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Original Article

Relationship between Functional Independence Measure (FIM) score on admission and influence of inhibitive factors in a comprehensive inpatient stroke rehabilitation ward

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ABSTRACT
Okamoto S, Sonoda S, Watanabe M, Okazaki H, Yagihashi K, Okuyama Y. Relationship between Functional Independence Measure (FIM) score on admission and influence of inhibitive factors in a comprehensive inpatient stroke rehabilitation ward. Jpn J Compr Rehabil Sci 2018; 9: 59−65.
Objective: Investigate how the influence of inhibitive factors was changed by the status of activities of daily living (ADL).
Methods: Subjects were 2,650 stroke hemiplegic patients admitted to our comprehensive inpatient rehabilitation wards. Decision tree analysis was performed in which motor subscore of the Functional Independence Measure (FIM-M) at discharge was set as the target variable. Distribution of the verticality item of the Stroke Impairment Assessment Set, age, and the cognitive subscore of the FIM were calculated for every score of the FIM-M on admission. The FIM-M gain was compared by stratifying trunk function, age, and FIM cognitive subscore with certain ranges of the FIM-M on admission.
Results: The FIM-M at discharge and the FIM-M gain were significantly low (p<0.05) in patients with decreased trunk function and low ADL score on admission. Both were significantly low (p<0.05) in patients with relatively wide-ranged ADL scores in elderly patients whose age was 68 years or older, and also significantly low (p<0.05) in low cognitive function patients who needed moderate or severe assistance.
Conclusion: These results demonstrated that the influence of inhibitive factors is not uniform but instead differs according to degree of ADL level on admission.
Key words: cerebrovascular disorders, rehabilitation, ADL, outcome prediction, inhibitive factors

Introduction

Outcome prediction of the activities of daily living (ADL) is an important issue in stroke rehabilitation, and how to treat inhibitive factors influences the preciseness of the prediction [1, 2]. Age, cognitive disturbance, hemispatial neglect, ADL status before onset of diseases, and period from onset to admission are factors related to the outcome [3] that have been validated by their correlation with the outcome [1] or by embedding them as independent variables in multiple regression analysis [4, 5]. Such analyses premised that various inhibitive factors uniformly influenced all patients. However, to determine if the influence is truly uniform, we investigated whether the effects of inhibitive factors change depending on the level of ADL at admission.

Methods

We have utilized the Full-time Integrated Treatment (FIT) program since 2000 [6], which provides 7 days per week exercise in a ward with a training gym. This program enables systematic and adequate amounts of exercise and provides homogeneous rehabilitation. Impairments and disabilities are evaluated upon admission and at discharge and results are accumulated in a database.

We selected 5,191 stroke patients who had been admitted to and discharged from our comprehensive inpatient rehabilitation wards from September 2004 to March 2017. Patients who had bilateral hemiplegia, no hemiplegia, or recurrence of stroke, sudden deterioration, and lower score on the Functional Independence Measure (FIM, version 3.1) [7] at discharge compared with the score on admission were

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excluded, and the remaining 2,650 patients were retrospectively analyzed.

1. Decision tree analysis

Decision tree analysis was performed using FIM motor subscore (FIM-M) as the target variable and including age, period from onset to admission, diagnosis of stroke (cerebral infarction, cerebral hemorrhage, and subarachnoid hemorrhage), items of the Stroke Impairment Assessment Set (SIAS) [8], total motor score of the SIAS, and 18 items of the FIM, FIM-M, and FIM cognitive subscore (FIM-C) as explanation variables. The Partition software in JMP 12.2 (SAS institute®) was employed and bifurcation was stopped just before the number in the group became less than 10 patients. Inhibitive factors that might influence the FIM improvement were assessed according to the score area of FIM-M on admission.

2. Relationship between FIM-M on admission, verticality item of the SIAS, age, and FIM-C

Build-up bar charts of the verticality item of the SIAS, FIM-C, and age were produced for every score of the FIM-M on admission. Age was stratified as 12 to 52 years, 13 to 67 years, and 68 to 91 years, and FIM-C on admission was categorized into scores of 5 to 27 and 28 to 35 according to results of the decision tree analyses.

3. Effects of trunk function, age, and cognitive function

Median values of FIM-M at discharge were calculated for every score of the FIM-M on admission for each age group and for each FIM-C group, and differences among strata were considered using charts. When the number of patients was less than 3, median values were not calculated and were considered missing values.

After arranging the values of FIM-M on admission according to results of the decision analysis and categorizing the verticality item of the SIAS into groups of 0 to 1 and 2 to 3, FIM-M gain was compared among groups using the Wilcoxon signed rank test. Age range was set as 12 to 52 years, 53 to 67 years, and 68 to 91 years, and the Steel-Dwass test was performed. For cognitive function, FIM-C groups were categorized as 5 to 27 and 28 to 35, and the FIM-M gain in both groups was compared using the Wilcoxon signed rank test.

Results

1. Decision tree analysis

The decision tree that predicts FIM-M at discharge is shown in Figure 1. At first, FIM-M at discharge was bifurcated by FIM-M on admission, after which FIM-M on admission frequently appeared as the branch variable. The verticality item of the SIAS was the first branch in patients with a FIM-M on admission score of less than 19. The next branch variable in patients with lower scores on the verticality item of the SIAS was age. Age became the branch variable in patients with a FIM-M on admission values of 31 to 54. The next branch variable in patients aged 68 years or more was FIM-C.

2. Relationship between FIM-M on admission, verticality item of the SIAS, age, and FIM-C

The build-up bar charts of the verticality item of the SIAS, age, and FIM-C for every score of the FIM-M on admission are shown in Figures 2a, 2b, and 2c. In Figure 2a, the higher the FIM-M on admission, the larger the ratio of a score of 3 in the verticality item of the SIAS. There were few patients with a verticality score from 0 to 2 among the patients with FIM-M on admission of 54 or more. In Figure 2b, there tended to

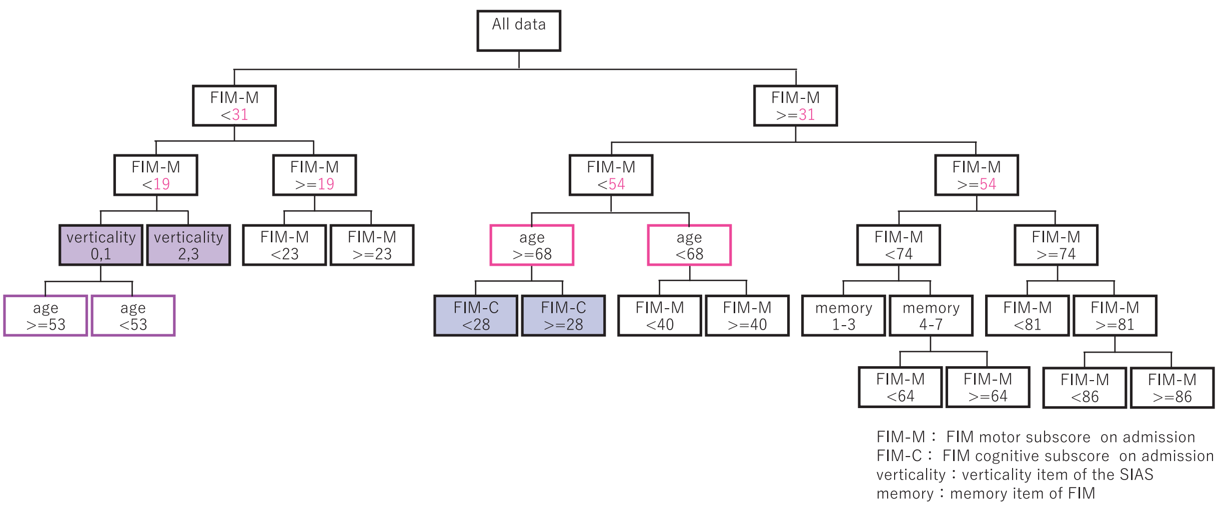

Figure 1. Decision tree that predicts FIM-M at discharge.

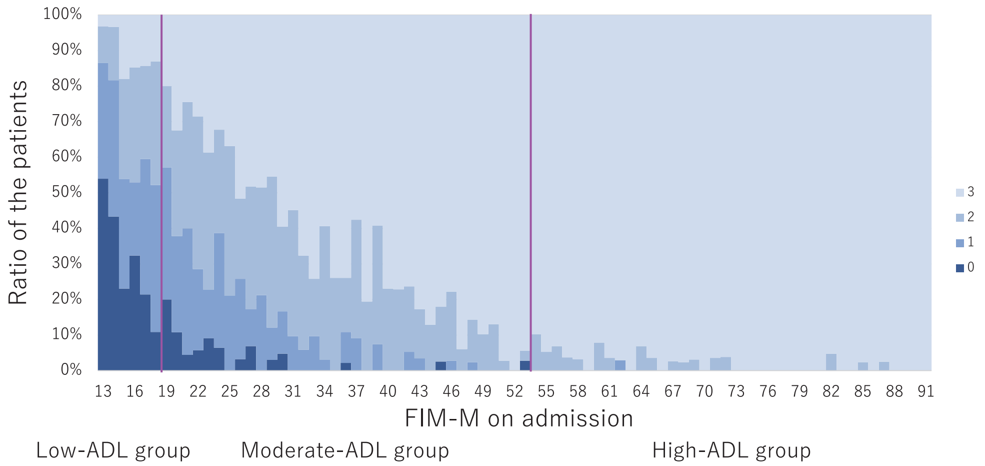

Figure 2a. Build-up bar charts of the verticality item of the SIAS for every score of the FIM-M on admission.

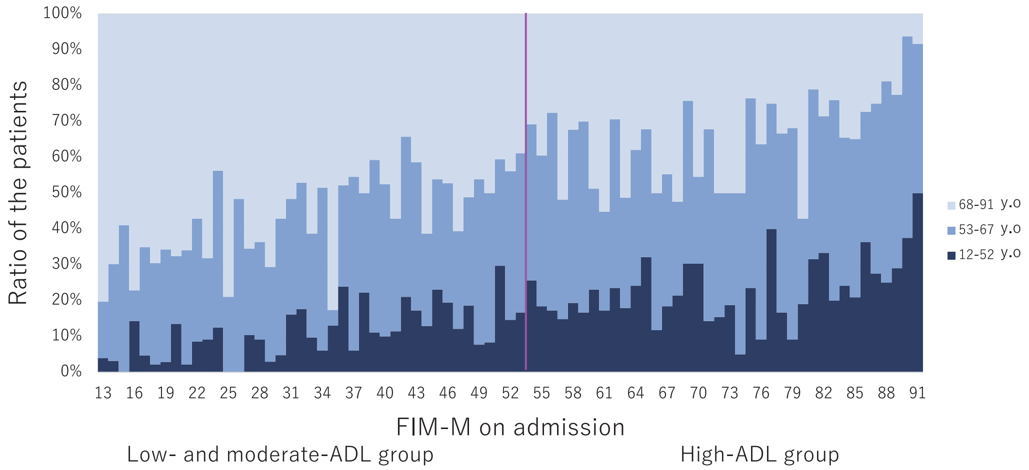

Figure 2b. Build-up bar charts of the age for every score of the FIM-M on admission.

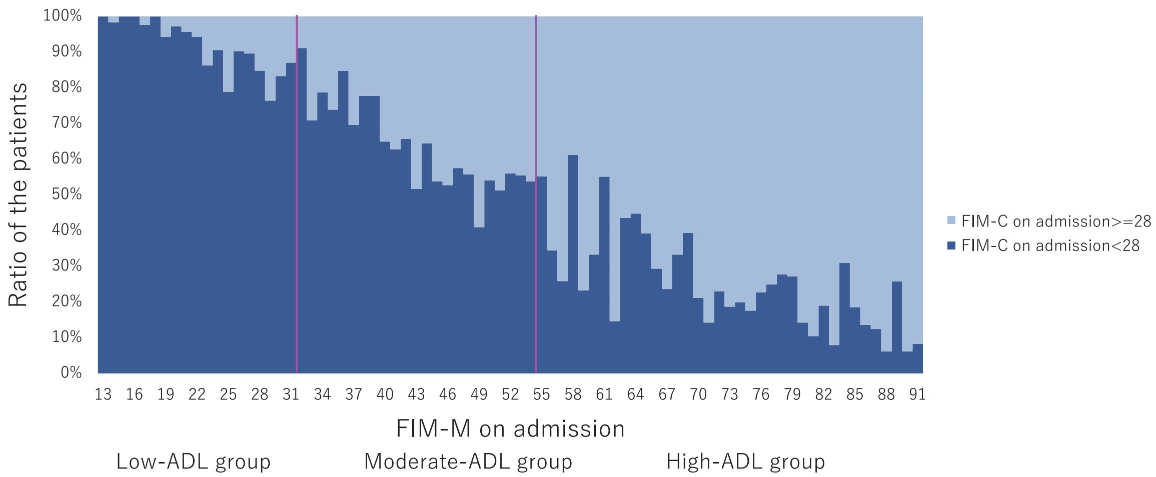

Figure 2c. Build-up bar charts of the FIM-C for every score of the FIM-M on admission.

be a small number of younger patients and a large number of elderly patients in cases of a low FIM-M on admission, and there tended to be less elderly in cases of a higher FIM-M on admission. Similar to the trend seen with age, the higher the FIM-M on admission, the larger the ratio of higher FIM-C patients.

3. Effects of trunk function, age, and cognitive function

A chart of FIM-M at discharge stratified by age for every score of the FIM-M on admission is shown in Figure 3a. Similarly, a chart stratified by FIM-C is illustrated in Figure 3b. In general, the younger the age, the higher FIM-M at discharge tended to be. The difference was large in patients with FIM-M on admission of less than 54, and this was a branch condition in the decision tree analysis. The FIM-M at discharge was high if FIM-C was high, and the group difference of FIM-M at discharge was large in patients if their FIM-M was less than 54 in the decision analysis.

The table shows a comparison of median values of FIM-M gain at discharge in each range of the FIM-M on admission. There was a significant difference (p<0.05) in the FIM-M gain between two groups of trunk function in patients with FIM-M on admission of less than 19. The FIM-M gain was significantly larger (p<0.05) in the age group of 68 to 91 years than it was in the other age groups in patients with FIM-M on admission of less than 74. The FIM-M gain in the group with FIM-C of 28 or more was significantly larger (p<0.05) if the patients were 68 years of age or older and the FIM-M on admission was between 31 and 53.

Discussion

Several researchers have examined the inhibitive factors related to stroke rehabilitation outcome. Kwakkel et al. reported that reliable predictors of functional recovery were age, history of stroke, urinary

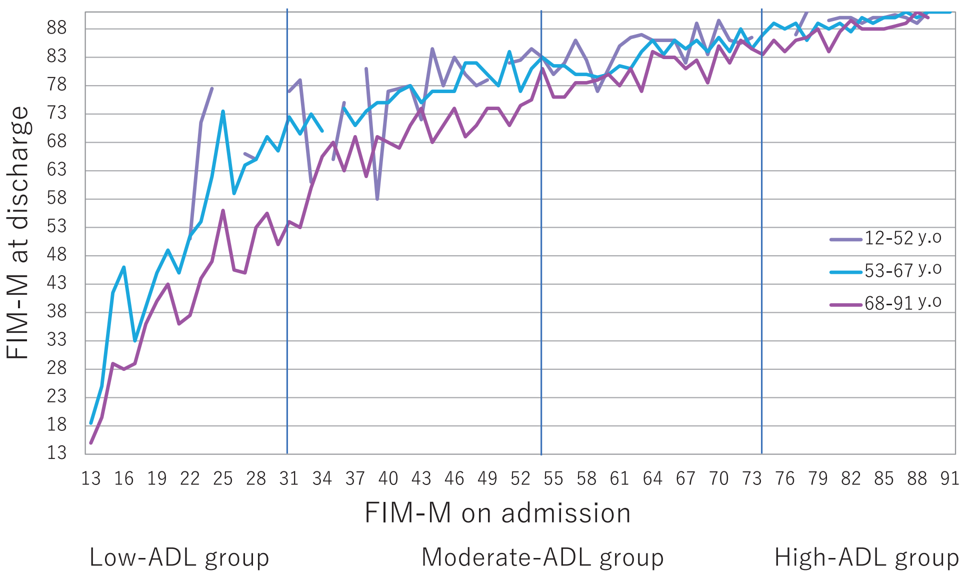

Figure 3a. FIM-M at discharge stratified by age for every score of the FIM-M on admission.

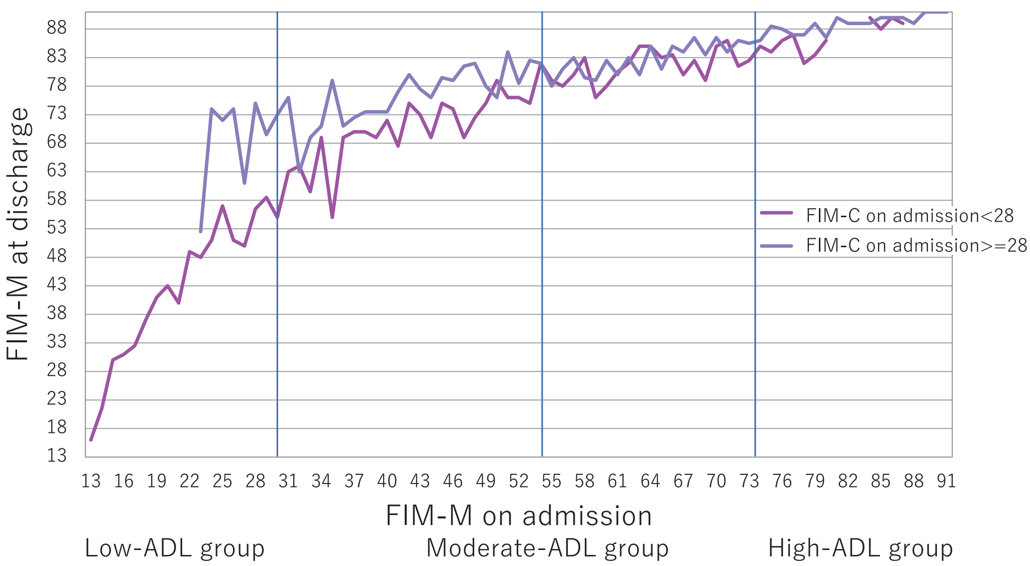

Figure 3b. FIM-M at discharge stratified by FIM-C for every score of the FIM-M on admission.

Table. Comparison of median values of FIM-M gain in each range of the FIM-M on admission.

		FIM-M on admission 13–18		
		25 percentile	median	75 percentile
Verticality item of SIAS	0–1	1	5 ┐*	17
	2–3	8.5	22 ┘	37

*$p<0.05$

For the groups of verticality item of the SIAS and the groups of FIM-C, the Wilcoxon signed rank test was used.

The Steel-Dwass test was employed for the age group.

For FIM-C, the patients over 68 years old were compared.

		FIM-M on admission 13–30			FIM-M on admission 31–53			FIM-M on admission 54–73		
		25 percentile	median	75 percentile	25 percentile	median	75 percentile	25 percentile	median	75 percentile
Age	12–52	30.5	39 ┐*	53.5	30	35 ┐	41	16	21 ┐	26
	53–67	14	28 ┤* *	41	27	34 ┐* *	38	16	19.5 ┐* *	24
	68–91	4	14 ┘	28	17	26 ┘	33	12	16 ┘	21
FIM-C	5–27				15	22 ┐*	31			
	28–35				25.25	31 ┘	35			

incontinence, consciousness disturbance at onset, disorientation, severity of paralysis, sitting balance, ADL on admission, and social resources [2]. Tei et al. proposed a predictive equation of FIM at discharge using regression analysis and concluded that the younger the age, the higher the FIM-M on admission, the higher the FIM-C on admission, the shorter the period from onset to admission, the lower the Modified Rankin Scale before onset, the higher the Glasgow Coma Scale, the fewer the complications, and the higher the FIM at discharge [9]. There are few other reports that considered the degree or difference of influence of various inhibitive factors. Our results clarified that the influence of inhibitive factors is not uniform across all patients but instead differs according to degree of ADL on admission.

Decision tree analysis conducted in this study is commonly used as a data mining tool [10, 11] and exhaustively seeks the variable and cut-off point that result in the largest difference between two groups. Since a branch chart is drawn in the stronger order of influence, decision tree analysis has several beneficial points that are easy to understand intuitively, easy to support logically, and can be treated as a nominal scale or an interval scale. Conversely, shortcomings of decision tree analysis are that it discards much information by dichotomization, overlearning might occur unless there is adjustment of the number of bifurcations, and it lacks versatility. In this study, ranges of the FIM-M were first categorized, after which inhibitive factors appeared downstream. Therefore, the best process to use for predicting clinical outcome became clear.

The verticality item of the SIAS, i.e., the trunk function, influenced outcome in low ADL patients with FIM-M on admission of less than 19. This is thought to be because one of the predictive factors for ADL improvement is whether sitting is or is not possible in severely disabled people [2, 12]. Franchignoni et al. reported better predictive results of FIM-M at discharge by the trunk control test on admission than by FIM-M on admission alone [13]. Saudin et al. described that functional outcome differed according to sitting balance on admission, and the improved group reached a higher score on the Barthel index [14]. Trunk function on admission strongly influenced FIM at discharge and changes in FIM in a study by Monaco et al. [15]. Since almost all patients with FIM-M on admission of 54 or more had a score of 3 (perfect score) in the verticality item of the SIAS, as can be seen in Figure 2a, trunk function is an inhibitive factor specific to low-ADL patients. As depicted in Figures 2b and 2c, there were many elderly (68 years of age or older) patients and patients with low cognitive function (FIM-C were less than 28) among the low-ADL patients. A cause of increased influence of trunk function in the elderly and deteriorated cognitive function might be decreased trunk ability before onset of stroke in the elderly [16, 17]. Since stroke hemiplegics often have disturbance of motor imagery, new motor learning becomes important in the control of standing and posture. Difficulty in learning in patients with deteriorated cognition would be one of the suspected causes [18, 19].

There are many articles about the influence of age on stroke functional outcome. In the Copenhagen Stroke Study [20], age did not influence improvement of neurological findings, however, it did influence the Barthel index or ADL status on admission and at discharge. Bagg et al. reported that age solely became the predictive factor of the FIM and the FIM-M at discharge, however, it did not become a predictive factor of FIM gain [21]. Stroke patients with age of more than 65 years had lower FIM scores on admission and at discharge, and the independent ratio was also low in a study by Bindawas et al. [22]. In contrast, Park et al. reported that FIM improved regardless of age, side, or localization of lesion [23]. Kugler stated that younger patients tended to be improved in the Barthel index, however, age was a weak factor for outcome prediction, and ability at onset was more influential [24]. One cause of the wide variability of these reports is thought to be the characteristics of the patient groups investigated. In this study, influence of age was evident in patients with FIM-M on admission of less than 54, which meant patients needing severe to moderate assistance. In these patients, inactivity and decreased fitness before onset due to aging, and the difference in improvement possibility for muscle strength or learning ability, would have an effect on outcome. This result resembles the Niki study [25], in which high correlation between age and independent gait was found and patients who needed total assistance had been prominently influenced by age.

There are several studies about cognitive function and outcome of rehabilitation, and many have reported that cognitive function influenced functional outcome. Heruti et al. demonstrated that cognitive function of stroke patients aged 60 years or more was deteriorated and lowered functional outcome [26]. Zinn et al. reported that cognitive function had an influence on instrumental ADL improvement but not on ADL improvement [27]. Özdmir et al. denoted strong correlation between MMSE on admission and improvement of FIM-M at discharge [28]. In our study, effect of cognitive function was seen in patients with FIM-M on admission of less than 54, and the significantly influenced range of FIM-M in group comparisons was 31 or more and less than 54. A likely reason that there was no significant influence of cognitive function in the low-ADL group (FIM-M was 31 or less) was that there were few patients who had good cognitive function (FIM-C was 28 or more) in this group. Furthermore, since simple and well-known movement exercise was frequently employed by low-ADL patients, any influence of cognitive function would become small. On the other hand, in patients needing moderate assistance, examples of content learning were compensation actions in dressing or actions with ingenious process, and these would be considered rather complex motor learning. In such situations, the influence of cognitive function would be greater.

There are some limitations to this study. Decision tree analysis has a risk of lacking versatility due to overlearning, as described above. Since this study was done in a single facility, the same result cannot be guaranteed in other facilities. And since there is the possibility of getting different results from different methods of rehabilitation, multicenter analysis would be needed if such methods were used in studies.

Conclusion

In this study, differences in influence of inhibitive factors on outcome were examined using decision tree analysis that predicted FIM-M at discharge in stroke hemiplegics. Trunk function influenced patients with low ADL on admission, and the influence of age extended to many patients with a relatively wide range of ADL. Cognitive function influenced patients who needed moderate to severe assistance. Since the influence of inhibitive factors changes according to the ADL level on admission, it is important to evaluate this influence correctly in order to predict outcome.

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