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Original Article

Relationship between outcome in acute stroke patients and multiple stroke related scores obtained after onset of stroke

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Abstract. [Purpose] The purpose of this study is to examine the effectiveness of a stroke-related scale with regard to outcome, onset, and timing of stroke patients. [Participants and Methods] The participants included 583 out of 996 patients who were admitted to the stroke care unit.The outcomes and 3 stroke scale (National Institutes of Health Stroke Scale: NIHSS, Functional Independence Measure: FIM, modified Rankin Scale: mRS) scores immediately at hospitalization, on day 7 after onset, and on day 30 after onset were investigated. This study was analyzed using a generalization linear model with a binomial distribution. The comparisons between outcomes were made in terms of home discharge versus convalescence, and convalescence versus hospital transfer. [Results] Comparisons of home discharge versus convalescence hospital transfer showed a significant difference in the NIHSS and mRS scores at the time of hospitalization, and a significant difference in the NIHSS scale score on day 7 after onset. In comparisons between convalescence and hospital transfer, significant differences were observed in NIHSS and FIM scores at hospitalization, and the FIM scale score showed significant differences on day 7 and day 30. [Conclusion] The study suggested the efficacy of using multiple scales for prediction of stroke outcome with higher accuracy.
Key words: Stroke scale, Prognosis, Acute phase stroke

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INTRODUCTION

It is a well-known fact that the symptoms and severity of stroke patients vary greatly, and that symptoms do not uniformly occur even between patients whose impairments occur in the same site within the brain. For this reason, general clinical practice utilizes a digital evaluation scale so as to understand and diagnose the pathological condition in an objective manner. D'Olhaberriague et al.[1)] mentioned the usefulness of evaluation scales specific to diseases for understanding the pathological condition.

However, scales currently used are diverse, ranging from evaluation characteristics to the time of use. For example, among scales used for the acute phase of cerebral strokes, the National Institutes of Health Stroke Scale (NIHSS), Japan Stroke Scale (JSS) and Stroke Impairment Assessment Set (SIAS) are available as comprehensive indicators of severity, while the Canadian Neurological Scale (hereinafter CNS) and Scandinavian Stroke Scale (SSS) are available for the evaluation of neurological symptoms. Furthermore, the Functional Independence Measure (FIM) and modified Rankin Scale (mRS) have been used as indicators of activities of daily life[2)]. The NIHSS can be used to report the possibility of predicting gait

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prognosis or upper limb function[3], and studies have observed trends that link NIHSS and outcome prognoses[4], and reports that show that NIHSS can be extracted as a factor related to the ability of patients to be discharged to home[5]. Therefore, evaluation scales not only help to objectively understand the patient's condition, but they are also being used as providers of useful information to plan treatments and predict disease prognosis[6–9].

On the other hand, there was a report which concluded that the prediction of prognosis is difficult based on initial phase functional impairment assessed using NIHSS alone at the time of hospitalization[10], and there are limitations to the use of a single scale immediately after the onset of a stroke with significant changes.

As acute hospitals are required to reduce the number of hospital days and to decide the course of treatment early, it is very important to predict the prognosis using early-onset objective indicators. As mentioned previously, since there are limitations to using a single scale. It is considered that multiple stroke-related scales should be used over time and their relationship with pathological condition changes from the acute phase should be clarified. However, there are only a few previous studies based on the changes in pathological condition, and there have been no comparisons of the severity of scales according to the time of onset. Therefore, this study examined the significance between multiple stroke-related scales according to outcome in acute stroke patients, from the disease onset to time points thereafter.

PARTICIPANTS AND METHODS

This was a retrospective cohort study. Out of the 996 cases of acute phase stroke patients that developed a stroke between January 1st, 2014 and February 28th, 2016, and who were hospitalized at the Stroke Care Unit (SCU) and underwent physical therapy, this study included 583 cases that were not excluded according to our exclusion criteria. The exclusion criteria corresponded to cases with relapsing stroke; cases with subarachnoid hemorrhage; cases of death; cases with deteriorating condition; cases for that were bedridden or using a wheelchair prior to onset; and cases with incomplete data. In this research, we obtained both oral and written consent from all patients with regards to the manner in which the contents and results of evaluation during hospitalization will be used. The study was carried out with approval from the Yokohamashintoshi Neurological Hospital ethics committee.

The survey items are shown below, and we investigated them in a retrospective manner using the patients' medical records.

1) Basic attributes: Age, gender, and diagnosis.

2) Outcomes: These were defined as a group that directly returned home from the acute phase disease group after onset (Discharged to Home Group), a group that was transferred to the convalescence period hospital wing (Convalescence Group), and a group that was transferred to a facility other than in the convalescence period hospital wing, such as the nursing ward or long-term geriatric healthcare facilities (Hospital Transfer Group).

3) Stroke related scale: We adapted a total of three types of scales. The NIHSS was for the comprehensive severity evaluation scale, and the FIM and the mRS as ADL evaluation scales. The characteristics of the three types of stroke related scales are mentioned below. NIHSS[11] is classified as a comprehensive severity scale, and it was developed as a scale that objectively evaluates changes in neurological findings during the acute phase of a stroke. FIM[12] is classified as an ADL evaluation scale, and it allows for a detailed understanding of the ADL level. mRS[13] is classified under ADL evaluation scale, it is also used for consequential evaluations in addition to providing an overview of living conditions. In each scale, we extracted the score(s) measured at the time of hospitalization and day 7 after onset and day 30 after onset.

In terms of statistical analysis, we used a generalized linear model of the Bernoulli distribution with the outcomes as the dependent variables and the scores from each stroke-related scale as the explanatory variables. The scale score data of the outcomes were compared at each point in time, namely at hospitalization, day 7 after onset and day 30 after onset. According to reports about the link between severity classification and outcomes, it is said that there is a high tendency for discharged to home in groups to have mild cases, convalescence phase hospitals for moderate cases, and direct transfer to maintenance period hospitals and facilities for severe cases[14]. Therefore, this research also assumed a similar relationship between the severity classification and the outcome, and the analysis respected the conditions 1) Discharge to Home vs. Convalescence/ Hospital Transfer and 2) Convalescence vs. Hospital Transfer, in order to compare the mild cases with moderate and severe cases, and to compare moderate cases with severe cases. The aforementioned outcomes were compared at each time point, and scale with a large significant difference was extracted, respecting a significance level of 5%. For statistical processing, we used IBM SPSS Statistics 20 (Japan IBM Inc.)

RESULTS

The basic attributes are shown in Table 1. The mean score of each scale and the results of the generalized linear model at the hospitalization, day 7, and day 30 are shown in Table 2 and Table 3, respectively. Comparisons between the Discharge to Home Group and Convalescence Group/Hospital Transfer Group showed significant differences in NIHSS ($p<0.01$) and mRS ($p<0.01$) at hospitalization and NIHSS ($p<0.01$) on day 7, but not on day 30. Comparisons between the Convalescence Group and Hospital Transfer Group revealed significant differences in NIHSS ($p<0.05$) and FIM ($p<0.01$) at hospitalization, and in FIM ($p<0.01$) on day 7 and day 30.

Table 1. Characteristics of the patients (n=583)

Variables	N (%) or average ± SD
Age (years)	73.6 ± 13.9
Gender	
Male	333 (57%)
Female	250 (43%)
Type of stroke	
Atherothrombotic cerebral infarction	142 (24%)
Cardiogenic cerebral embolism	162 (28%)
Lacunar infarction	151 (26%)
Cerebral hemorrhage	128 (22%)
Outcome	
Home discharge	285 (49%)
Convalescence	140 (24%)
Hospital transfer	158 (27%)

SD: standard deviation.

Table 2. Score of the stroke-related scale (average ± standard deviation)

Outcome	NIHSS score (points)			FIM score (points)			mRS score (points)		
	Onset	Day7	Day30	Onset	Day7	Day30	Onset	Day7	Day30
Home discharge	3.3 ± 4.5	3.1 ± 3.7	4.5 ± 3.5	66.5 ± 38.4	90.7 ± 31.9	49.0 ± 35.4	2.6 ± 1.4	3.2 ± 1.3	4.5 ± 0.7
Convalescence	9.9 ± 8.2	10.6 ± 6.6	13.3 ± 7.1	52.4 ± 35.1	55.7 ± 28.1	46.2 ± 23.2	4.0 ± 1.2	4.3 ± 0.7	4.5 ± 0.5
Hospital transfer	13.2 ± 9.1	18.0 ± 9.8	18.7 ± 8.9	63.7 ± 37.1	27.2 ± 16.1	21.8 ± 5.7	4.4 ± 0.9	4.7 ± 0.5	4.8 ± 0.4

The horizontal axis shows three types of Stroke related score.

DISCUSSION

This research examined the significance between multiple stroke related scales according to the outcome of acute phase stroke patients at each point in time after onset. As stated above, since stroke related scale vary greatly in terms of the evaluation characteristics and factors at the time of use, it is very difficult to properly understand the condition of a participant at all points in time using a single scale. Therefore, there is great clinical value to understanding and combining the characteristics of multiple stroke-related scales and using them together.

The characteristics of the three types of stroke related scales used on this study are mentioned below. NIHSS[11] is classified as a comprehensive severity scale, and it was developed as a scale that objectively evaluates changes in neurological findings during the acute phase of a stroke. It is capable of evaluating awareness level, motor function, and higher brain function, but it takes around 15 minutes to take measurements. FIM[12] is classified as an ADL evaluation scale, and it allows for a detailed understanding of the ADL level. It contains not only motor/exercise items but also cognitive items, and its major feature is the evaluation of "ADL being done". Although mRS[13] is classified under ADL evaluation scale, it is also used for consequential evaluations in addition to providing an overview of living conditions. Even though it classifies a disorder in a fairly rough manner from asymptomatic to death, it is a very convenient scale to use.

Based on the results of this study, we were able to observe that the link between the three types of scales change according to the outcome and the time of measurement. First, in the examination of highly related scales in Discharge to Home Group vs. Convalescence/Hospital Transfer Group, the significant scales differed depending on the time of measurement. NIHSS was significant on day 7 after initial onset, and mRS was significant only at initial onset. Thus, it was suggested that during initial onset, a method that primarily uses NIHSS may be useful, taking into consideration the outcome from the two types of scales as time passes. While FIM was significant for this comparison between outcome groups, it is conceivable that this is because FIM scores are "ADL", and because it scores the "ADL being done". The reason for this is that ADL is inhibited, particularly due to the fact that disease-specific symptoms during the hyperacute phase of strokes are transiently severe. What is more, during the hyperacute period, in order to avoid excessive physical burden on the body, restrictions such as maintenance of seated position and prohibition of walking have been imposed on the level of resting from a therapeutic viewpoint, which often leads to patients not being able to fully demonstrate their ADL potential in daily life. For this reason, FIM, which examines "ADL being done." does not likely reflect the correct score.

When comparing the Convalescence Group and the Hospital Transfer Group, NIHSS was significant up until day 7 since

Table 3. Generalized linear model

	Outcome	Factor	Coefficient	Standard error	Odds ratio	p value	95% CI	
Onset	Home discharge vs Convalescence• Hospital transfer	constant	−2.755	0.381				
		NIHSS	0.133	0.024	1.142	0.000	1.090–1.197	***
		FIM	−0.005	0.003	0.995	0.087	0.990–1.001	
		mRS	0.653	0.105	1.921	0.000	1.565–2.359	***
	Convalescence vs Hospital transfer	constant	−1.500	0.556				
		NIHSS	0.034	0.017	1.034	0.042	1.001–1.068	*
		FIM	0.009	0.003	1.009	0.009	1.002–1.015	**
		mRS	0.167	0.136	1.182	0.221	0.905–1.543	
Day7	Home discharge vs Convalescence• Hospital transfer	constant	−1.906	1.730				
		NIHSS	0.276	0.085	1.318	0.001	1.116–1.557	**
		FIM	−0.010	0.010	0.990	0.313	0.970–1.010	
		mRS	0.484	0.302	1.622	0.110	0.897–2.935	
	Convalescence vs Hospital transfer	constant	3.647	2.430				
		NIHSS	0.025	0.029	1.025	0.000	0.968–1.085	***
		FIM	−0.057	0.015	0.944	0.000	0.918–0.972	***
		mRS	−0.391	0.460	0.676	0.393	0.274–1.665	
Day30	Home discharge vs Convalescence• Hospital transfer	constant	2.455	8.520				
		NIHSS	0.420	0.307	1.522	0.171	0.834–2.779	
		FIM	0.009	0.040	1.009	0.816	0.933–1.092	
		mRS	−0.756	1.783	0.469	0.671	0.014–15.456	
	Convalescence vs Hospital transfer	constant	32.230	16.445				
		NIHSS	−0.090	0.082	0.914	0.271	0.779–1.073	
		FIM	−0.358	0.138	0.699	0.009	0.534–0.916	**
		mRS	−4.200	2.594	0.015	0.105	0.000–2.420	

Comparisons between conditions 1) Discharge to Home vs. Convalescence/Hospital Transfer and 2) Convalescence vs. Hospital Transfer, were made at each time of onset, day 7, day 30, respecting a significance level of 5%.
*p<0.05, **p<0.01, ***p<0.001.

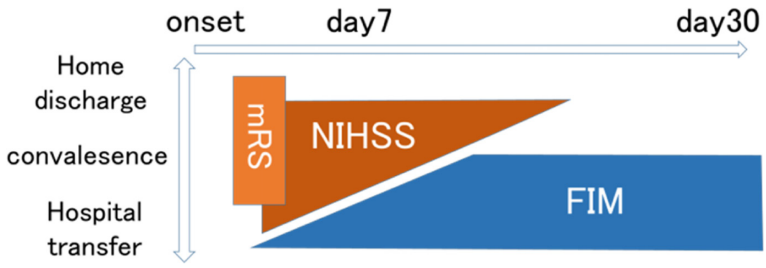

Fig. 1. Contribution of the scale by measurement time and the outcome.
The vertical axis shows the destination and the horizontal axis shows the period from onset. In each Stroke related scale, it shows the timing of high relation and the outcome.

onset, while FIM was highly significant at all points in time. This suggested that at initial onset, NIHSS can make predictions regardless of the outcome, and the accuracy of prediction could be improved by using mRS and FIM together depending on the outcome. It is said that the decision to transfer a severe stroke patient to convalescence depends not only on the functionality, but also on the ADL capacity, social skills, and their respective levels of change[15], which is why it was presumed that FIM is significant at all points in time.

Depending on time/outcome, the criteria for evaluating each group differs, and this study suggested that in groups with early onset and discharge to home cases, comprehensive information becomes important, whereas in cases where certain number of days have elapsed since onset or when making decisions about transferring a patient to the convalescence ward, information on ADL becomes more important (Fig. 1). In order to shorten the number of days spent at the hospital and to improve the rate of return to home, early treatment planning is essential[16], and we can expect this treatment planning to

become easier by appropriately using multiple scales.

This research examined the link between outcomes and the total scores of each stroke-related scale, but we did not examine the scale sub-items. In future, it is necessary to focus on each of the sub-items and examine the interactions with other items. Moreover, although it is well-known that the recovery process differs depending on the type of stroke and it is easy to predict that the trends in scales will change accordingly. We have not examined the link between the disease type, surgical history, and complications etc. We can expect to improve the prediction accuracy of outcomes by classifying conditions into more detail, including the difference in disease type, presence/absence of complications, and type of complications. This study focused its evaluations to the time of onset, day 7, and day 30 after onset and did not evaluate the period between these time points, so the course of recovery remains obscure. For this reason, it is necessary not only to perform relationship analysis between the aforementioned items and other information, but also to carry out analyses at each point in time as the frequency of evaluations increases. It is also necessary to clarify the determinants of discharge outcomes into more detail, and this remains a challenge for the future.

Conflict interest

None.

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