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Original Article

Relationships between training dose and Functional Independence Measure improvement in elderly stroke patients 75 years and older

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ABSTRACT
Tokunaga M, Watanabe S, Nakanishi R, Yamanaga H, Yonemitsu K, Tanaka M, Nakazono K, Kurotsuchi T, Kanaba S, Kawano S. Relationships between training dose and Functional Independence Measure improvement in elderly stroke patients 75 years and older. Jpn J Compr Rehabil Sci 2014; 5: 79−86.
Objective: To determine the relationships between training dose and functional independence measure (FIM) improvement in elderly stroke patients aged 75 years and older.
Methods: The subjects were 245 stroke patients hospitalized in a *kaifukuki* rehabilitation ward. Each subject's score can be calculated as follows: the value of A in the equation, Corrected motor FIM effectiveness = motor FIM gain / (A – motor FIM score at admission) was set as 38, 59, 80, 87, 91 (for motor FIM score at admission of 13−18, 19−24, 25−30, 31−36, 37−90 points, respectively). The subjects were divided into two groups according to the training dose: those with less than 5 sessions, and those with 5 or more sessions, and corrected motor FIM effectiveness was compared between these two groups.
Results: In patients aged 75−84 years and 85−96 years, corrected motor FIM effectiveness was significantly higher in the group attending 5 or more sessions than in the group attending less than 5 sessions.
Conclusion: Our study indicates that not only in elderly patients aged 75−84 years but also in those 85−96 years FIM improvement (corrected motor FIM effectiveness) was significantly higher in the subjects with a larger amount of training dose.
Key words: elderly patients, training dose, FIM gain, corrected motor FIM effectiveness, *kaifukuki* rehabilitation ward

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Introduction

It has been reported that the larger the amount of training dose, the more gains are achieved in functional independence measure (FIM), calculated as FIM score at discharge − FIM score on admission [1, 2]. On the other hand, there are studies reporting that the elderly showed low FIM gains [3−6].

There were two studies performed among stroke patients hospitalized in a *kaifukuki* rehabilitation ward [7], and demonstrated that "even among elderly with low FIM gains, those gains were significantly higher in the elderly with a larger amount of training dose than among elderly with a smaller amount of training dose [8, 9]." However, because patients were stratified into three age groups, those under 60, 60−69 and 70 years or older, both studies failed to show whether FIM gain was higher in patients with a larger amount of training dose versus patients with a smaller amount of training dose, even in the 75 years and older group and in the 85 years and older group.

This study aims to determine the relationship between the training dose and FIM improvement in elderly patients aged 75 years or older.

Subjects and Methods

A retrospective epidemiological study was conducted. Stroke patients who were admitted to a *kaifukuki* rehabilitation ward in M Hospital between Sep 27, 2006 and Oct 27, 2011, after undergoing treatment at acute hospitals, were enrolled. The following patients were excluded: those with subarachnoid hemorrhage, those who age was other than 65−96 years old, those admitted within 4 days or more than 60 days after onset, and those with a motor FIM score on admission of 91 points. And the remaining 245 patients were enrolled in this study (Table 1).

The subjects were older, had fewer days from onset of stroke to admission, were hospitalized for longer periods, had a lower total FIM score both at discharge and on admission, and had a smaller amount of training dose versus subjects of a national survey of *kaifukuki* rehabilitation wards [10].

Items surveyed include age, duration from onset to admission, total scores for motor items of FIM scores on admission (motor FIM on admission), total scores for cognitive items of FIM scores on admission (cognitive FIM on admission), total FIM gain for two months post-hospitalization, and number of training sessions per day for physical therapy, occupational therapy, and speech-language-hearing therapy. All survey items were entered, with no missing data. Each training session consisted of 20 minutes. The training sessions per day value was calculated from the average of the number of training sessions over 60 days. The FIM we used was FIM version 3 [11]. To eliminate the influence of the hospitalization, we used a 2-month FIM gain (FIM score at 2 months − FIM on admission), instead of the standard FIM gain (FIM score at discharge − FIM score on admission). Therefore, patients who were hospitalized for less than 60 days were excluded.

The *kaifukuki* rehabilitation ward of M Hospital has 85 beds where 17 physical therapists, 14 occupational therapists, and four speech-language-hearing therapists are assigned. In M Hospital, physicians who prescribe a rehabilitation program to determine the basic number of training sessions according to the status of each patient. Based on the number of available training sessions, they also carry out adjustments when visiting patients.

Study 1: Relationships between training dose and survey items

Five groups were created according to training dose: less than 4 sessions, 4−5 sessions, 5−6 sessions, 6−7 sessions, and a group who attended with a frequency of between 7 and 8.7 sessions. These five groups' median age, duration from onset of stroke to admission, motor FIM on admission, cognitive FIM on admission, and total FIM gain over two months were calculated. A Kruskal-Wallis test was conducted to determine whether there was a significant difference in these five survey items between the five groups. For the items found to have a significant difference, a multiple comparison procedure was done using Scheffé's method. A significance level of 5% or less was adopted.

Study 2: Relationships between training dose and motor FIM effectiveness/corrected motor FIM effectiveness

Regarding FIM gain, there is one drawback, in that

Table 1. Clinical characteristics of subjects in this study compared with national survey.

	This study	National survey [10]
Number of patients	245	4,908
Sex	Males 106, females 139	56.8% males, 43.2% females
Infarction, hemorrhage	Infarction 174, hemorrhage 71	−
Age	80.5 ± 7.6 (81)	72.0
Duration from onset of stroke to admission	18.1 ± 9.7 (16)	36.6
Length of hospital stay	133.8 ± 43.9 (133)	89.4
Motor FIM score at admission	34.8 ± 21.5 (31)	−
Cognitive FIM score at admission	18.0 ± 10.2 (17)	−
Total FIM score at admission	52.8 ± 29.9 (49)	68.4
Motor FIM score at 2 months	51.9 ± 28.7 (58)	−
Cognitive FIM score at 2 months	20.8 ± 10.8 (22)	−
Total FIM score at 2 months	72.7 ± 38.2 (82)	−
Motor FIM score at discharge	56.3 ± 29.0 (68)	−
Cognitive FIM score at discharge	21.8 ± 10.7 (24)	−
Total FIM score at discharge	78.0 ± 38.7 (89)	85.8
PT per day	2.4 ± 0.6 (2.5)	−
OT per day	2.3 ± 0.6 (2.5)	−
ST per day	0.8 ± 0.7 (0.8)	−
Training dose per day (POS)	5.6 ± 1.4 (5.7)	6.3

FIM, Functional Independence Measure.
Data for this study are expressed as number of patients, mean, or mean ± standard deviation.
POS, total number of training dose of physical therapy (PT), occupational therapy (OT), and speech therapy (ST).

the gain is low in the ranges of both low and high FIM on admission [12]. Out of this, the data of the range for high FIM on admission were corrected as follows: motor FIM effectiveness: motor FIM gain / (91 points − motor FIM on admission) [13]. Furthermore, the FIM improvement index was reached after correcting for the range of low gain in patients with low motor FIM on admission, from which we arrived at the corrected motor FIM effectiveness [14]. Thus, it became resistant to the influence of motor FIM on admission.

The scores of A for corrected motor FIM effectiveness, motor FIM gain / (A − motor FIM on admission), which were calculated according to the procedure by Tokunaga et al. [14] in M Hospital, were 38, 59, 80, 87, and 91 points when motor FIM on admission was 13−18, 19−24, 25−30, 31−36, and 37−90 points, respectively. A Kruskal-Wallis test was conducted to determine whether there was a significant difference in motor FIM gain, motor FIM effectiveness, and corrected motor FIM effectiveness among the five groups divided by training dose. For the items with significant difference, a multiple comparison test was done using Scheffé's method.

Study 3: Studies stratified according to age and training dose

Significantly, in Study 1, many training sessions were assigned to patients who were younger and showed higher motor FIM and cognitive FIM on admission. Therefore, we stratified age and used corrected motor FIM effectiveness, which is resistant to the influence of FIM on admission scores, as the FIM improvement index [14].

Patient age was stratified into three groups: 65−74, 75−84, and 85−96 years old. The number of training sessions was stratified into two groups: a group of patients attending less than 5 sessions, and a group of patients attending 5 or more sessions. In the 65−74-year-old patient group, a Mann-Whitney test was conducted to determine whether there was a significant difference in corrected motor FIM effectiveness between the two groups divided by training dose (the significance level was set at 5% or less). In 75−84- and 85−96-year-old patient groups, a comparison between the two groups was similarly performed. Another survey was performed using FIM gain and motor FIM effectiveness as the FIM improvement index.

This epidemiologic study was conducted with the approval of the institutional review board of M Hospital. All personal data were processed so as not to identify any individuals.

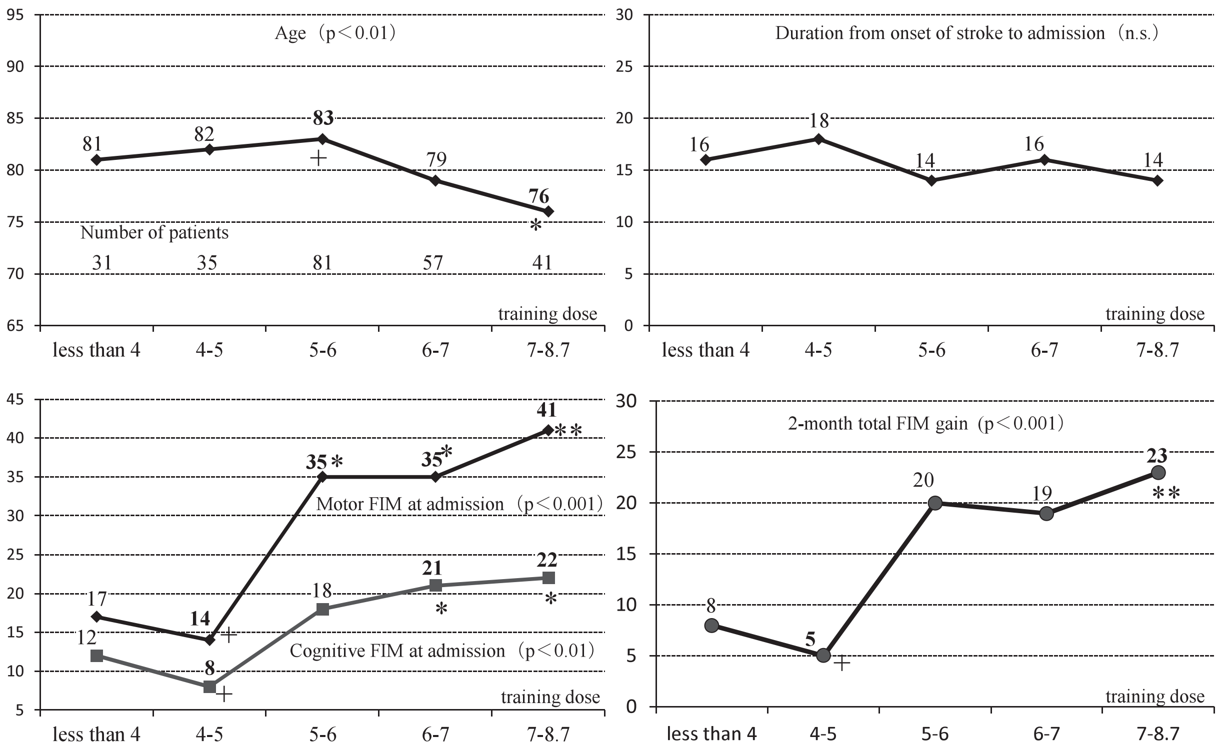

Figure 1. Relationships between training dose and median survey values.
Significant difference, significant difference among the five groups according to training dose (determined using Kruskal-Wallis test).
n.s., non-significant; Numerical value, number of patients or mean value.
+ and * (**), in a multiple comparison procedure (Scheffé's method), significant differences were seen between + and * (**); $p < 0.05$ ($p < 0.01$).

Results

Figure 1 shows the relationships between training dose and the median value item. The patients who had a higher number of training sessions showed significantly higher motor FIM on admission and cognitive FIM on admission and higher total FIM gain over two months (Kruskal-Wallis test, Figure 1). The multiple comparison showed significant differences in the following groups: for age: between the 5 session group and the 7 or more session group, for motor FIM on admission: between the 4 session group and the 5, 6 and 7 session groups; for cognitive FIM on admission: between the 4 session group and the 6 and 7 or more session groups; for total FIM gain over two months: between the 4 session group and the 7 or more session group (determined using Scheffe's method). For duration from onset of stroke to admission, there was no significant difference among the five groups divided by training dose (determined using the Kruskal-Wallis test, Figure 1).

Figure 2 shows the relationships between the training dose and the 2-month motor FIM gain, the 2-month motor FIM effectiveness, and the 2-month corrected motor FIM effectiveness. The larger the amount of training dose, the higher were the scores of all items (determined using the Kruskal-Wallis test). Multiple comparison showed significant difference in the following groups: for 2-month motor FIM gain: between the 4 session group and the 6 and 7 or more session groups; for 2-month motor FIM effectiveness: between the under 4 session group and the 7 or more session group, and for 2-month corrected motor FIM effectiveness: between the 4 session group and the 5, 6 and 7 or more session groups (Scheffe's method).

In patients aged 64−74 years, although the corrected motor FIM effectiveness was higher in the 5 or more session group than the under 5 session group, there was apparently no significant difference (Figure 3a). However, in patients aged 75−84 years and 85−96 years, the corrected motor FIM effectiveness was significantly higher in the 5 or more session group than in the under 5 session group (determined using the Mann-Whitney test, Figure 3a). The results of motor FIM gain (Figure 3b) and motor FIM effectiveness (Figure 3c) were similar to the results of corrected motor FIM effectiveness (Figure 3a).

Discussion

We were able to find two studies performed on stroke patients hospitalized in a *kaifukuki* rehabilitation ward that reported FIM gain as higher in elderly patients with a larger amount of training dose versus elderly patients with a smaller amount of training dose [8, 9]. Sonoda et al. [8] stratified the ages of the

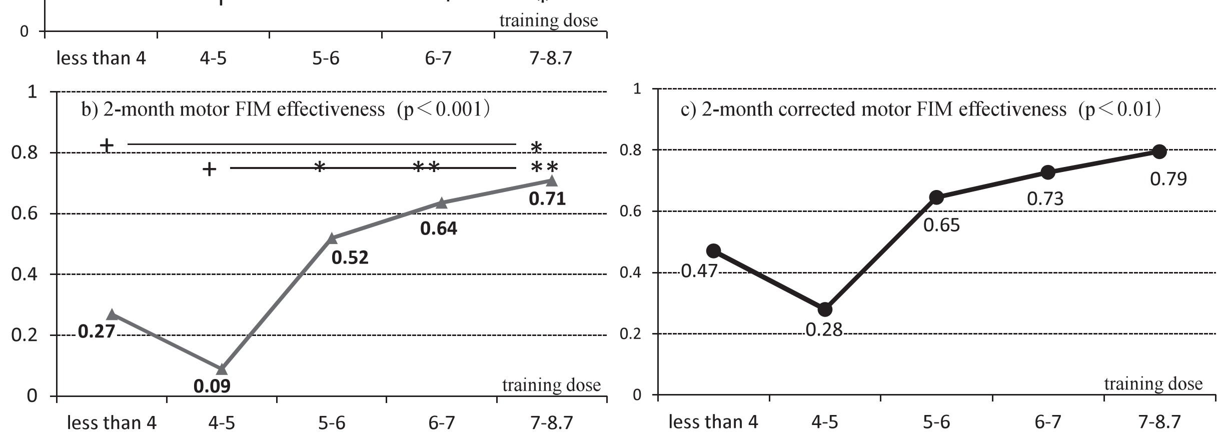

Figure 2. Motor FIM gain (a), motor FIM effectiveness (b), and corrected motor FIM effectiveness (c).
Significant difference, significant difference among the five groups according to training dose (determined using Kruskal-Wallis test).
Numerical value, median value.
⁺ and * (**), in a multiple comparison procedure (Scheffé's method), significant differences were seen between ⁺ and * (**); $p < 0.05$ ($p < 0.01$).

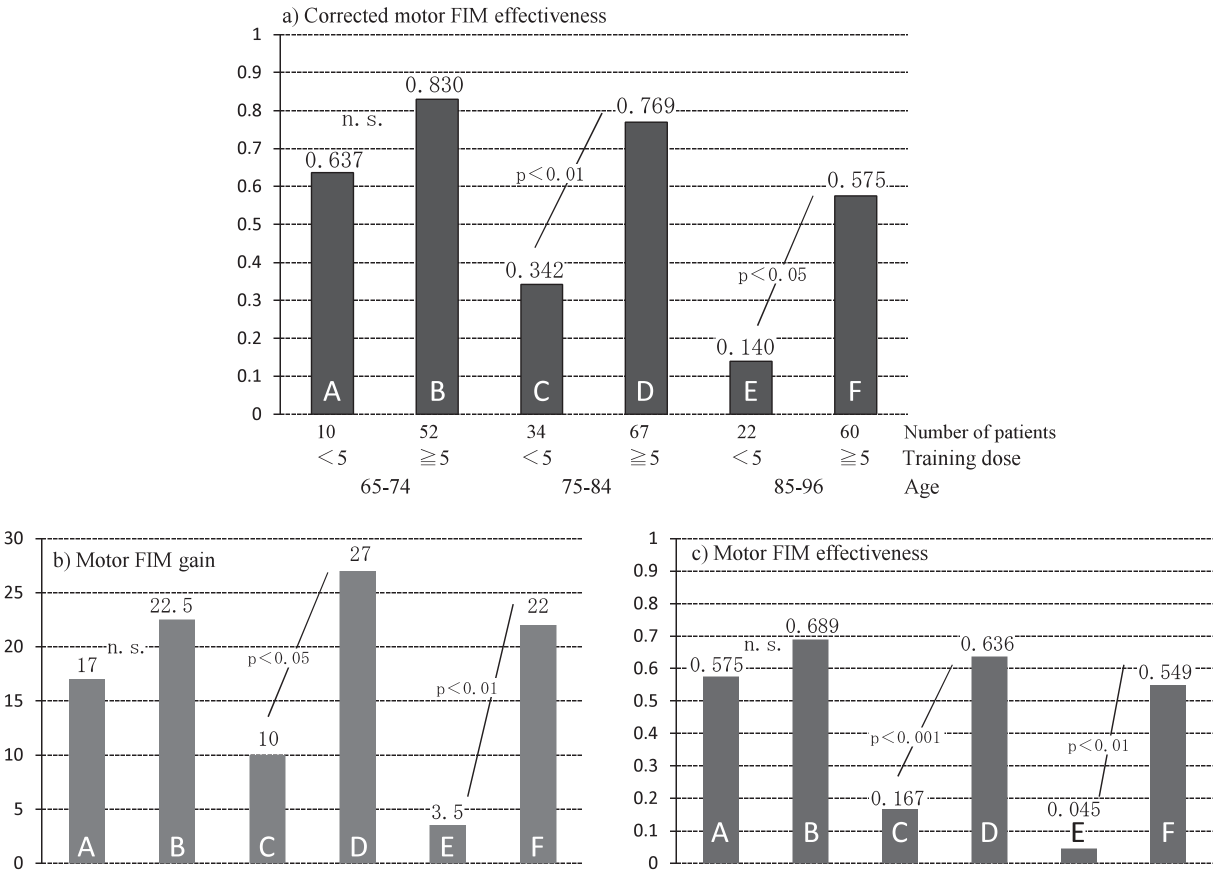

Figure 3. Corrected motor FIM effectiveness (a), motor FIM gain (b), and motor FIM effectiveness (c).
Significant difference, significant difference between the two groups divided by training dose (determined using Mann-Whitney test).
Numerical value, median value.
Training dose was less than five (A, C, and E) and five or more (B, D, and F); the ages were 65−74 (A and B), 75−84 (C and D), and 85−96 (E and F).

patients into three groups (those under 60, 60−69, and 70 years or older) and stratified the amount of training dose into two groups (conventional rehabilitation and Full-time Integrated Treatment [FIT] Program) [15]. They reported that the motor FIM gain in patients aged 70 years or older was significantly higher in the FIT Program group than in the conventional rehabilitation group (Table 2).

Watanabe et al. [9] also stratified the patients into a total of 12 groups, 3 by patient age (under 60, 60−69, and 70 years or older), 2 by amount of training dose (5−6 sessions and 7−9 sessions), and 2 by motor FIM on admission (less than 54 points and 54 points or more). They reported that the motor FIM gain in patients aged 70 years or older was significantly higher in the 7−9 session group than in the 5−6 session group (Table 2). However, in both studies, the patients aged 70 years or older were considered collectively.

Our study showed that FIM improvement (motor FIM gain, motor FIM effectiveness, and corrected motor FIM effectiveness) was significantly higher in patients with a larger amount of training dose, even in patients aged 75 years or older and patients aged 85 years or older, for whom there have been no reported findings.

There is controversy about whether many training sessions are truly required for elderly patients with low FIM gain. However, Wylie [16] emphasized that a uniform age limit should not be established for rehabilitation because some elderly patients recover in a similar manner to young people, though elderly patients over 65 years showed a poor response to rehabilitation on the whole.

The results of previous studies [8, 9], and our study demonstrate a significant difference in FIM improvement between patients with a larger amount of training dose and patients with a smaller amount of training dose among elderly stroke patients versus younger stroke patients. This indicates that there is great importance in increasing the number of training sessions among the elderly (Table 2).

Including the many patients requiring total assistance who show difficulty in FIM improvement, as well as patients requiring slight assistance and who show the ceiling effect exhibit only small FIM gains. Meanwhile, many patients requiring moderate

Table 2. Reports on training dose and FIM improvement in elderly.

Reports	Age: under 60	Age: 60−69	Age: 70 years or older	FIM improvement	Stratification by motor FIM at admission	Training dose
Sonoda et al. [8]	n.s.	n.s.	< 0.01	motor FIM gain	none	FIT > pre FIT
Watanabe et al. [9]	< 0.05 < 0.05	< 0.01 n.s.	< 0.01 < 0.05	motor FIM gain	less than 54 points 54 points or more	P+O: 7−9 training group > 5−6 training group

	65−74	75−84	85−96	FIM improvement	Stratification by motor FIM at admission	Training dose
This study	n.s.	$p < 0.01$	$p < 0.05$	corrected motor FIM effectiveness	not necessary	P+O+S: 5 or more training group > less than 5 training group

FIT: Full-time Integrated Treatment Program [15].
In patients aged 59 years or younger, there was no significant difference in motor FIM gain between the two groups (aged 59 years or younger) by Sonoda et al. [8].
FIT, group of patients who underwent long-term training; pre-FIT, group of patients who underwent short-term training before the introduction of FIT.
Motor FIM gain was significantly higher in the group in which P+O (total training dose of PT and OT) was 7−9 sessions than in the group in which P+O was 5−6 sessions in patients 59 years or younger in the study by Watanabe et al. [9].

assistance may have high gains [12]. The equation that adjusts for the ceiling effect is as follows. For motor FIM effectiveness: motor FIM gain / (91 points − motor FIM on admission) [13]. This can be used to determine the percentage of true improvement out of the total possibility for improvement. However, for motor FIM effectiveness, the low score in patients with low motor FIM on admission cannot be corrected. The corrected FIM effectiveness, solved the weakness of FIM effectiveness, became resistant to the influence of motor FIM on admission [14].

To demonstrate the association between the two factors of “age and training dose” and “FIM gain,” it is necessary to examine the relationships between the three factors of “age, training dose, and FIM on admission” and “FIM gain.” However, by stratifying patients according to these three factors, as shown in Watanabe et al. [9] the patients were classified into 12 groups only when classified into patient groups of three, two, and two, which leads to a smaller number of patients in each group. In addition, the mere classification into two groups by FIM on admission is insufficient to correct the low FIM gain in the range of low motor FIM on admission and high motor FIM on admission. For corrected motor FIM effectiveness, it is unnecessary to stratify patients according to FIM on admission, and instead what should be examined are the relationships between the two factors of “age and training dose” and the “corrected motor FIM effectiveness.” Therefore, corrected motor FIM effectiveness [14, 17] and corrected total FIM effectiveness [18] have begun to be used in studies on the impact of various factors on FIM improvement and for inter-hospital comparisons of FIM improvement.

In our study, the results of motor FIM gain, motor FIM effectiveness, and corrected motor FIM effectiveness were similar (Figures 2 and 3). It is thought that the results were not influenced by differences in examination method due to the clear fact that FIM improvement was significantly higher in elderly stroke patients who had a larger amount of training dose.

However, a close examination revealed that the scores of corrected motor FIM effectiveness (Figure 2c) were higher than those of motor FIM effectiveness (Figure 2b). The reason for this is that the low scores of motor FIM effectiveness in the range of motor FIM on admission of 36 points or less was corrected. Especially in the 4 session group, with low FIM on admission, the scores were greatly influenced by correction (a median motor FIM effectiveness of 0.09 increased to a corrected 0.28 motor FIM effectiveness).

The difference between motor FIM gain and corrected motor FIM effectiveness is as follows: the highest motor FIM gain was found in the patients with motor FIM on admission of 30−40 points [19], and both the patients with low motor FIM on admission and the patients with high motor FIM on admission showed low gain, while corrected motor FIM effectiveness was corrected so that the mean became approximately 0.65 regardless of the score of FIM on admission [14]. Therefore, the ratio between the 5 session group, in which the median FIM on admission was 35 points (entailing an easy gain in FIM), and the 4 session group, in which the median FIM on admission was 14 points, there was an approximately three times higher (21 points/7 points) corrected motor FIM gain (Figure 2a), more than the approximately 2.3 times (0.65/0.28) increase of the corrected motor FIM effectiveness (Figure 2c).

This study includes the following limitations. First, it was conducted within a single hospital.

Second, the patients under study were older and many of them had lower FIM on admission than those appearing in the national survey [10]. The preponderance of elderly patients made this study possible. The issue of low FIM on admission was solved by using corrected motor FIM effectiveness, which was resistant to the influence of FIM on admission. However, it is necessary to confirm the generalizability of these results using national data.

Third, the number of training sessions was not randomized, and there were various reasons for a smaller amount of training dose (a scarce number of available therapists, patients unable to undergo a rehabilitation program due to their physical condition, as well as other related reasons). We cannot deny the possibility that FIM improvement was low because many patients who could not undergo many rehabilitation programs due to physical conditions were included in the group with a smaller amount of training dose. In the future, further studies in which physical conditions such as comorbidities can be matched are expected.

Fourth, it is unclear what kind of influence the practice of excluding patients who were discharged within 60 days had. The patients whose FIM was so high that they were discharged within two months, as well as the patients whose FIM improvement was higher during periods of hospitalization, were excluded from this study. To determine how it influenced the results, it would be necessary to perform a study in which all patients (using the FIM gain of total length of hospital stay), which requires the correction of the impact of days of hospitalization. In addition, when 1-month FIM gain and 3-month FIM gain are surveyed, the presence of differences between the results of the survey and those of our study should be examined.

Fifth, the validity of the use of FIM effectiveness and corrected motor FIM effectiveness should be examined. There are few reports on FIM effectiveness in Japan, and it has been used more frequently for the study of the impact of factors on FIM improvement than on FIM gain in other countries [13]. However, corrected motor FIM effectiveness, which has only recently been reported in Japan in 2014, has not yet become widespread, and its validity as an FIM improvement index is not established. Corrected motor FIM effectiveness is expected to be used by many researchers in the future and its validity as an FIM improvement index that does not depend on FIM on admission will also be established.

Sixth, in this study, the usefulness of rehabilitation that consisted of 9 sessions for elderly stroke patients 75 years or older was not clear because a comparison between the under 5 session group and the 5 or more session group was performed.

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