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Original Article

Relationship between hospital ranking based on Functional Independence Measure (FIM) efficiency and factors related to rehabilitation system for stroke patients -A study of three hospitals participating in Kumamoto Stroke Liaison Critical Pathway-

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ABSTRACT

Tokunaga M, Sannomiya K, Watanabe S, Nakanishi R, Yamanaga H, Yonemitsu H, Terasaki T, Mita S, Kawano S, Hirata Y, Yamaga M, Hashimoto Y, Sonoda S. Relationship between hospital ranking based on Functional Independence Measure (FIM) efficiency and factors related to rehabilitation system for stroke patients —A study of three hospitals participating in Kumamoto Stroke Liaison Critical Pathway—. Jpn J Compr Rehabil Sci 2012; 3: 51−58.

Purpose: The purpose of this study was to clarify the factors related to rehabilitation systems that yield high functional independence measure (FIM) efficiency by conducting a questionnaire survey in the kaifukuki rehabilitation hospitals (KRHs) participating in the Kumamoto Stroke Liaison Critical Pathway.

Methods: A total of 765 stroke patients were studied. FIM score gain and length of stay (LOS) at three hospitals in Kumamoto were classified into two groups according to patients' age and into three groups according to their FIM score at the time of admission. Then, FIM score gain and LOS were adjusted by the standard severity distribution value of the 765 patients to obtain the adjusted FIM efficiency. The hospitals were ranked by the adjusted FIM efficiency. In addition, we conducted a questionnaire survey on six factors related to the rehabilitation system and determined the factors that ranked the hospitals in the same order as that from ranking based on adjusted FIM efficiency.

Results: The adjusted FIM efficiencies were 0.251 in Hospital A, 0.205 in Hospital B, and 0.225 in Hospital C. Among the six factors surveyed, the factors that gave the same hospital ranking as that based on adjusted FIM efficiency were the number of rehabilitation and nursing staff members, and the number of patients hospitalized for stroke.

Conclusion: Among the three hospitals in Kumamoto, the FIM efficiency was high in the hospital with a large number of rehabilitation and nursing staff members and a large number of patients hospitalized for stroke.

Key words: FIM efficiency, rehabilitation system, stroke, liaison critical pathway, comparison among hospitals

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Introduction

Our search of the literature identified only four

Table 1. Comparison of ADL score gain and efficiency among KRHs participating in Stroke Liaison Critical Pathway

	Toyoda, et al [2]	Maejima, et al [3]	Tokunaga, et al [4]	Tokunaga, et al [5]	This study
Regions	Hiroshima	Saitama	Kumamoto	Kumamoto	Kumamoto
Number of patients	48	204	219	409	765
Number of KRHs	2	6	4	3	3
Description of number of patients at each KRH	—	—	+	+	+
Adjustment of severity among KRHs	—	—	+	+	+
Description of amount of training	—	—	—	—	+
Description of rehabilitation system	—	—	—	—	+
Items compared among KRHs	FIM gain	FIM gain FIM efficiency	BI gain BI eficiency	NSKH gain	FIM efficiency

The study using NSKH is included in this table because NSKH is similar to, although different from, an ADL assessment method.
KRH, kaifukuki rehabilitation hospital; FIM, functional independence measure; NSKH, Nichijo-seikatsu-kino-hyokahyo; BI, Barthel index.

reports that compared the gain of activities of daily living (ADL) score (ADL scores at the time of discharge−ADL scores at the time of admission) and ADL efficiency [ADL score gain / length of stay (LOS)] in hospitals with kaifukuki (convalescent) rehabilitation wards (KRWs) [hereinafter, kaifukuki rehabilitation hospitals (KRHs)] [1] participating in the liaison critical pathway (Table 1) [2−5]. However, the two articles from our group [4, 5] were the only reports in which the difference in patient severity among hospitals was adjusted. Moreover, these four reports did not describe the amount of exercise and the rehabilitation system in the hospitals. To compare ADL score gain and efficiency among KRHs participating in the liaison critical pathway, it is necessary to identify the rehabilitation system that yields high ADL score gain and efficiency after adjusting for the difference in patient severity among the hospitals.

In our previous study, we obtained adjusted ADL score gain with the assumption that the severity distribution of the patients admitted to the participating hospitals was the same as that for all KRHs in Kumamoto. In those studies, the stroke patients were classified according to the total scores of the Nichijo-seikatsu-kino-hyokahyo (NSKH; English translation: Functional Assessment of Daily Living Table; a tool for the assessment of severity) [6], and the NSKH score gain in each group was multiplied by the severity distribution value for all hospitals in Kumamoto (Kumamoto standard severity distribution value). By this method, the NSKH score gain in each hospital was adjusted [5]. Using the same method, we also adjusted LOS and the rate of discharge to home, and examined the relationship between adjusted LOS and adjusted rate of discharge to home [7]. In another study, we attempted to compare Barthel index (BI) score gain and BI efficiency among hospitals for a subgroup of patients with BI scores 15 to 85 at admission [4], based on the observation that although there was a significant difference in BI score at admission among the hospitals, no significant difference among hospitals was observed when the study group was limited to subjects with BI scores 15 to 85 at admission. However, ADL score gain is affected by the admission ADL score [8] and patient's age [9, 10]. Therefore, it seems more appropriate to stratify the patients according to both age and admission ADL score, than by admission ADL score alone.

In the present study, by classifying the patients according to age and functional independence measure (FIM) total score at admission [11] and adjusting for the difference in patient severity among the participating hospitals, we elucidated the severity-adjusted FIM efficiency in the KRHs participating in the Kumamoto Stroke Liaison Critical Pathway and identified the rehabilitation system that yields high severity-adjusted FIM efficiency.

Subjects and Methods

Between 6 June 2007 and 16 December 2011, 4,133 stroke patients in acute hospitals were registered with the electronic version of the Kumamoto Stroke Liaison Critical Pathway [12]. Among them, the dates of discharge from KRHs were recorded in 1,978 patients; the names of KRHs were recorded in 1,952 patients; and FIM scores were determined at admission to and discharge from the KRHs in 1,054 patients. The age, LOS at acute hospitals, and LOS at KRHs were all recorded in 831 patients. Among them, 14 patients who died in KRHs and 52 patients who were transferred from KRHs to acute hospitals were excluded from the study. The remaining 765 patients were included as subjects in this study. The 4,133 patients examined in this study included all the patients in our previous reports of adjusted NSKH score gain [5], adjusted LOS and adjusted rate of discharge to home [7], and BI score gain of patients with BI scores ranging from 15 to 85 at admission [4], as well as in a conference presentation on adjusted FIM score gain and adjusted LOS [13].

Personal information examined in this study was compiled into a database and processed in a manner that no individuals were identifiable. This study was conducted in accordance with the regulations of the Clinical Research Ethics Committee of the hospital with which the first author was affiliated.

Assessment 1: Data before adjustment

The KRHs were designated, in descending order of the number of patients, as Hospital A (315 patients), Hospital B (106 patients), Hospital C (95 patients), and “other hospitals” (249 patients in total, comprising 23 hospitals with 25 or less patients per hospital). The 26 hospitals that admitted the 765 patients were referred to as “all hospitals”.

The Kruskal-Wallis test was conducted to determine whether there were differences among Hospitals A, B, and C in the age of stroke patients at admission to acute hospitals, the LOS at acute hospitals, the LOS at KRHs, the FIM total score at admission to KRHs (admission FIM score), the FIM total score at discharge from KRHs (discharge FIM score), and the FIM score gain (discharge FIM score minus admission FIM score). The level of statistical significance was set at less than 1%. FIM efficiency for each hospital was obtained by dividing the mean FIM score gain by the mean LOS.

Assessment 2: Adjustment based on Kumamoto standard severity distribution [5, 7]

The patients were classified according to their admission FIM score into three groups: 18 to 49 points, 50 to 90 points, and 91 to 126 points. Moreover, the patients were classified into two age groups: 74 years or younger, and 75 years or older. The number of patients in each of these six groups classified according to admission FIM score and age was determined for Hospitals A, B, and C, and all hospitals. The distribution of all patients classified into the six groups was referred to as the “Kumamoto standard severity distribution”. The adjusted values were obtained on the assumption that the patients admitted to Hospital A, B, or C were of the same age profile and showed the same FIM score pattern as those admitted to all hospitals [5, 7]. For example, the adjusted FIM score gain in Hospital A was obtained by multiplying the FIM score gain in each of the six groups for Hospital A by the Kumamoto standard severity distribution value (not by the patient distribution value in Hospital A). LOS and admission FIM score were also adjusted in a similar manner to obtain adjusted LOS and adjusted admission FIM score. Adjusted FIM efficiency for each hospital was obtained by dividing the adjusted FIM score gain by the adjusted LOS. Hospitals A, B and C were ranked by the adjusted FIM efficiency.

Assessment 3: Rehabilitation system in Hospitals A, B, and C

A questionnaire survey on the rehabilitation system (Table 2) was conducted in Hospitals A, B, and C. The questionnaire consisted of six items; namely, the mean units of rehabilitation time (hereinafter, the amount of exercise), the number of patients hospitalized for stroke, the proportion of stroke patients among hospitalized patients, the number of rehabilitation staff members, the number of nursing staff members, and the total number of rehabilitation staff and nursing staff members (hereinafter, the number of rehabilitation and nursing staff members). Hospitals A, B and C were ranked by each of the six items. We examined the items that ranked the hospitals in the same order as that from ranking based on adjusted FIM efficiency.

Results

There were significant differences among the three hospitals in the age of patients, LOS at acute hospitals, LOS at KRHs, admission FIM score, discharge FIM score, and FIM score gain (Table 3). The FIM efficiencies were 0.267, 0.196, and 0.218 in Hospitals A, B, and C, respectively.

The number of patients, the FIM score gain, LOS, and admission FIM scores in the six groups classified according to the age of patients and the admission FIM scores in Hospitals A, B and C are shown in Table 4. In Hospitals A and C, patients 74 years or younger with admission FIM scores 91 to 126 constituted the largest group. In Hospital B, patients 75 years or older with admission FIM scores 18 to 49 made up the largest group (Fig. 1A). Although the distributions of FIM score gain in these three hospitals showed a similar tendency, the FIM score gain in the group of patients 74 years or younger with admission FIM scores 18 to 49 was low in Hospital C (Fig. 1B). Even when the patients were classified into six groups, the LOS was long in Hospital B and short in Hospitals A and C (Fig. 1C).

Figure 2A shows the LOS and the admission and discharge FIM scores and Fig. 2B shows the adjusted LOS and adjusted admission and discharge FIM scores for each hospital. The 26.0-point difference in admission FIM scores between hospitals (86.7 points in Hospital C – 60.7 points in Hospital B) was reduced to a 2.1-point difference (71.2 points – 69.1 points) by the adjustment (Table 4 and Fig. 2B). The adjusted

Table 2. Rehabilitation systems in three hospitals

	Hospital A	Hospital B	Hosptal C	National survey [14]
Number of beds	125	85	58	35,291
Bed occupancy rate	96.9%	89.9%	99.6%	89.1%
Number of patients hospitalized for stroke, percentage of stroke	291 (34.9%)	177 (66.5%)	201 (56.9%)	49.6%
Number of patients hospitalized for orthopedic diseases	537 (64.5%)	75 (28.2%)	150 (42.5%)	37.5%
Number of patients hospitalized for disuse syndrome	5 (0.6%)	14 (5.3%)	2 (0.6%)	11.8%
Number of physical therapists (PT) per 100 patients	16	17.6	37.9	9.7
Number of occupational therapists (OT) per 100 patients	14.4	15.3	15.5	6.6
Number of speech therapists (ST) per 100 patients	6.4	4.7	3.4	2.5
Number of rehabilitation staff members (PT＋OT＋ST) per 100 patients	36.8	37.6	56.8	18.8
Number of nurses per 100 patients	50.4	42.4	43.1	16.5/ward
Number of caregivers per 100 patients	21.6	20	5.2	9.46/ward
Number of nursing staff members (nurses ＋ caregivers) per 100 patients	72.0	62.4	48.3	—
Number of rehabilitation and nursing staff members per 100 patients	108.8	100.0	105.1	—
Mean number of rehabilitation units per day	5.6	5.9	5.3	5.6
Rehabilitation on Saturdays, Sundays, and holidays	Saturdays and holidays	Saturdays, Sundays, and holidays	Saturdays	Saturdays97.9%, holidays85.8%, Sundays69.3%
ADL assessment method	FIM	FIM, BI	FIM, BI	—

Data on kaifukuki rehabilitation wards obtained in FY2010

Mean number of rehabilitation units: one unit is defined as 20 minutes of rehabilitation.

Table 3. Comparison among hospitals and regions

	Hospital A	Hospital B	Hospital C	Significance	All hospitals	National survey [14]	Saitama (Maejima, et al) [3]	Hyogo (Ohsaka, et al) [15]
Number of patients	315	106	95	—	765	9,825	190	151
Age	67.8±13.7	73.8±12.2	68.6±13.6	P＜0.001	71.1±13.6	71.5	—	—
LOS at acute hospitals	18.1± 8.5	15.6± 7.4	18.9± 7.5	P＜0.001	17.7± 8.3	36.9	29.5	36.1
LOS at KRHs	83.6±43.2	125.3±65.9	71.8±43.2	P＜0.001	94.4±55.2	91.5	101.1	96.4
Admission FIM score	75.9±34.4	60.7±33.1	86.7±34.2	P＜0.001	70.5±36.2	68.1	63.6	67.9
Discharge FIM score	98.1±30.6	85.3±38.3	102.3±30.6	P＜0.001	91.3±35.3	85.2	92.6	83.5
FIM gain	22.3±19.8	24.6±22.1	15.6±16.3	P＜0.01	20.8±20.3	17.1	29.0	15.6
FIM efficiency	0.267	0.196	0.218	—	0.220	0.187	0.287	0.162

Significance, Presence of significant difference among Hospitals A, B, and C (Kruskal-Wallis test);
FIM, functional independence measure total score, LOS, length of stay, KRH, kaifukuki rehabilitation hospial;
FIM efficiency, mean FIM score gain of hospital divided by mean LOS (the FIM efficiencies, i.e., 0.38 in Saitama and 0.18 in Hyogo, differed from those indicated in the report owing to the difference in the calculation equation.).
Although the FIM score gain in Saitama was reported as 29.7 points, it was changed to 29.0 points, which was obtained by subtracting admission FIM score from discharge FIM score

FIM score gain was the largest in Hospital B (23.5 points) followed by Hospitals A (21.9 points) and C (18.5 points). The adjusted FIM efficiency corresponded to the slope of the line connecting the admission FIM score and the discharge FIM score in Fig. 2B, and was the highest in Hospital A (0.251) followed by Hospitals C (0.225) and B (0.205).

Among the six items examined (the amount of exercise, the number of patients hospitalized for stroke, the proportion of stroke patients among hospitalized patients, the number of rehabilitation staff members, the number of nursing staff members, and the number of rehabilitation and nursing staff members), “the number of rehabilitation and nursing staff members” and “the number of patients hospitalized for stroke” were the largest in Hospital A, followed by Hospitals C and Hospital B, which was consistent with the hospital ranking based on adjusted FIM efficiency.

Discussion

This study was different from our previous studies using the Kumamoto standard severity distribution value for adjustment [5, 7], in that FIM scores instead

Table 4. Survey on six groups of patients classified according to age and admission FIM score

Number of patients	75～years FIM 18–49	～74 years FIM 18–49	75～years FIM 50–90	～74 years FIM 50–90	75～years FIM 91–126	～74 years FIM 91–126	Sum
Hospital A	47	41	41	60	34	92	315
Hospital B	32	10	20	23	5	16	106
Hospital C	9	11	12	7	15	41	95
All hospitals	175	89	113	116	76	196	765
Kumamoto standard severity distribution value	0.229	0.116	0.148	0.152	0.099	0.256	1

FIM gain	75～years FIM 18–49	～74 years FIM 18–49	75～years FIM 50–90	～74 years FIM 50–90	75～years FIM 91–126	～74 years FIM 91–126	FIM gain	Adjusted FIM gain
Hospital A	86	46.73	26.59	32.98	8.53	9.62	22.3	21.9
Hospital B	17.69	52.1	24.6	32.26	13.6	13.63	24.6	23.5
Hospital C	15.56	33.73	18.5	32.86	7.47	10.02	15.6	18.5

Length of stay (LOS)	75～years FIM 18–49	～74 years FIM 18–49	75～years FIM 50–90	～74 years FIM 50–90	75～years FIM 91–126	～74 years FIM 91–126	LOS	Adjusted LOS
Hospital A	117.7	123	93.2	97	47.7	48.7	83.6	86.9
Hospital B	171.7	170.4	113.8	109.8	81.8	54.8	125.3	114.7
Hospital C	88.9	130.1	91.9	103.7	49.7	49.1	71.8	82.3

Admission FIM score (AFIM)	75～years FIM 18–49	～74 years FIM 18–49	75～years FIM 50–90	～74 years FIM 50–90	75～years FIM 91–126	～74 years FIM 91–126	AFIM	Adjusted AFIM
Hospital A	27.7	32	72.5	108.2	74.2	110.7	75.9	71.1
Hospital B	24.7	28.5	69.8	109.6	72.7	109.1	60.7	69.1
Hospital C	27.8	36.3	70.8	109.3	68.9	112.6	86.7	71.2

FIM, functional independence measure total score; LOS, length of stay at kaifukuki rehabilitation hospitals, Data are expressed as mean values, except the number of patients.
Kumamoto standard severity distribution value: number of patients in six groups in all hospitals divided by 765 (for example, the Kumamoto standard severity distribution level of 0.229 for patients 75 years or older with FIM scores 18 to 49 in Hospital A was obtained by dividing 175 by 765.)
Adjusted FIM score gain: FIM score gain in each hospital multiplied by Kumamoto standard severity distribution level (for example, the adjusted FIM score gain in Hospital A＝18.26*0.229＋46.73*0.116＋26.59*0.148＋32.98*0.152＋8.53*0.099＋9.62*0.256)

of NSKH scores were examined and the patients were classified according to not only the ADL score at admission but also the age. Moreover, a questionnaire investigating the amount of exercise and the rehabilitation system was conducted, revealing that the adjusted FIM efficiency was high in the hospital with a large number of rehabilitation and nursing staff members and a large number of patients hospitalized for stroke. However, it should be noted that this was the result of an investigation of rehabilitation system-related factors that match the hospital ranking based on adjusted FIM efficiency in three hospitals in Kumamoto.

The factors based on which the hospitals were ranked in the order of Hospitals A, C, and B, which was consistent with the hospital ranking based on adjusted FIM efficiency, were the number of patients hospitalized for stroke and the number of rehabilitation and nursing staff members. The hospitals were ranked in different orders when ranking was based on the amount of exercise, the proportion of stroke patients among hospitalized patients, the number of rehabilitation staff members, and the number of nursing staff members. We adopted the assessment method based on the consistency in rank order because the number of hospitals was too small for statistical analysis. Therefore, the conclusion of this study is not statistically based.

Moreover, there remained a question of whether there may be more appropriate factors related to the rehabilitation system, apart from the six factors examined. These six factors were chosen because hospitals can easily assign numerical values and these factors were suspected to be related to FIM efficiency. However, the involvement of rehabilitation doctors, the ability of doctors to manage the general condition of patients, the individual ability of rehabilitation and nursing staff members, the staff education system, the motivation level of staff members, the cooperation among different health professionals, the content of rehabilitation, and self-exercise (environment conducive to self-exercise, the time, and whether implemented correctly) may also be related to the FIM efficiency of the hospitals. How to evaluate such factors, which are difficult to quantify, is a future task.

The mean FIM score gain in Kumamoto was 20.8 points, which was 3.7 points higher than the national

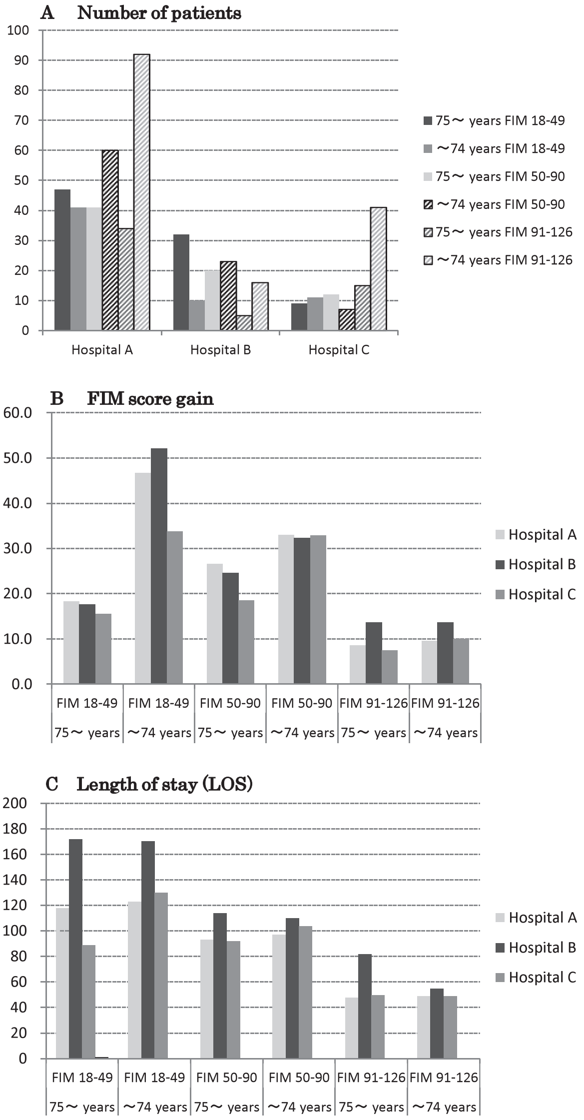

Figure 1. Number of patients (A), FIM score gain (B) and LOS (C) in six groups classified according to age and admission FIM score.

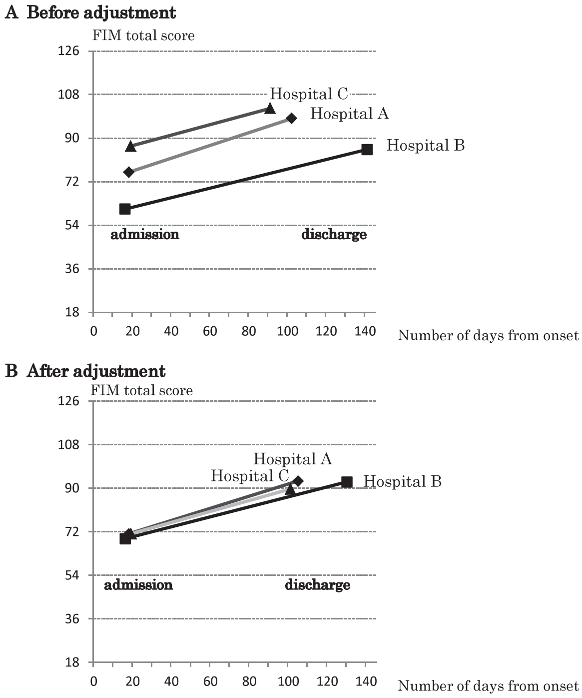

Figure 2. Admission and discharge FIM scores and LOS before (A) and after (B) adjustment.

average of 17.1 points [14]. The FIM score gain in other regions were, for example, 29.0 points in Saitama [3] and 15.6 points in Hyogo [15] (Table 3). However, there were no descriptions about the amount of exercise and the rehabilitation system in previous reports. Even if the FIM score gain in the liaison critical pathways is reported from around the country, it will be difficult to evaluate the data without information on the amount of exercise and the rehabilitation system. Such information from each region is necessary for comparing the effectiveness of rehabilitation among regions.

There are few reports on the regional comparison of ADL score gain and the amount of exercise. Mon *et al*. [16] compared the BI score gain and the rehabilitation system in Kumamoto, where patients were transferred from acute hospitals to KRHs at an early stage and efforts are made to provide community-based total medical care to stroke patients, with those in other regions using a database of rehabilitation patients [17]. Their results showed that the numbers of days to admission to KRHs were 19.7 days in Kumamoto and 32.3 days in other regions, and the numbers of days from admission to acute hospitals to discharge from KRHs were 106.4 days in Kumamoto and 125.0 days in other regions. The BI efficiency was higher in Kumamoto (0.42) than in other regions (0.36). However, the efficiency per rehabilitation unit was lower in Kumamoto (0.007) than in other regions (0.12). Moreover, there was no significant difference in cost-effectiveness, which was 1.40 in Kumamoto and 1.33 in other regions [16]. As shown in this report, information on the amount of training is necessary for comparing ADL score gain among regions and hospitals. The information on the rehabilitation system is also useful.

As for the number of rehabilitation and nursing staff members, Woo *et al*. [18] reported that FIM efficiency decreased as the number of occupational therapists and nurses decreased in a hospital. This was consistent with the finding of our study that among the three hospitals in Kumamoto, the adjusted FIM efficiency was high in the hospital with a large number of rehabilitation and nursing staff members. On the other hand, the number of patients hospitalized for stroke might not have directly affected FIM efficiency. Rather, a hospital employing a large number of rehabilitation and nursing staff members and offering high-quality medical care would attract a large number of patients. However, because there is no report on the relationship between the number of patients hospitalized for stroke and FIM efficiency, further study is needed to examine whether our finding that "among the three hospitals in Kumamoto, the adjusted FIM efficiency was high in a hospital with a large number of patients hospitalized for stroke" is also valid in other regions.

In this study, the questionnaire was conducted only in three hospitals because it is difficult to summarize the rehabilitation systems of the remaining 23 hospitals. Therefore, one of the limitations of our study is the small number of hospitals surveyed. To determine the trend in an entire region, it may be necessary to conduct a questionnaire on a large number of hospitals even though the accuracy of the survey will decrease owing to the small number of patients per hospital.

Few studies have examined the differences in the factors related to the rehabilitation system between hospitals with high FIM score gains and those with low FIM score gains. Jeong *et al*. [19] estimated the discharge FIM scores of 680 stroke patients registered in the database of rehabilitation patients [17] based on the clinical indices at admission to rehabilitation hospitals. Next, they compared the percentage of patients with discharge FIM scores 5 or more points lower than the estimated scores among 12 hospitals. When the high-performance hospitals in which the percentage was low and the low-performance hospitals in which the percentage was high were compared, there were significant differences in the degree of involvement of rehabilitation doctors, the frequency of conferences, the amount of exercise, self-exercise without a therapist, and exercise in hospital wards. No significant difference was observed in the rate of discharge to home [19]. There were no questionnaire items common to the study of Jeong *et al*. [19] and our study, except for the amount of exercise, and the results regarding the amount of exercise were different.

A relationship between the amount of exercise and rehabilitation outcomes has been reported [20]. Kawahara *et al*. [21] classified the patients in a hospital into groups with equal conditions except the number of rehabilitation units, and compared 122 patients who underwent five to six units of rehabilitation in 2005 with 41 patients who underwent seven to nine units of rehabilitation in 2008. They reported that the motor FIM score gain, the motor FIM efficiency, and the rate of discharge to home were significantly higher in the group with seven to nine units of rehabilitation than in the group with five to six units of rehabilitation. Nagai *et al*. [22] compared the amount of exercise and the rehabilitation outcomes among many hospitals. Classifying 11 hospitals into three groups according to the number of rehabilitating units offered: less than four units, four or five units, and six or more units, they reported that the motor FIM efficiency was significantly higher in the hospitals offering six or more units than in those offering less than four units. However, in the group offering six or more units, the admission FIM scores of the patients were significantly lower than those in the other groups. The difference in patient's severity among the hospitals made it difficult to analyze the relationship between the amount of exercise and rehabilitation outcomes. Moreover, unlike single hospital surveys, it is difficult to equalize all the factors related to the rehabilitation system, other than the amount of exercise, among multiple hospitals even when the difference in patient severity among the hospitals can be adjusted. Therefore, there are difficulties in clarifying the relationship between the amount of exercise and rehabilitation outcomes. A previous study reported that the rehabilitation system-related factors that affected the rehabilitation outcomes in a hospital included the number of staff members, the layout of the hospital ward, the equipment and instruments of the hospital, and cooperation with other medical and welfare institutions [22]. Considering the fact that not only the amount but also the quality of rehabilitation affects the rehabilitation outcomes, it is understandable that there was a significant difference in FIM score gain between the two groups classified according to the amount of exercise in the report of Jeong *et al*. [19] and that the ranking of the three hospitals based on adjusted FIM efficiency differed from that based on the amount of exercise in our study.

The study by Jeong *et al*. [19] and our study differ not only in the outcome studied (FIM score gain versus FIM efficiency) but also in the assessment method. Jeong *et al*. [19] estimated discharge FIM score on the basis of clinical indices at admission to rehabilitation hospitals. The accuracy of their estimation equation was crucial in their study. On the other hand, the problem of our study is that the conclusion does not have statistical validity. Moreover, in both the study of Jeong *et al*. [19] and our study, it is impossible to state conclusively that there is a causal relationship between the rehabilitation system and ADL score gain or efficiency. It would be very interesting to determine which rehabilitation system has the greatest impact on the variability in ADL score gain and efficiency among hospitals. However, further study is needed to examine how to select the rehabilitation system-related factors to be studied and the methods to analyze these factors.

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