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Original Research

Factors Associated With Time to Achieve Physical Functional Recovery in Patients With Severe Stoke After Inpatient Rehabilitation: A Retrospective Nationwide Cohort Study in Japan

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KEYWORDS
Activities of daily living;
Functional status;
Recovery of function;
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Stroke

Abstract *Objective:* To describe characteristics of patient with severe stroke (FIM motor score [FIM motor] 20-49 at admission) and examine association between pre-specified factors (age, sex, modified Rankin Scale before stroke onset, body mass index, FIM motor, and FIM cognitive) and time to achieve FIM motor ≥70, that is, self-independent level.
Design: Retrospective cohort study using a large database in Japan.
Setting: Rehabilitation wards.
Participants: Patients with severe stroke (N=1422) who received inpatient rehabilitation were included (median age: 76 years; interquartile range [IQR]: 68.0-84.0). A total of 54.6% were men, and 65.8% were ischemic stroke.

List of abbreviations: ADL, activities of daily living, BMI: body mass index, CI: confidence interval, FIM: functional independence measure, HR: hazard ratio, ICD-10: International statistical classification of diseases and related health problems, 10th revision, IQR: interquartile range, mRS: modified Rankin Scale

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Interventions: Not applicable.
Main Outcome Measure(s): Time to achieve FIM motor ≥70.
Results: After inpatient rehabilitation, 40.4% (N=575) achieved FIM motor ≥70 (admission FIM motor 20-29, 30-39 and 40-49: 18.6%, 33.6%, and 47.8%, respectively). Patients who achieved FIM motor ≥70 stayed median 81.0 days [IQR, 51.0-120.0]) and received median: 6.94 units per day [IQR, 5.48-7.78], 1 unit=20 minutes). Adjusted Fine–Gray regression revealed that shorter time to achieve FIM motor ≥70 was associated with higher admission FIM motor (hazard ratio [HR] 2.87 [95% confidence interval [CI] 2.27-3.62]: 20-29 vs 40-49), higher admission FIM cognitive (HR 1.81 [95% CI: 1.39-2.35]: 5-14 vs 25-35), and younger (HR 3.20 [95% CI: 2.32-4.42]: ≥85 years vs 20-69 years).
Conclusions: Most patients with severe stroke did not achieve FIM motor ≥70 after inpatient rehabilitation. Older patients and patients with lower admission FIM motor require more attention. They should be prioritized for state-of-the-art rehabilitation therapy.

Stroke is the second leading cause of disability worldwide.[1] In Japan, although mortality caused by stroke has decreased in recent decades,[2-4] the condition remains as one of the major causes of decreased activities of daily living (ADL),[5] resulting in reduced quality of life,[6] and an increased need for nursing care.[7]

As tertiary prevention, rehabilitation programs play a vital role in reducing the effect of stroke. Predicting functional recovery before starting rehabilitation programs is recommended.[8] Previous studies of inpatient rehabilitation outcomes in Japan using multiple regression models reported that the functional independence measure motor (FIM motor) score and age are strong predictors of physical functional recovery.[9-11] While sex did not show any association with physical functional recovery,[10] FIM cognitive[9-11] and pre-stroke modified Rankin Scale (mRS)[10] were found to be related factors. Body mass index (BMI) also showed an association with rehabilitation volume in the lower FIM motor group.[12] However, these factors in patients with severe stoke have not been thoroughly examined.

When it comes to the extent of physical recovery, a study[13] reported that patients with FIM motor ≥50 in 14 days after stroke onset recovered a high level of physical function, often achieving self-independent level requiring minimum assistance for walk and wheelchair (FIM motor 70-79 points) or acquiring independent walking (FIM motor ≥80).[14] Thus, achieving FIM motor ≥70 is an important indicator both for patients and care givers.

Although the prognosis of severe stroke (FIM motor ≤50) is poor[13] and varies between patients,[15] development of rehabilitation and other therapies targeting this population is ongoing, including neurorehabilitation,[15] robot-assisted rehabilitation,[16] and regenerative medicine.[17] To date, studies in this area have been limited with small sample sizes.[9,13] An increased understanding of the characteristics and outcomes of severe stroke is essential for further development in this area.

Thus, this study aimed to describe patient characteristics, including treatment outcomes, and to examine the association between a set of a priori identified independent factors and time to achieve FIM motor ≥70 among patients with severe stroke in a real-world setting.

Methods

Study setting

In Japan, patients undergoing inpatient rehabilitation were treated under the following conditions. Rehabilitation is covered by universal health care insurance[18] for up to 9 units per day (a unit accounts for 20 minutes), and for up to 150 days or 180 days if the patient had suffered from cognitive or executive dysfunction since stroke onset.[19] However, patients who were expected to improve clinically could continue rehabilitation beyond this duration at their doctors' discretion.

Patients with stroke received rehabilitation in acute care wards initially, followed by a more intensive regime in rehabilitation wards. While some patients continued rehabilitation in the same hospital, others moved to another hospital at some time point during rehabilitation therapy. The timing of discharge from the hospital depended on the situation, including patients' preferences. Generally, doctors consider discharge when patients become independent, or achieve ADL goals, or if no more improvement was expected.[8]

Data source

We used Diagnostic Procedure Combination (DPC) data. The data format was created by the Japanese government for insurance reimbursement and health care assessment, comprising administrative claims data and patient discharge summary containing demographic, clinical, and treatment information, including rehabilitation therapy type and facility level.[20,21] The diagnosis was described using the WHO's international statistical classification of diseases and related health problems, 10th revision (ICD-10).[22]

The DPC database used in this study consisted data of 32 million patients across 1332 hospitals, between the period of April 2015 and March 2019, to evaluate the quality of care in the study group.[23] The dataset was extracted from the DPC database by K.B.I. in September 2019 and cleaned by R.Y. in June 2021. Informed consent was waived because we used anonymous clinical data. The Institutional Review Board of the International University of Healthcare and Welfare approved this study (Permission number: 18-Ig-115).

Study population

This retrospective cohort study included patients with severe stroke and who were hospitalized and subsequently discharged between April 2016 and March 2018. We selected this study period because FIM values have been adopted in DPC data format since April 2016 and the admission fees for rehabilitation wards remained the same until March 2018. Patients with severe stroke (ICD-10 codes I60, 61, 63, or 64 and FIM motor <50 at admission) were included if they were ≥20 years old, were hospitalized in acute-care words within 3 days from stroke onset and underwent rehabilitation in a rehabilitation ward. Patients were excluded if their rehabilitation was interrupted, or if they were unlikely to improve (FIM motor <20),[24] or if they suffered from moderate disability before stroke onset (pre-stroke mRS ≥3; patients requiring some help with movements, but are able to walk without assistance).

Patient characteristics, improvements, and rehabilitation intensity

Patient baseline characteristics were collected at the time of hospitalization, and FIM scores were collected at the time of admission to rehabilitation ward and discharge. Rehabilitation intensity was defined as total rehabilitation units divided by length of stay in acute care wards or rehabilitation wards. The proportion of the observed number of patients who achieved FIM motor ≥70 and the probability of achieving FIM motor ≥70 were both computed.

Factors associated with time to achieve FIM motor ≥70

We examined the pre-identified factors associated with the time to achieve FIM motor ≥70. Independent variables of interest were categorized as follows: age (20-69 years; 70-84 years; ≥85 years), sex (men, women), BMI (underweight [<18.5 kg/m^2], normal [18.5 to <25.0 kg/m^2], or obese [≥25 kg/m^2]), pre-stroke mRS (0, 1, or 2), FIM motor at admission (by 10 points: 20-29 points, 30-39 points, or 40-49 points) and FIM cognitive at admission (5-14 points, 15-24 points, or 25-35 points[9]). FIM motor at discharge from rehabilitation ward was used to assess FIM motor ≥70.

Statistical analysis

All descriptive summaries were computed as n (%) or median (interquartile range [IQR]) as applicable. Probabilities to achieve FIM motor ≥70 with 95% confidence intervals (CIs) were estimated using cumulative incidence function[25] and factors associated with time to achieve FIM motor ≥70 were investigated using a Fine—Gray model.[26] A Fine-Gray subdistribution hazard model was used when a competing risk is not precluded and assumed covariates in this model had an effect on the probability of events occurring over time.[27] The number of days from admission to rehabilitation ward to discharge from rehabilitation ward was used as the time variable for all patients (majority of patients were discharged within 180 days but only a few patients stayed longer than 180 days). Considering the inpatient rehabilitation scheme in Japan, patients who move to other hospitals with FIM motor at discharge <70 within 60 days after admission to rehabilitation wards without deterioration (defined as FIM motor gain <0) generally continue intensive inpatient rehabilitation to improve their physical function, which is considered non-informative censoring. Therefore, discharge with FIM motor <70 after 60 days, in-hospital deaths with FIM motor <70, and deterioration were considered informative censoring (ie, competing risk).

To compute rehabilitation intensity, patients who were censored for the analyses were excluded to eliminate the effect of patients who continued rehabilitation in other hospitals.

To describe differences in more than 1 group, two-sided tests with a significance level of 0.05 were used. Missing values were reported but not imputed because of the smaller effect on the outcome. All statistical analyses were performed with R version 3.6.3 or 4.0.2[a] using cmprisk[b] and survival[c] packages.

Sensitivity analysis

The following sensitivity analyses were performed: first, the time to achieve FIM motor ≥85 and ≥58 was examined. FIM motor ≥85 and FIM motor ≥58 were considered cut-off points for independent walking outside[14] and community discharge,[28,29] respectively. Second, discharge to hospitals with FIM motor <70 after 60 days without deterioration was censored instead of being handled with competing risk.

Results

Patient characteristics

Of the 11107 patients with stroke, 2419 had severe stroke, and 1422 were hospitalized within 3 days after onset were included in this study (supplemental fig S1). Patients were older with median age of 76.0 years (IQR, 68.0-84.0) and the majority was men (54.6%). Most were not disabled before stroke onset (pre-mRS 0: 61.8%) and were hospitalized from home (86.4%). Ischemic stroke (65.8%) was most common, followed by hemorrhagic stroke (31.2%).

All patient characteristics before stroke onset, except the place before hospitalization, significantly differed between the 2 groups (did not achieve vs achieved FIM motor ≥70). At discharge, FIM motor ≥70 group gained at median 80.0 (IQR, 75.0-85.0). The other patient characteristics before and at discharge are summarized in table 1.

When the cut-off points for FIM motor were changed to ≥85 or ≥58, differences between 2 groups were similar to those for FIM motor ≥70. Further details are summarized in supplemental table S1.

Table 1 Characteristics of all patients, and by physical functional recovery status at discharge: did not achieve or achieved FIM motor subscore ≥70 (N=1422, 85 institutions)

	All Patients (N = 1422)	FIM Motor Subscore ≥70 Did Not Achieve (N = 847)	Achieved (N = 575)	*P* Value
At baseline				
Age, y, median (IQR)	76.0 (68.0-84.0)	80.0 (71.0-86.0)	72.0 (63.079.0)	<0.001
Age group, n (%)				
20-69 y	433 (30.5)	175 (20.7)	258 (44.9)	<0.001
70-84 y	676 (47.5)	414 (48.9)	262 (45.6)	
≥85 y	313 (22.0)	258 (30.5)	55 (9.6)	
Sex, men, n (%)	777 (54.6)	431 (50.9)	346 (60.2)	0.001
BMI, kg/m^2, median (IQR)	22.6 (20.3-25.1)	22.2 (20.0-24.5)	23.2 (20.9-25.7)	<0.001
BMI group*, n (%)				
Underweight	157 (11.6)	109 (13.6)	48 (8.7)	<0.001
Normal	851 (62.8)	523 (65.3)	328 (59.2)	
Obese	347 (25.6)	169 (21.1)	178 (32.1)	
Pre-stroke modified Rankin Scale, n (%)				
0	879 (61.8)	477 (56.3)	402 (69.9)	<0.001
1	341 (24.0)	217 (25.6)	124 (21.6)	
2	202 (14.2)	153 (18.1)	49 (8.5)	
Place before hospitalization, n (%)				
Home	1228 (86.4)	734 (86.7)	494 (85.9)	0.206
Nursing home	27 (1.9)	20 (2.4)	7 (1.2)	
Hospital	166 (11.7)	92 (10.9)	74 (12.9)	
Unknown	1 (0.1)	1 (0.1)	0 (0.0)	
Stroke type, n (%)				
Subarachnoid hemorrhage	42 (3.0)	17 (2.0)	25 (4.3)	< 0.001
Intracerebral hemorrhage	444 (31.2)	234 (27.6)	210 (36.5)	
Cerebral infarction	935 (65.8)	595 (70.2)	340 (59.1)	
Others†	1 (0.1)	1 (0.1)	0 (0.0)	
Length of stay in an acute-care ward, d, median (IQR)	18.0 (11.0-29.0)	19.0 (13.0-31.0)	16.0 (9.0-26.0)	< 0.001
Rehabilitation intensity in an acute-care ward, unit, median (IQR)	4.11 (2.82-5.43)	4.00 (2.73-5.32)	4.29 (3.00-5.49)	0.040
Rehabilitation standard facility level‡				
Level 1	1418 (99.7)	845 (99.8)	573 (99.7)	1.00
Level 2	4 (0.3)	2 (0.2)	2 (0.3)	
Level 3	0 (0.3)	0 (0.0)	0 (0.0)	
FIM motor subscore, median (IQR)	35.0 (26.0-42.0)	32.0 (25.0-39.0)	39.0 (32.0-45.0)	<0.001
FIM motor subscore, group				
20-29 points	475 (33.4)	368 (43.4)	107 (18.6)	<0.001
30-39 points	461 (32.4)	268 (31.6)	193 (33.6)	
40-49 points	486 (34.2)	211 (24.9)	275 (47.8)	
FIM cognitive subscore, points, median (IQR)	22.0 (16.0-27.0)	20.0 (15.0-25.0)	25.0 (19.0-30.0)	<0.001
FIM cognitive subscore, n (%)				
5-14 points	271 (19.1)	192 (22.7)	79 (13.8)	<0.001
15-24 points	612 (43.1)	418 (49.4)	194 (33.9)	
25-35 points	536 (37.8)	237 (28.0)	299 (52.3)	
Total FIM, points, median (IQR)	56.0 (46.0-66.0)	52.0 (43.0-61.0)	63.0 (53.0-72.0)	<0.001
At discharge				
Length of stay in rehabilitation ward, d, median (IQR)	77.0 (48.0-113.8)	75.0 (47.0-110.0)	81.0 (51.0-120.0)	0.02
Rehabilitation intensity in rehabilitation ward, unit, median (IQR)	6.67 (4.88-7.58)	6.41 (4.48-7.42)	6.94 (5.48-7.78)	<0.001
FIM motor subscore at discharge, points, median (IQR)	64.5 (48.0-78.0)	52.0 (40.0-62.0)	80.0 (75.0-85.0)	<0.001
FIM cognitive subscore at discharge, points, median (IQR)	27.0 (21.0-32.0)	23.0 (18.0-28.0)	31.0 (28.0-34.0)	<0.001
Total FIM at discharge, points, median (IQR)	90.0 (70.0-108.0)	75.0 (60.0-86.0)	111.0 (104.0-117.0)	< 0.001
Discharge disposition, n (%)				
Home	1017 (71.5)	495 (58.4)	522 (90.8)	<0.001
Nursing home	249 (17.5)	218 (25.7)	31 (5.4)	
Hospital	142 (10.0)	121 (14.3)	21 (3.7)	
Other	12 (0.8)	12 (1.4)	0 (0.0)	

NOTE. Data is n (%) or median (IQR) for characteristics; missing value (did not achieve, achieve) for BMI: n = 87 (47, 20); Missing value for FIM cognitive subscore after acute phase: n = 3 (0, 3).

* Underweight, normal, and obese denote <18.5 kg/m^2, 18.5 to <25.0 kg/m^2, and ≥25.0 kg/m^2, respectively.

† A patient diagnosed with subarachnoid hemorrhage and cerebral infarction incurred the most medical costs to treat a disease other than stroke.

‡ Rehabilitation standard facility level was designated depending on the number of medical staff, including rehabilitation doctors, physical and occupational therapists, and area of rehabilitation room, with a highest score of 1 and lowest score of 3. Hospitals with rehabilitation facility standard level 1 were mandated to have a capability to provide rehabilitation every day, but hospitals with levels 2 and 3 were not.

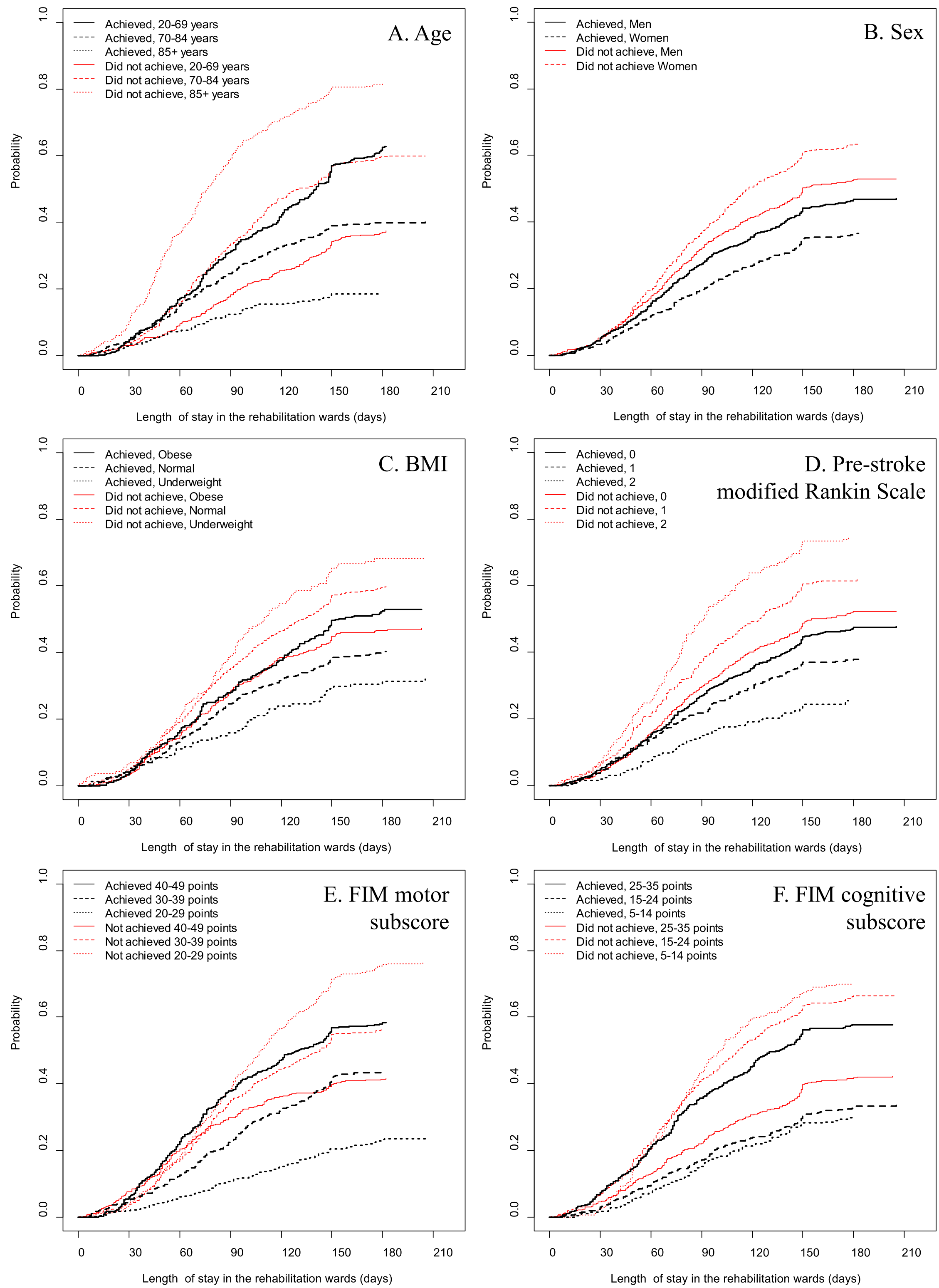

Fig 1 Proportion of patients who achieved FIM motor subscore ≥70.

Note: Red lines denote patients who did not achieve FIM motor subscore ≥70 at discharge (i.e., FIM motor subscore <70), including those who were discharged to other hospitals after 60 days.

Total number of patients and number of patients who were censored were as follows: Of total 1422 patients, A. 16, 23, and 21 patients were censored in groups of ≥85 , 70-84 , and 20-69 years old, respectively. B. 19 women and 41 men were censored. C. 7, 36, and 10 patients were censored in groups of underweight, normal, and obese patients, respectively. D. 10, 14, and 36 patients were censored in group of pre-modified Rankin Scale scores of 2, 1, and 0, respectively. E. 24, 21, and 15 patients were censored in groups of 20-29, 30-39, and 40-49 points, respectively. F. Of total 1419 patients, 9, 33, and 18 patients were censored in group of 5-14, 15-24, and 25-35 points, respectively.

Table 2 Hazard ratios for physical functional recovery status at discharge: did not achieve or achieved FIM motor subscore ≥70

	FIM Motor Subscore ≥70	
	Did Not Achieve Hazard Ratio (95% CI)	Achieved Hazard Ratio (95% CI)
Age		
≥85 y	Reference	Reference
70-84 y	0.55 (0.47-0.66)	2.31 (1.69-3.16)
20-69 y	0.32 (0.26-0.41)	3.20 (2.32-4.42)
Sex		
Women	Reference	Reference
Men	0.94 (0.81-1.09)	1.23 (1.03-1.46)
BMI*	Reference	
Underweight		Reference
Normal	0.94 (0.77-1.16)	1.06 (0.78-1.44)
Obese	0.8 (0.63-1.03)	1.24 (0.9-1.71)
Modified Rankin Scale		
2	Reference	Reference
1	0.79 (0.63-0.98)	1.54 (1.09-2.18)
0	0.71 (0.58-0.87)	1.76 (1.28-2.41)
FIM motor		
20-29 points	Reference	Reference
30-39 points	0.76 (0.64-0.90)	1.97 (1.55-2.50)
40-49 points	0.56 (0.46-0.69)	2.87 (2.27-3.62)
FIM cognitive		
5-14 points	Reference	Reference
15-24 points	0.99 (0.83-1.19)	0.99 (0.75-1.30)
25-35 points	0.57 (0.46-0.70)	1.81 (1.39-2.35)

NOTE. The hazard ratios were computed using a Fine—Gray subdistribution hazard model.
* Underweight, normal, and obese patients had BMI of <18.5 kg/m^2, 18.5 to <25.0 kg/m^2 and ≥25.0 kg/m^2, respectively.

Observations and probabilities of achieving FIM motor ≥70

FIM motor ≥70 at discharge was observed in 575 patients (40.4% [95% CI, 37.9-43.0]) and probability was estimated as 42.1% (95% CI, 39.4-44.7). Details are summarized in supplemental table S2 and fig 1 without adjustment for covariates.

Observed and unadjusted probability of achieving FIM motor at discharge ≥85 and ≥58 showed a similar trend, with fewer patients achieving FIM motor ≥85 (observed, 11.7% [95% CI, 10.0-13.3]; estimated, 12.2% [95% CI, 10.5-14.0]). Details are summarized in supplemental table S2 and supplemental figs S2 and S3. Sensitivity analyses that changed competing risk showed similar results, with an increase of 1%—2% (data not shown).

Adjusted factors associated with achieving FIM motor ≥70

Adjusted subdistribution hazard ratios (HRs) in table 2 show that a shorter period to achieving FIM motor ≥70 was associated with higher admission FIM motor (HR, 2.87 [95% CI, 1.55-2.50]: 20-29 vs 40-49), higher admission FIM cognitive (HR, 1.81 [95% CI, 1.39-2.35]: 5-14 vs 25-35), younger age (HR, 3.20 [95% CI, 2.32-4.42]: ≥ 85 years vs 20-69 years), men (HR, 1.23 [95% CI, 1.03-1.46]), and pre-stroke of mRS 0 or 1 (HR, 1.76 [95% CI, 1.28-2.41]: 2 vs 0; 1.54 [1.09-2.18]: 2 vs 1).

When changing cut-off points to FIM motor 85 or 58, only FIM motor, age, and pre-stroke mRS 0 showed association (supplemental table S3). Sensitivity analyses of changing competing risk yielded similar results (data not shown).

Rehabilitation intensity

Rehabilitation intensity in rehabilitation ward increased in both groups compared with that in acute-care ward (did not achieve: 4.0 units [95% CI, 2.7-5.3] vs 6.4 units [95% CI, 4.5-7.4]; achieved: 4.3 units [95% CI, 3.0-5.5] vs 6.9 units [95% CI, 5.5-7.8]). Most patients in both groups received ≥6 days per week rehabilitation in rehabilitation ward (did not achieve: 77.3%; achieved: 84.2%; data not shown).

Rehabilitation intensity differed between the 2 groups (P<.001), with the achieved group receiving 10 more minutes per day in rehabilitation wards. Irrespective of group, patients who were younger (both: P<.001) and heavier (did not achieve: P=.031; achieved: P=.034) received more intensive rehabilitation (table 3). In addition, patients with pre-stroke mRS of 0-1 received more intensive rehabilitation in the did not achieve group (P=.002).

This trend was observed when using an FIM motor cut-off point of 85 or 58 for all factors except BMI level. Details are summarized in supplemental table S4.

Discussion

In this study, we described characteristics of patients with severe stroke in Japan. In addition, we examined the factors associated with the time to achieve FIM motor ≥70 using

Table 3 Rehabilitation intensity by factors of interest: achieved or did not achieve FIM motor subscore ≥70

	Did Not Achieve FIM Motor Subscore ≥70 (N=787)*			Achieved FIM Motor Subscore ≥70 (N=575)		
	n	Unit (IQR)	*P* value	N	Unit (IQR)	*P* value
All patients	787	6.46 (4.48-7.46)	—	575	6.94 (5.48-7.78)	<0.001
Age group						
20-69 y	154	6.89 (5.18-7.83)	<0.001	258	7.23 (6.18-7.94)	<0.001
70-84 y	391	6.52 (4.81-7.45)		262	6.77 (5.37-7.6)	
≥85 y	242	5.74 (3.83-7.23)		55	6.30 (4.2-7.55)	
Sex						
Men	390	6.56 (4.85-7.5)	0.106	346	6.99 (5.68-7.83)	0.312
Women	397	6.35 (4.16-7.4)		229	6.88 (5.34-7.76)	
BMI group†						
Underweight	102	6.06 (4.01-7.22)	0.031	48	6.94 (4.81-7.84)	0.034
Normal	487	6.54 (4.51-7.51)		328	6.86 (5.43-7.67)	
Obese	159	6.70 (5.2-7.51)		178	7.29 (5.99-7.94)	
Pre-stroke modified Rankin Scale						
0	441	6.64 (4.62-7.66)	0.002	402	6.96 (5.57-7.87)	0.231
1	203	6.40 (4.25-7.28)		124	6.85 (5.46-7.51)	
2	143	6.06 (3.98-7.04)		49	7.07 (4.93-7.62)	
FIM motor subscore at admission, group						
20-29 points	344	6.50 (4.52-7.51)	0.224	107	6.90 (5.71-7.67)	0.774
30-39 points	247	6.48 (4.52-7.56)		193	7.05 (5.33-7.91)	
40-49 points	196	6.40 (4.40-7.20)		275	6.91 (5.58-7.75)	
FIM cognitive subscore at admission phase						
5-14 points	183	6.41 (4.23-7.42)	0.822	79	7.33 (5.7-7.76)	0.075
15-24 points	385	6.48 (4.47-7.42)		194	6.82 (5.12-7.66)	
25-35 points	219	6.51 (4.78-7.51)		299	7.03 (5.72-7.87)	

NOTE. Data are median (IQR); 1 unit is equivalent to 20 minutes; — denotes not applicable; rehabilitation intensity was calculated with total rehabilitation dose (units) divided by length of stay; *P* value was computed for within factors of interest in the did not achieve or achieved group except "All patients" in the first line in the table: all patients were compared between the did not achieve and achieved groups irrespective of factors of interest.

* Patients who did not achieve FIM motor subscore ≥70, including patients who were censored in the analysis using cumulative incident function (fig 1).

† Underweight, normal, and obese patients had BMI of <18.5 kg/m^2, 18.5 to <25.0 kg/m^2 and ≥25.0 kg/m^2, respectively.

cumulative incidence function and a Fine–Gray model. Most patients with severe stroke were ≥75 years and had ischemic stroke followed by hemorrhagic stroke. The probability of achieving FIM motor ≥70 in this population was estimated to be 42.1% (95% CI, 39.4-44.7). Admission FIM motor and cognitive, age, sex, and pre-stroke mRS were associated with time to achieve FIM motor ≥70.

A strength of this study is that we analyzed patient characteristics using an FIM motor cut-off of ≥70. Patients whose FIM motor in 70-79 are considered self-care independent (ie, they require assistance for bathing and partial assistance for walking or wheelchair use but are able to take care of other things by themselves[14]). Previous studies revealed an association between factors and functional outcome or formula. However, patients with severe stroke (FIM motor <50) and their families typically desire more information about their prognosis. For example, a patient may wish to know the likelihood of them achieving self-care independence (FIM motor ≥70), considering their age and the severity of their condition at the acute phase. Our results suggest that less than half of the patients achieve this goal, with the probability decreasing to 23.3% in the lowest FIM motor group and 18.5% in the oldest age group. Such information might be informative and valuable for patients undergoing rehabilitation and their families, encouraging acceptance of their physical recovery level after inpatient rehabilitation and preparing for their life after discharge when they start inpatient rehabilitation. The current results may need modification for generalization and practical application.

Another strength of the current study is that we examined a large nationwide inpatient database, which enabled us to study a substantial population of patients with severe stroke. Patient characteristics exhibit substantial variability, particularly in severe stroke.[15] However, this issue has not been systematically reported in Japan. Compared with a population-based stroke registry[3] conducted in the same study period, age and sex in the current sample were similar, reflecting Japan's super-aged society, although a higher proportion of patients with hemorrhagic stroke was observed in our study (22.3% vs 31.2%). This type of patient is reported to be more prone to severe stroke because of the volume of leision.[30] When it comes to rehabilitation, most patients in this study received 6.5-7.0 units (approximately 130-140 minutes) of rehabilitation every day in rehabilitation wards. Patients with more severe conditions stayed longer in rehabilitation wards, although older patients were likely to be discharged early and received less intensive rehabilitation (P<.001) in did not achieve motor and achieved FIM motor ≥70 groups.

The results of the Fine–Gray model used in this study revealed that age and FIM motor at admission had the strongest association with time to achieve FIM motor ≥70 or ≥85. However, higher FIM cognitive (25-35 points) was only associated with time to achieve FIM motor ≥70 but not ≥85. This result suggests that FIM motor is more predictive of better outcome status than FIM cognitive, in accord with previous studies predicting patient outcomes using FIM score with multiple regression.[9,10,24] Furthermore, FIM motor after the acute phase may reflect the severity of stroke itself considering the results from AVERT,[31] indicating that stroke severity was the most profound factor predicting independent walking recovery.

Compared with rehabilitation intensity in each group without adjustment (did not achieve or achieved FIM motor ≥70), only pre-stroke mRS showed a difference between the 2 groups: intensity in the did not achieve group differs among mRS 0 to mRS 2, but that in the achieved group did not. The reason for this finding is not clear. However, previous studies reported that rehabilitation intensity was notably associated with recovery in an acute-care ward[32] and in a rehabilitation ward after adjustment.[33] Our result may indicate that a higher rate of attendance at rehabilitation program predicts better physical outcomes. This issue requires further study.

Overall, our results suggest that patients with lower FIM motor at admission and older patients require more attention and should be prioritized for state-of-the-art rehabilitation therapy in the aging global population.

Study limitations

The current study involved several limitations that should be considered. First, because we used retrospective data obtained from the DPC database, we were unable to return to individual charts if concerns arose. However, DPC data were validated in terms of diagnoses, procedures, and laboratory results.[34] Second, because of the limitations of DPC data, information regarding transfer to other hospitals or the actual outcome of physical functional outcome were not described. Therefore, we considered more than 60 days as a competing risk to examine endpoints. In addition, actual onset dates were not included in DPC data, which could provide useful information about variability in functional recovery (eg, shorter stay at the acute phase might predict better recovery). Third, we treated rehabilitation hours on the assumption that rehabilitation content or strength was similar, and that equal self-rehabilitation was performed. However, in reality, it is known that patients who participated in a self-exercise program achieved higher FIM motor at discharge.[35] Fourth, we did not include comorbidity or treatment information. Although physical functional status after the acute phase provided strong evidence for prediction,[36] this information might provide a clearer picture. Fifth, the results of this study cannot be generalized to outpatient settings, because inpatients are expected to be well managed for complications, including those related to medication and diet. Furthermore, the hospitals included in the current study were standard level 1 facilities. This indicates that many rehabilitation professionals treat patients at a high level in multiple ways.

Conclusions

Less than half of patients with severe stroke (FIM motor <50) after inpatient rehabilitation achieved FIM motor ≥70. Higher admission FIM motor and younger age were strongly associated with time to achieve FIM motor ≥70, followed by the absence of disability or less severe disability before stroke onset. Patients who achieved FIM motor ≥70 received 10 more minutes of rehabilitation per day. In addition, patients with lower FIM motor at admission and patients who were younger at the time of hospitalization were hospitalized longer. This study provides the fundamental data to inform future studies testing the effects of new treatments for improving physical function after severe stroke.

Suppliers

a. R version 3.6.3 and R 4.0.3; The R Project for Statistical Computing.
b. Cmprks Package; Bob Gray.
c. Survival Package; Terry M. Therneau.

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