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ORIGINAL REPORT

DISCRIMINATIVE, PREDICTIVE AND EVALUATIVE PROPERTIES OF THE SIMPLIFIED STROKE REHABILITATION ASSESSMENT OF MOVEMENT INSTRUMENT IN PATIENTS WITH STROKE

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Objective: **To justify the utility of the Simplified Stroke Rehabilitation Assessment of Movement Instrument (S-STREAM), we examined the discriminative, predictive and evaluative properties of the 3 subscales of the S-STREAM (i.e. upper-limb movements, lower-limb movements and mobility) in patients after stroke.**
Subjects: **A total of 388 patients after stroke participated in this study. To examine the discriminative property, the patients were divided into 3 groups according to their Barthel Index scores. A comprehensive measure of activities of daily living was administered at 6 months after hospital discharge as an external criterion to examine the predictive property. Changes in the S-STREAM scores from the time of admission for rehabilitation, to hospital discharge, were used to examine the evaluative property.**
Results: **All pair-wise comparisons of mean scores among the 3 groups on the 3 subscales of the S-STREAM were significant. The scores of the S-STREAM showed moderate to good correlations with the comprehensive activities of daily living scores. There were large changes in the 3 subscales of the S-STREAM.**
Conclusion: **All 3 subscales of the S-STREAM demonstrate good discriminative, predictive and evaluative properties in patients after stroke. These findings provide strong evidence that the S-STREAM is useful in measuring motor and mobility function in patients after stroke.**

Key words: psychometrics, stroke, simplified stroke rehabilitation assessment of movement, Rasch analysis.

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INTRODUCTION

Since motor and mobility problems are very common in patients after stroke (1), assessment of motor and mobility in those patients is important in planning treatment, making a prognosis, and assessing recovery over time (2). Measures useful for assessing motor and mobility in both clinical and research settings should have 3 properties: discrimination, prediction and evaluation (3). The *discriminative* property of a measure is important in determining whether it can differentiate between patient groups and identify differences in patients' abilities (4). A *predictive* measure can be used to predict outcome or make a prognosis, help clinicians set treatment goals or discharge plans, and anticipate the need for home adjustments or community support (5, 6). An *evaluative* measure is useful for detecting the magnitude of longitudinal change over time in an individual or group (3, 7). Therefore, to ensure that a measure can be used properly in clinical and research settings, it is important to examine the discriminative, predictive and evaluative properties of the measure (3).

The Stroke Rehabilitation Assessment of Movement (STREAM) was developed as an outcome instrument to evaluate the motor and basic mobility function of patients after stroke (8). The STREAM consists of 3 10-item subscales: upper-limb movements, lower-limb movements, and mobility subscales (8). The psychometric properties of the STREAM are satisfactory in patients after stroke (2, 9, 10). However, since some items of the STREAM have been shown to be redundant (11), and it would be useful to improve the efficiency of administration of this measure, the 30-item STREAM was shortened to produce the 15-item Simplified STREAM (S-STREAM), with changes based on expert opinions and the results of multidimensional Rasch modelling (11).

The multidimensional Rasch model is an extension of the unidimensional Rasch model. The unidimensional Rasch model can be used to examine whether items from a scale measure a unidimensional construct through fit statistics and produce interval-level scores called logits (12). However, in practice, there are many instruments that contain multiple subscales that measure different dimensions. To compensate for this, the multidimensional Rasch model has been advocated recently (13). The multidimensional Rasch model can be used not only to determine the unidimensionality (a type of construct validity) of each domain of a measure but also to increase measurement precision by simultaneously taking the correlations of

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all subscales into account (13, 14). The higher the correlations among the subscales, the greater the measurement precision (i.e. reliability) (14). The multidimensional Rasch model can also be applied to the simplification of measures while maintaining measurement precision. Because the 3 subscales of the STREAM are highly correlated with each other (2), the multidimensional Rasch model was used to produce the S-STREAM (11). The S-STREAM has high reliability (Rasch reliability coefficient ≥ 0.91) and high concurrent validity with the STREAM (intraclass correlation coefficient (ICC) ≥ 0.99) in patients after stroke (11).

There are 2 advantages of the S-STREAM scores that come with using the multidimensional Rasch analysis: interval scores, and the large number of estimates (i.e. levels of functions) of the patients' motor and mobility functions. While the raw scores of the S-STREAM are ordinal, the Rasch transformed scores are interval and are reported in units called logits. Logits, which can be added, subtracted, multiplied and divided, are more useful and meaningful for comparison than ordinal scores. Thus, the interval Rasch scores of the 3 subscales of the S-STREAM (11) can more precisely quantify the motor and mobility functions than can the ordinal scores of the original form. In addition, because there are large numbers of estimates of the patients' motor and mobility functions of the S-STREAM (e.g. 191 estimates in a previous study compared with 11 possible scores (0–10) of the raw scores of the upper-limb movement subscale) (11), these additional estimates might improve its psychometric properties (e.g. discriminative and evaluative properties). However, the discriminative, predictive and evaluative properties of the 3 subscales of the S-STREAM have not been examined, which could limit understanding of its utility for documenting differences, making prognoses and evaluating progress in motor and mobility function after stroke.

The purpose of this study was to examine the discriminative, predictive and evaluative properties of the 3 subscales of the S-STREAM in patients with stroke at 3 time points (at admission for rehabilitation, at hospital discharge and at 6 months after hospital discharge). We also compared these properties of the S-STREAM with those of the STREAM.

METHODS

This study had 3 parts. First, the discriminative property of the S-STREAM was examined in the patients at 2 time points (i.e. admission for rehabilitation and hospital discharge). Secondly, the predictive property was examined to determine whether the patients' scores on the S-STREAM at admission for rehabilitation and at hospital discharge could predict comprehensive activities of daily living (C-ADL) function at 6 months after hospital discharge. Thirdly, the evaluative property of the S-STREAM was determined by examining the extent of the patients' change scores between the time of admission for rehabilitation and hospital discharge.

Participants

Patients were recruited from the Departments of Physical Medicine and Rehabilitation at 5 hospitals in Taiwan between April 2004 and October 2005. The following criteria were used to determine whether patients could be included in this study: (*i*) first or recurrent onset of cerebrovascular accident without other major diseases (e.g. cancer, amputation, severe rheumatoid arthritis); (*ii*) stroke with hemiparesis or hemiplegia; (*iii*) ability to follow instructions to complete the measures; (*iv*) informed consent given personally or by proxy. The patients were excluded if they were discharged within one week of admission for rehabilitation. This study protocol was approved by a local Institutional Review Board.

Procedure

At admission for rehabilitation and at hospital discharge, the STREAM and the Barthel Index (BI) were administered to patients after stroke by one therapist from a group of 12 (3 physical therapists and 9 occupational therapists) who were experienced in using the measures. The inter-rater reliabilities of these raters on the 3 subscales of the STREAM (ICCs > 0.96) and the BI (ICC = 0.99) were satisfactory. The S-STREAM data were obtained from the full-length STREAM data of the same sample. In addition, at 6 months after hospital discharge, the BI and the Frenchay activities index (FAI) were administered to patients with stroke through telephone interview by an occupational therapist. The BI and the FAI scores were combined to represent the C-ADL function (15). Demographic characteristics and co-morbidity data for the participants were collected from medical records.

Instruments

STREAM. The STREAM consists of 30 items that are equally distributed among 3 subscales: upper-limb movements, lower-limb movements and mobility (8). Limb movements are scored on a 3-point scale (0–1–2). Mobility items are scored on a 4-point scale (0–1–2–3) (8, 10). Thus, each of the 10-item limb subscales was scored out of 20 points, and the 10-item mobility subscale was scored out of 30 points. The psychometric properties (including the inter-rater reliability, intra-rater reliability, internal consistency, concurrent validity, convergent validity, discriminant validity, predictive validity and responsiveness) of the STREAM are satisfactory in patients with stroke (2, 9, 10). The raw scores of each subscale of the STREAM were used in this study.

S-STREAM. The S-STREAM also contains 3 subscales. Each of the subscales has 5 items retrieved from the STREAM (Appendix) (11). The scaling of each subscale is the same as that of the STREAM. The raw scores of each subscale of the S-STREAM can be transformed to Rasch scores (11) using a computer program (which can be downloaded at http://homepage.ntu.edu.tw/~clhsieh/s-stream/). Due to the use of the multidimensional Rasch model (13, 14), patients who, for example, have the same raw upper-limb movement scores but different lower-limb movement scores or mobility scores could have different, and thus increased, numbers of Rasch estimates for their upper-limb movement scores. The Rasch transformed scores of each subscale of the S-STREAM were used in this study.

BI. The BI was developed to assess ADL function in persons with neurological or musculoskeletal disorders (16). The BI comprises 10 items of basic ADL (16). The total score range of the BI is 0–20 (17). A higher score indicates higher independence in basic ADL function. The psychometric properties of the BI in patients after stroke have been shown to be satisfactory (17–19). As in a previous study (20), the patients were classified into 3 levels of disability on the basis of their BI scores in this study, i.e. independent (BI = 19–20), mild to moderate disability (BI = 11–18), and severe disability (BI = 0–10).

FAI. The FAI (21) was developed to measure instrumental ADL and social activities following stroke. It comprises 15 items, and the total score ranges from 0 to 45. The FAI has been shown to be a reliable and valid measure of instrumental ADL in patients after stroke (22, 23).

C-ADL. The BI and the FAI scores can be combined to represent C-ADL function, representing the entire continuum of disability (15). The C-ADL contains 10 items of the BI and 13 items of the FAI (15). In addition, the BI (24) and the FAI (25) are reliable and valid when administered via telephone interview. The Rasch scores (logits) of the C-ADL proposed by Hsueh et al. (15) were used in this study.

Data analysis

Because the Rasch scores for each subscale of the S-STREAM and the total scores for each subscale of the STREAM have different score ranges, all scores were linearly transformed to a range of 0–100 (11). In addition, to facilitate comparison of the psychometric properties of the S-STREAM and the STREAM, we followed previous studies (9, 10) in using parametric statistical procedures to analyse the STREAM scores.

Discriminative property

A previous study showed that the STREAM can distinguish between different levels of disability (9). Thus, we examined the ability of the 3 subscales of the S-STREAM and the STREAM to discriminate between the 3 groups with different levels of disability according to their BI scores (independent, mild to moderate disability, and severe disability groups) (20) at admission for rehabilitation and at hospital discharge, respectively. Differences of mean scores among the 3 groups were tested with 1-way analysis of variance (ANOVA). All pair-wise comparisons of mean scores of the 3 subscales among 3 groups used the Tukey-Kramer test, where necessary. In addition, the floor and ceiling effects of the subscales of the S-STREAM and the STREAM were examined.

Predictive property

A previous study found that the STREAM at first week post-stroke can predict independence in ADL function at 3 months post-stroke (9). In this study, we examined whether the scores of the S-STREAM at admission for rehabilitation and at hospital discharge could predict the C-ADL function in patients after stroke at 6 months after hospital discharge. The associations between the 3 subscales of the S-STREAM and the C-ADL function were examined with the Pearson's correlation coefficient (r), as well as the STREAM and the C-ADL. Correlations between 0 and 0.25 were considered to indicate low predictive ability of the measures; those between 0.25 and 0.5, fair predictive ability; those between 0.5 and 0.75, moderate to good predictive ability; and those greater than 0.75, good to excellent predictive ability (26).

Evaluative property

Various indicators have been proposed to examine the responsiveness of a measure, but there is no consensus on the preferred method (27, 28). The paired t-test and the standardized response mean (SRM) are widely used for examination of responsiveness in the literature (27). The paired t-test focuses on the statistical significance of the observed change in the measure (27). The SRM, a type of effect size, is the ratio of mean observed change and standard deviation of the changed scores (27). These 2 indicators were used to examine the evaluative properties of the 3 subscales of the S-STREAM and the STREAM in this study. First, the SRMs of the S-STREAM and the STREAM were calculated based on the scores on both measures at admission for rehabilitation and at hospital discharge. According to Cohen's criteria (29), an effect size greater than 0.8 is large, one of 0.5 to 0.8 is moderate, and one of 0.2 to 0.5 is small. Second, a paired t-test was performed to examine the statistical significance of the changes in scores from admission for rehabilitation to hospital discharge.

RESULTS

Sample description

A total of 388 patients after stroke were recruited in this study and completed the first assessment (at admission for reha-

Table I. *Demographic and clinical characteristics of participants.*

Characteristic	All patients (n = 388)	Patients who completed 2 assessments (n = 195)	Patients who completed 3 assessments (n = 157)
Sex (men/women) (n)	259/129	130/65	107/50
Age (mean (SD)) (years)	64.7 (13.4)	63.4 (13.7)	62.8 (13.8)
Side of lesion, right/left (n)	221/167	109/86	85/72
Time from stroke onset to admission for rehabilitation (mean (SD)) (days)	44.8 (62.5)	53.0 (66.2)	54.6 (67.0)
BI scores at admission for rehabilitation (mean (SD))	7.9 (5.7)	8.1 (5.9)	8.2 (6.0)
S-STREAM* scores at admission for rehabilitation (mean (SD))			
Upper-limb subscale score	45.4 (33.9)	43.5 (31.6)	43.5 (31.6)
Lower-limb subscale score	44.7 (32.6)	43.0 (30.3)	43.2 (30.3)
Mobility subscale score	43.3 (29.8)	42.1 (27.6)	42.5 (27.5)
S-STREAM* scores at hospital discharge (mean (SD))			
Upper-limb subscale score		54.4 (32.7)	54.1 (32.8)
Lower-limb subscale score		54.5 (31.6)	54.5 (31.6)
Mobility subscale score		54.6 (28.9)	55.1 (28.9)
STREAM* scores at admission for rehabilitation (mean (SD))			
Upper-limb subscale score	46.8 (42.7)	43.3 (40.1)	42.8 (41.1)
Lower-limb subscale score	42.5 (38.1)	40.2 (36.3)	40.4 (36.5)
Mobility subscale score	39.2 (29.4)	38.2 (28.3)	38.6 (28.3)
STREAM* scores at hospital discharge (mean (SD))			
Upper-limb subscale score		52.7 (41.4)	51.3 (41.8)
Lower-limb subscale score		51.9 (38.3)	51.4 (38.1)
Mobility subscale score		52.8 (29.5)	53.5 (29.5)
Interval between admission for rehabilitation and hospital discharge (mean (SD)) (days)		29.4 (14.0)	
Interval between hospital discharge and 6 months after hospital discharge (mean (SD)) (days)			184.1 (7.3)

*The Rasch scores of the S-STREAM and the raw scores of the STREAM were linearly transformed to a 0–100 range. STREAM: Stroke Rehabilitation Assessment of Movement; S-STREAM: Simplified STREAM; SD: standard deviation; BI: Barthel index.

bilitation), but 193 of these were lost to second assessment either because they were discharged directly from the wards without the therapists being informed or because the patients developed other major medical conditions. The remaining 195 patients (50.3%) completed the second assessment at hospital discharge, and their data were analysed for this study. The scores of the 195 patients were found to be scattered entirely throughout the ranges of the 3 subscales of the STREAM, indicating that the patients had a wide range of motor and mobility deficits. The mean baseline scores of the 3 subscales between the remaining 195 patients and the 193 patients lost at second assessment were not statistically different ($p > 0.05$), indicating that the motor and mobility functions of these 2 groups did not differ statistically. A telephone interview was conducted at 6 months after hospital discharge. Thirty-eight (19.5%) out of the 195 patients were lost to follow-up because of incorrect contact information, unavailability or death. Demographic and clinical characteristics of the participants are shown in Table I. Their mean age was about 65 years, and 2/3 (66.8%) were male. The average time from stroke onset to admission for rehabilitation was 1.5 months. The mean baseline BI score of the patients was 7.9, indicating severe disability.

Discriminative property

Table II shows that the Rasch transformed scores of the 3 subscales of the S-STREAM had neither a notable floor effect nor a notable ceiling effect at admission for rehabilitation or at hospital discharge. Furthermore, the extents of the floor and ceiling effects on the 3 subscales of the S-STREAM were all the same (e.g. the numbers of patients achieving the highest possible scores of the 3 subscales were all the same (i.e. 7) at admission for rehabilitation). Because of the use of the multidimensional Rasch analysis, only the patients who achieved the lowest or highest raw scores of all 3 subscales of the S-STREAM simultaneously (e.g. the raw scores of the 3 subscales were all zero) had the lowest or highest Rasch transformed scores. In other words, the patients who achieved the above conditions were exactly those who had the lowest or highest Rasch transformed scores on each individual subscale. Therefore, the same number of patients had the lowest or highest Rasch transformed scores of the 3 subscales of the S-STREAM.

In addition, it was noted that both the upper-limb and the lower-limb movement subscales of the STREAM showed notable floor and ceiling effects (13–33%) at admission for rehabilitation and at hospital discharge (Table II).

The patients were divided into 3 groups based on their BI scores. Table III shows the number in each group of disability level at admission for rehabilitation and at hospital discharge. At admission for rehabilitation, just over 2/3 (68%) of the patients had severe disability. At hospital discharge, about half (52%) of the patients had mild to moderate disability.

At admission for rehabilitation, all pair-wise comparisons of mean scores among 3 groups using the Tukey-Kramer test on the 3 subscales of the S-STREAM and the STREAM were statistically significant ($p < 0.05$), except that the differences between the independent group and the mild to moderate disability group on the upper-limb movement subscales of the STREAM ($p = 0.24$) were not statistically significant.

At hospital discharge, all pair-wise comparisons of mean scores among the 3 groups using the Tukey-Kramer test on the 3 subscales of the S-STREAM and the STREAM were statistically significant ($p < 0.05$). The results indicate that the 3 subscales of the S-STREAM and the STREAM can discriminate patients with the 3 different levels of disability at hospital discharge.

Predictive property

Table IV shows that the scores of the 3 subscales of the S-STREAM at 2 different times had moderate to good correlations with the C-ADL scores at 6 months after hospital discharge (Pearson's $r = 0.51–0.60$). In addition, the scores of the upper-limb movement subscale of the STREAM showed fair correlations with the C-ADL scores at admission for rehabilitation (Pearson's $r = 0.39$) and at discharge (Pearson's $r = 0.45$). The scores of the lower-limb movement and mobility subscales of the STREAM at the 2 different times showed moderate to good correlations with the C-ADL scores (Pearson's $r = 0.51–0.62$). The results indicate that the 3 subscales of the S-STREAM and the STREAM have acceptable predictive ability for C-ADL function.

Table II. *Floor and ceiling effects of the S-STREAM and the STREAM at admission for rehabilitation (n = 388) and at hospital discharge (n = 195).*

	Admission for rehabilitation		Hospital discharge	
Scale	Floor effect *n* (%)	Ceiling effect *n* (%)	Floor effect *n* (%)	Ceiling effect *n* (%)
S-STREAM*	28 (7.2)	7 (1.8)	4 (2.1)	3 (1.5)
STREAM				
Upper-limb subscale	127 (32.7)	88 (22.7)	41 (21.0)	51 (26.2)
Lower-limb subscale	94 (24.2)	53 (13.7)	25 (12.8)	38 (19.5)
Mobility subscale	20 (5.2)	3 (0.8)	5 (2.6)	3 (1.5)

STREAM: Stroke Rehabilitation Assessment of Movement;
S-STREAM: Simplified STREAM.
*Only 1 set of values of the floor and ceiling effects of the S-STREAM is presented in this table since the values of the floor and ceiling effects of the 3 subscales of the S-STREAM are the same due to the use of the multidimensional Rasch model.

Table III. *The number in each group of disability level at admission for rehabilitation and at hospital discharge.*

	Independent group	Mild to moderate disability group	Severe disability group
At admission for rehabilitation (*n* = 388)	19	105	264
At hospital discharge (*n* = 195)	18	101	76

Table IV. *Relationships between the S-STREAM and the STREAM at 2 different time points and C-ADL function at 6 months after hospital discharge (n = 157).*

Scale	Predictive validity for C-ADL function	
	At admission for rehabilitation r (95% CI)	At hospital discharge r (95% CI)
S-STREAM		
Upper-limb subscale	0.51* (0.37–0.65)	0.54* (0.41–0.68)
Lower-limb subscale	0.54* (0.41–0.67)	0.56* (0.43–0.69)
Mobility subscale	0.58* (0.45–0.71)	0.60* (0.47–0.73)
STREAM		
Upper-limb subscale	0.39* (0.24–0.53)	0.45* (0.31–0.59)
Lower-limb subscale	0.51* (0.38–0.65)	0.52* (0.39–0.66)
Mobility subscale	0.59* (0.46–0.71)	0.62* (0.50–0.75)

*$p < 0.01$.
STREAM: Stroke Rehabilitation Assessment of Movement; S-STREAM: Simplified STREAM; C-ADL: comprehensive activities of daily living; CI: confidence interval.

Evaluative property

Table V shows that the evaluative properties of the 3 subscales of the S-STREAM were large from admission for rehabilitation to hospital discharge (SRM = 0.90–1.06, $p < 0.001$). In addition, the evaluative properties of the upper-limb and lower-limb movement subscales of the STREAM were moderate (SRM = 0.56 and 0.72, $p < 0.001$), and that of the mobility subscale of the STREAM was large (SRM = 1.00, $p < 0.001$) from admission for rehabilitation to hospital discharge.

DISCUSSION

For the sample of patients after stroke in the current study, the results show that the 3 subscales of the S-STREAM have good discriminative, predictive and evaluative properties. They suggest that the S-STREAM can enable both clinicians and researchers to identify, monitor and manage motor and mobility function after stroke.

Neither a floor effect nor a ceiling effect was found when the 3 subscales of the S-STREAM were applied to the sample of patients. Since the S-STREAM, using a multidimensional Rasch model incorporating information from all 3 subscales, produced more estimates of motor and mobility function for the patients than those of the original scoring scheme, fewer patients achieved the highest and lowest scores on the S-STREAM. In addition, the 3 subscales of the S-STREAM can discriminate differences in motor and mobility function in patients with 3 different levels of disability (independent, mild to moderate disability, and severe disability) at admission for rehabilitation and at hospital discharge. The ability of the S-STREAM to differentiate among the 3 groups reflects its clinical usefulness for distinguishing patients with stroke with different levels of disability.

In clinical settings, clinicians may rely on a measure with good predictive ability as their reference to determine appropriate rehabilitation interventions and discharge plans for patients with stroke. Predictive validity is frequently obtained by computing correlation coefficients between 2 measures separated by the required time interval (30). In this study, the scores of the 3 subscales of the S-STREAM at admission for rehabilitation and at hospital discharge were moderately to highly associated with those of the C-ADL at 6 months after hospital discharge. These results indicate that the 3 subscales of the S-STREAM have good predictive validity for C-ADL function in patients with stroke. However, we did not control the possible covariates (e.g. cognition, postural control) when we examined the association between the STREAM and the C-ADL. The covariates may also contribute to predictions of the C-ADL function of patients. Further studies that control for covariates may be needed in order to further validate the predictive validity of the S-STREAM.

The evaluative properties are affected by the timing of the assessments. In this study, we examined how large changes can be detected by the S-STREAM in patients with stroke between admission for rehabilitation and hospital discharge (the mean interval was about one month). The average time from stroke onset to admission for rehabilitation of the patients was 1.5 months. We expected changes in motor and mobility function in the stroke patients to occur over periods of 1.5 months to 2.5 months after stroke onset. As the results show, the 3 subscales of the S-STREAM showed high responsiveness in detecting changes in the motor and mobility function of patients after stroke from the time of admission for rehabilitation to hospital discharge. In addition, the sample size of this study (195 patients) appeared to have sufficient statistical power to detect changes (31, 32). These results provide strong evidence that the S-STREAM is a good outcome measure. Particularly, the responsiveness of the S-STREAM was similar to that of the STREAM. One possible explanation is that multidimensional Rasch analysis can create an interval scale of scores and a large number of estimates of patients' functions (e.g. more levels of function), which allows us to detect change efficiently (14).

We also found that the discriminative, predictive, and evaluative properties of the S-STREAM were comparable with those of the STREAM. Regarding the discriminative property, floor and ceiling effects were noted in the STREAM (13–33% of the patients), but not in the S-STREAM. Regarding the predictive

Table V. *Responsiveness of the S-STREAM and the STREAM between admission for rehabilitation and hospital discharge (n = 195).*

Scale	SRM	Paired t-test
S-STREAM		
Upper-limb subscale	0.90	12.57*
Lower-limb subscale	0.97	13.54*
Mobility subscale	1.06	14.79*
STREAM		
Upper-limb subscale	0.56	7.89*
Lower-limb subscale	0.72	10.01*
Mobility subscale	1.00	14.00*

*$p < 0.001$.
STREAM: Stroke Rehabilitation Assessment of Movement; S-STREAM: Simplified STREAM; SRM: standardized response mean.

property, the upper-limb movement subscale of the STREAM showed fair correlations with the C-ADL scores, whereas the corresponding subscale of the S-STREAM showed moderate to good correlations. Regarding the evaluative property, the STREAM showed moderate to high responsiveness, whereas the S-STREAM showed high responsiveness in detecting changes in motor and mobility function in patients after stroke. The S-STREAM, despite having only half the number of items of the STREAM, not only retained the ability to discriminate, predict and evaluate the motor and mobility function of patients after stroke, but in fact had somewhat better properties than the STREAM. This was mainly due to the fact that the large number of estimates of the patients' motor and mobility function and the interval Rasch transformed scores of the S-STREAM contributed to the good discriminative, predictive and evaluative properties of the S-STREAM in patients after stroke.

There are 3 advantages of using the S-STREAM in rehabilitation settings as routine motor and mobility assessments in patients after stroke. First, the S-STREAM has much fewer items (5 items for each of the 3 subscales) than the other instruments commonly used in stroke patients for measuring motor and mobility function (e.g. the Fugl-Meyer motor scale (33) and Rivermead Mobility Index (34)). With fewer items, the S-STREAM improves efficiency of administration. Secondly, the S-STREAM is convenient for clinicians to use because it can be administered easily, as no special equipment is required. Third, the scores of the S-STREAM are interval scores, which allow clinicians directly to interpret and compare the change/difference scores within/between patients.

There was a high attrition rate (49.7%), which might threaten the generalizability of our findings. However, we found that the upper-limb, lower-limb, and mobility deficits of the remaining 195 patients and those of the 193 patients lost at second assessment did not differ statistically. Furthermore, the scores of the 195 patients were found to cover the entire ranges of the 3 subscales on the STREAM. Thus, the high attrition rate might not limit the generalizability of our findings. However, we excluded patients who were discharged within a week of admission. The level of disability of those excluded patients tended to be very mild. Furthermore, most (68%) of the participants had severe disability, based on their BI scores at admission for rehabilitation in this study. Thus, our results should not be generalized to patients with very mild stroke.

Two issues might concern the readers. The first issue might be the test-retest and inter-rater reliabilities of the S-STREAM. However, since the items of the S-STREAM were retrieved from the STREAM, the test-retest and inter-rater reliabilities of which have been shown to be satisfactory in patients with stroke (2, 10), the reliabilities of the S-STREAM are very likely to be acceptable. Secondly, the evaluative property of this study was to examine the ability of the S-STREAM to detect changes over time. However, whether the changes reach clinical importance (i.e. the minimal clinically important change) (35, 36) remains to be investigated.

In summary, all 3 subscales of the S-STREAM demonstrate good discriminative, predictive and evaluative properties in patients with stroke in this study. The 3 properties of the S-STREAM were somewhat better than those of the STREAM. The S-STREAM is recommended for assessing the motor and mobility function of patients after stroke in both clinical and research settings.

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APPENDIX. *The 15 items of the Simplified Stroke Rehabilitation Assessment of Movement.*

5 items of the upper-limb movement subscale.
- Elbow extension while supine
- Scapular protraction
- Making a fist
- Raising arm to fullest elevation
- Fingers total extension

5 items of the lower-limb movement subscale:
- Knee extension while sitting
- Hip flexion while sitting
- Knee flexion while sitting
- Plantarflexion while sitting
- Dorsiflexion while standing

5 items of the mobility subscale:
- Rolling
- Supine to sitting
- Sitting to standing
- 10-metre walk
- Walking down 3 stairs