and moderate/minimal assistance groups, and between on and 60 days after admission in the completely dependent/maximal assistance group.

Significant improvements in walking were observed between on and 60 days after admission in the moderate/minimal assistance group, and between on and 30 days after admission in the completely dependent/maximal assistance group of the early elderly. For the late elderly, significant improvements were observed between on and 30 days after admission in the moderate/minimal assistance and completely dependent/maximal assistance groups ($p<0.05$).

DISCUSSION

We divided stroke patients admitted to a post-acute rehabilitation unit into the early and late elderly, and analyzed time-dependent changes in ADL independence. Among the three groups, categorized according to admission total motor and cognitive FIM scores (completely dependent/maximal assistance, moderate/minimal assistance, and supervision/completely independent), no differences in the sex, primary disease, or region of paralysis were observed. Therefore, the groups were similar in these baseline attributes. On the other hand, a difference was observed in the length of time from the onset to the initiation of rehabilitation after admission to the post-acute rehabilitation unit from acute care hospitals: approximately 50 days in the completely dependent/

maximal assistance group, 40 days in the moderate/minimal assistance group, and 30 days in the supervision/completely independent group of both the early and late elderly. This may be explained as a result of lower levels of independence on admission due to severer cerebral impairment requiring a longer period of time for recovery. Although this difference conflicts with the uniform baseline of subject attributes in the groups, it should be regarded as a result of the current medical environment, and the following discussion takes this into consideration.

Rosenbaum and colleagues[22] and Hanna and colleagues[23] performed analyses of a large amount of time-dependently accumulated data of children with cerebral palsy, adopting the Gross Motor Function Measure 66 (GMFM-66) for the evaluation of their motor functions. They showed, the Gross Motor Function Classification System (GMFCS), a 5-level scale for the classification of the severity of cerebral palsy, is stable over the course of time, demonstrating its validity as a predictor. This finding was significant in terms of the prediction of motor functions of patients with cerebral palsy within a certain range. In addition, the accuracy of the GMFCS verified in the early stages was expected to facilitate the effective and appropriate achievement of abilities over a long period of medical treatment with a long-term vision. As there is no such predictor for stroke, this study aimed to establish a similar predictor for stroke patients, whose number is greater than that of patients with cerebral palsy. Accordingly the results are discussed from this point of view.

In the comparison of total motor and cognitive scores among the groups, the time-dependent changes in total motor and cognitive FIM scores up to 120 days after admission showed a linear progression, rarely overlapping with each other in all the groups for both the early and late elderly. The three groups were stratified in order of FIM scores, with the completely dependent/maximal assistance group in the lowest layer, and the moderate/minimal assistance and supervision/completely independent groups in the higher layers. The point here is that the linear changes in the level of independence based on FIM scores and their distribution were similar to those of the GMFCS shown in the analysis using the GMFM-66 for patients with cerebral palsy. The difference between them is the time frame of measurement. Measurements were performed up to 120 days after admission in this study, while the GMFCS is conducted over a period of more than 10 years. The time frame for changes in cerebral palsy as a developmental impairment is longer than that for stroke, as an age-related disease, in which fundamental changes in motor functions are considered to occur within 3 months after the onset. Therefore, the measurement period of the study, longer than 4 months may be considered to have covered the time frame for fundamental motor changes, although it was still shorter than that for changes in cerebral palsy. The linear progression of the time-dependent changes also illustrates a ceiling effect. In line with this, total motor and cognitive FIM scores may be valid as predictors, independent of age, conditional on the difference in the length of time from stroke onset: 30 days or longer for the supervision/completely independent group, 40 days or longer for the supervision/completely independent and moderate/minimal assistance groups, and 50 days or longer for the supervision/completely independent, moderate/minimal assistance, and completely dependent/maximal assistance groups. Namely, the results of our study suggest that total motor and cognitive FIM scores measured 50 days after the onset may be valid for the long-term prediction of the level of independence. Based on this idea, the level of independence may be predicted based on stroke severity: supervision/completely independent, mild; moderate/minimal assistance, moderate; and completely dependent/maximal assistance, severe. On the other hand, a similar analysis of motor sub-items showed the majority of linear changes in individual items tended to overlap in all groups, suggesting the inappropriateness of sub-items as predictors. This may be explained by the structure of FIM which consists of items related to gross motor functions and upper-body movements. However, the findings obtained through analysis of time-dependent changes in the sub-items are clinically significant as discussed below.

A large number of preceding studies[24–26] have examined the prediction of functional outcomes on discharge based on admission data, as rehabilitation periods and goals are set in consideration of functions, ADL independence, and discharge destination. A prediction of outcomes is regarded as highly valid for effectively and appropriately providing rehabilitation care from the viewpoints of time, space, and manpower, and total (or total motor) scores of FIM or the Barthel Index[27] are generally used for this purpose. In this study, total FIM scores were used to determine severity and independence levels as a comprehensive approach to the quality of life by examining the overall ADL grade. At the same time, although the previously mentioned prediction of independence levels reflects changes in ADL sub-items, it is not necessarily consistent with changes in each ADL item, and, consequently, it should be regarded as limited and inappropriate as a direct index for the development of actual ADL training programs. In this study, the time-dependent changes in FIM sub-items, in addition to the overall ADL grade, were compared among the independence level groups to predict the period of changes in ADL independence and ceiling effect, in order to enhance the reliability of clinical pathways for ADL training approaches. Further, the average life expectancy is increasing year after year in Japan, and the elderly aged 65 or over accounted for 23.1% of the population in 2011. This percentage is expected to reach 40.5% in 2055, and 26.5% of the population (1 in 4 people) will be late elderly[28]. Along with an increase in the number of late elderly patients with stroke, the need for rehabilitation care is likely to further increase in the future. Particularly among females, who have a longer life expectancy, prolonged assistance dependency—in other words, a marked decline in living functions—is expected. Taking this forecast into consideration, the changes in ADL independence were analyzed based on age, and the results are discussed below.

First, as a premise, the changes in total FIM scores were compared between the age-based groups. Early improvements in motor items were observed in the moderate/

minimal assistance and late completely dependent/maximal assistance groups of the early and elderly 30 days after admission. In the completely dependent/maximal assistance group, a significant improvement was observed 2 to 3 months after admission, not in the early stages. As total motor scores improved in the moderate/minimal assistance and completely dependent/maximal assistance groups of both the early and late elderly, it may be concluded that the period of improvement was longer for those with a lower level of ADL independence. In addition, for the early elderly, there were no significant differences in the degree of improvement between the moderate/minimal assistance and completely dependent/maximal assistance groups 120 days after admission. This suggests that independence levels may improve over a long period of time in those at a younger age, even when they have a lower level of independence on admission. Therefore, it is important to continuously provide rehabilitation approaches. Total cognitive score showed a tendency to improve in the moderate/minimal assistance group, regardless of age, although it required a long time span. A similar tendency was also observed in the completely dependent/maximal assistance group of the late elderly. After discharge from the post-acute rehabilitation unit, the majority of elderly patients use social resources, such as services provided by Long-term Care Insurance; however, home-visit rehabilitation services tend to be focused on the achievement of basic daily movements[29, 30], and very few studies have reported outcomes of approaches for cognitive functions. Nishio and colleagues[31] conducted a study examining severe stroke patients with total FIM scores of 36 or less on admission to the post-acute rehabilitation unit, and defined the level of cognitive functions on admission as a determinant of discharge destination. Based on these findings and the results of the present study, and considering the age-related use of services provided by Long-term Care Insurance, it may be concluded that cognitive functions of the late elderly can be improved by actively providing approaches for them.

In the analysis of motor FIM sub-items, no significant differences were observed between the moderate/minimal assistance and supervision/completely independent groups of both the early and late elderly 120 days after admission in terms of improvement of most items. This suggests that the level of ADL independence of the elderly slowly improves not in the early stages, but over a long period of time, and particularly the elderly requiring moderate or minimal assistance may deteriorate to reach levels requiring supervision. In the comparison of the early and late elderly, the degree of ADL improvement was higher in the former; and this tendency was marked in the toilet-related activities, including sphincter control, toileting, and dressing. The walking level of the moderate/minimal assistance group 2 months after admission was similar to that of the supervision/completely independent group in both the early and late elderly groups. This result overthrows the conventional ideas of the elderly, which emphasizes their difficulties in regaining the walking ability. While walking is one of the most important needs of the patients and their families, the results of this study suggest the necessity of actively providing walking training approaches in clinical settings. Further, cognitive functions of both the early and late elderly patients, nevertheless did improve. This representing low levels of sociability and problem-solving ability, tended to improve slowly, but apparently; this result, in addition to the finding of Yokoi and colleagues[32], who reported that a significant decline in ADL independence as a result of increased difficulties in performing each activity with the development of cognitive impairment, suggests the importance of providing approaches promoting cognitive functions, such as social problem-solving abilities and sociability, especially after discharge to home.

In this study, time-dependent changes in ADL independence were compared between the early and late elderly. As a result, levels of ADL independence were shown to improve over a long period of time in both groups, suggesting the importance of continuously providing approaches not only for motor, but also for cognitive functions after discharge from a post-acute rehabilitation unit. While the abilities to perform toilet-related activities and walking are the most common needs in clinical settings, the results of the present study demonstrated their improvement, as well as a slow improvement in cognitive functions. The results also suggested that, when providing continuous ADL-training approaches, it is important to appropriately show patients procedures and key points for performing activities.

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