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Development of a new scale to assess physical performance related to activity of daily living in patients with stroke: Stroke mobility scale.

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The purposes of this study were to develop a new scale, Stroke Mobility Scale (SMS) that assesses physical performance related to activities of daily living (ADL) in patients with stroke and to investigate its reliability and validity. The preliminary scale consisting of 25 physical performances that are selected by observation of ADL was administrated to 118 patients with stroke. Item selection was performed in 2 selection criteria. Of these patients, 66 were retested by different raters to assess the interrater reliability and agreement. As the result, after the first selection criterion was applied to investigate the validity of rating scale categories, 3 items were removed. Concerning unidimensionality of scales as applied by the second selection criterion, factor analysis using the principal factor method extracted 2 factors, the second of which was loaded heavily enough in 2 items to be excluded. We thus completed the SMS consisting of a total of 20 items. The SMS demonstrated good internal consistency, interrater reliability and interrater agreement. It also demonstrated good concurrent validity for ADL scale and criterion related scales. The SMS presents good reliability and validity to assess physical performances of patients with stroke. It can be useful in clinical practice.

Key Words
Physical performance, Stroke, Scale

Introduction

In clinical practice, physical therapists often assess abilities of physical performance and activity of daily living (ADL). The former impaired ability corresponds to functional limitation, while the latter to disability according to the disablement model. [1,2] Functional limitation is defined as restrictions in the performance of activities that are essential to daily living or as a restricted part of ADL. In the case of toileting, for example, we need to evaluate the ability such as walking, turning to the toilet, sitting on the toilet, standing-up, and reaching the lever to flush the toilet. Limitation of these physical performances result in disabled ADL, whereas improvement of those is associated with better ADL.[3] In clinical practice, physical therapists not only have patients practice directly ADL itself but also often make indirect approaches to having them practice repeatedly individual performances in which patients are found to be poor by analysis of awkward physical performances. Since physical performances associated with standing or ambulation are especially related to risks of falls, assessment of these performances can provide very important informa-

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Table 1. Sample characteristics (N=118)

Characteristics	Values
Age (y)	69.5±9.7 (45–88)
Sex	
Male	86
Female	32
Stroke type	
Ischemic	74
Hemorrhagic	44
Stroke location	
Right cortical hemisphere	61
Left cortical hemisphere	57
Weeks since stroke	49±66 (2–322)
Mobility	
Nonambulatory	39
Assistant ambulation	35
Independent ambulation	44

Values are mean ± standard deviation (range) or n.

tion on the determination of their independence of ADL or on fall prevention.

A variety of tools for evaluating these physical performances have been reported. The Functional Reach Test (FR)[4] and the Berg Balance Scale[5] are assessment tools for dynamic balance except walking, while the Timed "Up and Go" Test (TUG)[6] and the Dynamic Gait Index[7] are assessment tools for dynamic balance during walking. Although these tools are designed for the evaluation of physical performances either in standing position or during ambulation, performance in both of them should be evaluated to prevent falls in daily living. In addition, the Berg Balance Scale is claimed to be invalid in the rating scale category since rating is not consistently done for the reason that its rating scale categories of each item have not been uniformly defined and that there exist rarely used rating scale categories.[8] On the other hand, the Performance Oriented Mobility Assessment[9] and the modified Rivermead Mobility Index[10] are comprehensive assessment tools consisting of a number of items, including physical performances in a standing position and during ambulation. However, in the Performance Oriented Mobility Assessment, problems exist in the validity of the rating scale category. Because this scale is scored by 2 or 3 grades and the weight for evaluation differs according to the item. The modified Rivermead Mobility Index, which consists of 8 items, shows problems in item difficulty and hierarchy because it contain as many as 6 items that are not difficult to perform at the bedside. Moreover, these scales, excluding the Dynamic Gait Index, are generic scales, which are not a tool targeted at a specific disease. Patients with evident characteristics of asymmetry, such as patients with stroke, should be evaluated by a disease-specific scale that reflects the capacity of patients with a high sensitivity in changes.[11]

There exists no such a post-stroke hemiplegic-specific scale with good reliability and validity as measures physical performances in a standing position or during walking that are associated with ADL and are at a high risk of falls. The purposes of this study were to develop a new scale, Stroke Mobility Scale (SMS) that assesses physical performance related to activities of daily living (ADL) in patients with stroke and to investigate its reliability and validity.

Subjects and Methods

1. Preliminary scale development

A preliminary scale was created as a step toward the SMS. Items of physical performance for the preliminary scale were selected from performance scenes of ADL in post-stroke hemiplegic patients since such physical performance had to agree with the concept of the scale fulfilling our purpose that scales should consist of physical performances during standing or walking which were necessary for the performance of daily life activities in post-stroke hemiplegic patients. Hence we made a videotaped record of three patients with chronic stroke differing in grades of ADL (assistance-requiring, supervision-requiring, and independent). They provided informed consent to the study after its contents were fully explained. We picked up scenes related to standing or ambulation from the videotape and edited them. ADL consisted of 8 scenes: eating, dressing, grooming, toileting, bathing, stepping over an obstacle, going through the door, and stair climbing. To select physical performances, this videotape was observed by 12 physical therapists with more than 5 years of practice experience. Physical performances were defined as those in a standing position or during ambulation that were hardly affected by environments except for daily life activities themselves. In videotape observations, focus was placed on the characteristics of asymmetry. The observers were instructed to pay attention to the affected and unaffected side separately and to select physical performances in a standing position and during ambulation separately. In addition, a questionnaire survey of the 12 observers was made as to what physical performances they thought to be important for the evaluation of ADL of patients with stroke. From videotape observation, 46 physical performances were selected. Through the integration of some similar physical performances, videotape observation resulted in the selection of 20 physical performances. From this survey, 5 physical performances were added to the preliminary scale. The preliminary scale of SMS included a pool of 25 items that consisted of 18 standing items and 7 ambulation items (Table 2).

2. Rating scale category

For each item, the rater evaluated the physical performance of the patient using a 4-level rating scale. For evaluation of each of the rating scale categories, 3 trials were performed to exclude the influence of chance and to reflect the ability accurately. Each rating category was defined as follows: “complete independence” for a case that could accomplish the performance without a cane and assistance for consecutive 3 times and 3 points were given; “modified independence” for a case that could with a case but without assistance for consecutive 3 times and 2 points were given; “light assistance” for a case that could with a cane as well as minimal assistance for balancing for consecutive 3 times and 1 point was given; and “firm assistance or impossible” for a case that needed more assistance or that could not accomplish the performance and 0 point was given. The use of leg brace was permitted, if the patient used it in daily living. A cane was limited in use to one that was regularly used in daily living. Taking hold of something fixed like a handrail was not permitted in any performance. If “walking forward” of the ambulation item was not completely independence (3 points), “touching the floor,” “reaching forward,” or “reaching laterally” of the standing item was assessed as modified independence (2 points) or inferior. This was because these three items were assessed as to upper limbs on the unaffected side, making it hard to discriminate between ‘complete independence’ and ‘modified independence’ and also because a patient, who usually used a cane during walking, did so very often at the time of practicing these 3 items. Confirmation of these rating scale categories and the evaluation criteria were allowed at any time with the table and measurement guideline (Appendix 1).

Table 2. Frequency of the rating scale category and factor loading value of the preliminary scale.

NO.	Standing item	Number of the rating scale category (rate)				Factor loading value of the preliminary scale	
		0	1	2	3	Factor 1	Factor 2
* 1	Standing hold	1 (0.8)	10 (8.5)	14 (11.9)	93 (78.8)	0.71	-0.28
2	Sitting and standing	14 (11.9)	12 (10.2)	13 (11.0)	79 (66.9)	0.81	-0.25
* 3	Extending and flexing the trunk	38 (32.2)	6 (5.1)	6 (5.1)	68 (57.6)	0.82	0.04
4	Turning the trunk	18 (15.3)	15 (12.7)	12 (10.2)	73 (61.9)	0.80	-0.12
5	Reaching forward	15 (12.7)	22 (18.6)	31 (26.3)	50 (42.4)	0.90	-0.17
6	Reaching laterally	17 (14.4)	25 (21.2)	28 (23.7)	48 (40.7)	0.89	-0.11
7	Touching the floor	34 (28.8)	12 (10.2)	25 (21.2)	47 (39.8)	0.88	-0.04
8	Stepping forward	14 (11.9)	26 (22.0)	21 (17.8)	57 (48.3)	0.92	-0.05
9	Stepping laterally	19 (16.1)	21 (17.8)	21 (17.8)	57 (48.3)	0.92	-0.09
10	Stepping backward	21 (17.8)	26 (22.0)	22 (18.6)	49 (41.5)	0.92	-0.03
11	Raising the toe	14 (11.9)	19 (16.1)	23 (19.5)	62 (52.5)	0.89	-0.13
12	Raising the heel	26 (22.0)	18 (15.3)	20 (16.9)	54 (45.8)	0.83	0.03
13	Standing on the affected foot	22 (18.6)	22 (18.6)	38 (32.2)	36 (30.5)	0.89	0.04
14	Standing on the unaffected foot	21 (17.8)	28 (23.7)	38 (32.2)	31 (26.3)	0.85	0.08
15	Stepping forward Tandemly	46 (39.0)	22 (18.6)	31 (26.3)	19 (16.1)	0.81	0.41
*16	Stepping backward Tandemly	61 (51.7)	28 (23.7)	22 (18.6)	7 (5.9)	0.72	0.41
*17	Jumping	56 (47.5)	16 (13.6)	10 (8.5)	36 (30.5)	0.73	0.21
	Ambulation item						
18	Walking forward	16 (13.6)	18 (15.3)	32 (27.1)	52 (44.1)	0.90	-0.15
19	Walking laterally	19 (16.1)	20 (16.9)	23 (19.5)	56 (47.5)	0.92	-0.04
20	Walking backward	24 (20.3)	22 (18.6)	27 (22.9)	45 (38.1)	0.88	0.00
21	Turning forward	20 (16.9)	24 (20.3)	24 (20.3)	50 (42.4)	0.92	0.00
22	Turning backward	31 (26.3)	27 (22.9)	19 (16.1)	41 (34.7)	0.87	0.18
23	Stepping forward over the obstacle	27 (22.9)	22 (18.6)	28 (23.7)	41 (34.7)	0.91	0.06
*24	Stepping laterally over the obstacle	36 (30.5)	27 (22.9)	16 (13.6)	39 (33.1)	0.90	0.21
25	Rapid turning while walking	20 (16.9)	20 (16.9)	25 (21.2)	53 (44.9)	0.92	-0.12

*: The exclusion item in item selection of SMS.

3. Administration of the preliminary scale

The preliminary scale, consisting of 25 items, was administered to the 118 patients with stroke in 3 rehabilitation hospitals. Participants met the following inclusion criteria: the ability to maintain a standing position with light assistance, the ability to follow the oral instructions required for measurement. All patients provided informed consent to the study after its contents were fully explained. Sample population characteristics are shown in Table 1. Physical therapists working at the hospitals were selected for raters. All raters were provided with the preliminary scale and written instructions for administering the scale. They were given enough time to confirm the preliminary scale items, rating scale categories, and instructions for administering the scale.

4. Item selection

Items were carefully selected after the importance of items and the 2 selection criteria were comprehensively contemplated. The first selection criterion was the validity of rating scale category. The validity of rating scale category was determined by calculating the frequency of rating scale categories. From results of the preliminary scale applied to 118 patients, numbers and rates of observations of 4 scale categories for each item were calculated. If an item showed a ratio less

than 10% of the whole, it was disqualified because of lack of validity in the scale category. The second selection criterion was unidimensionality, which means that the scale reflects a single latent trait rather than multiple constructs. Using these 2 selection criteria, SMS was modified so that it had valid scale categories as well as unidimensionality in rating.

5. Assessment of reliability and validity

After the development of the SMS, the reliability and validity of SMS were assessed. Of these patients, 66 were retested by different raters to assess the interrater reliability and agreement. The interval of test sessions was within 3 days to avoid influence of the change in the patient's ability. In addition, test results were blinded to other raters to prevent a measurement bias. Concurrent validity of the SMS was assessed by comparing it with ADL scale of the motor items of the functional independence measure (FIM-M) and criterion related scales of the FR, TUG, and the maximum walking speed of a 10 m walkway (MWS). Some participants who could not be evaluated by these scales but could be by the SMS were excluded in the analysis of these scales.

6. Data analysis

Data analysis was performed using the SPSS version 11.5, for Windows computer program. Unidimensionality was confirmed using confirmatory factor analysis with the principal factor method. Factors with an eigenvalue of ≥1 were extracted. Factor loading value of each item and proportion of variance explained were then calculated. If multiple factors were extracted, an item with a larger loading value borne by other factor than the first factor was removed one after another until only one factor remains as a target of extraction.

Internal consistency was determined using the Chronbach's coefficient alpha. Interrater reliability was determined using the intraclass correlation coefficiency (ICC(2,1)) in total score, standing items and ambulation items respectively. Interrater agreement for individual SMS items was determined using kappa statistic. Concurrent validity of the SMS was assessed using the Spearman rank order correlation coefficient. The criterion for statistical significance was *P* less than .05.

Results

1. Results of measurements by the preliminary scale and item selection

The mean score on the preliminary scale of the participants was 45.6 (SD=24.5). Numbers and rates of scale category observations as to individual items are shown in Table 2. The rate was found to be less than 10% in items including " Standing hold" (0.8% for 0 point and 8.5% for 1 point), " Extending and flexing the trunk" (5.1% for 1 and 5.1% for 2 points), "Stepping backward tandem" (5.9% for 3 points), and "Jumping" (5.9% for 3 points). These 4 items were selected as omission candidates based on the first selection criterion of 'validity of scale categories.'

Table 2 shows also the result of factor analysis of the preliminary scale. Two factors with an eigenvalue of ≥ 1 were extracted, which may represent separate domains of performance on the total battery. The proportion of variance explained of the first factor was 74.4%. The factor loading values of each item ranged from .71 to .92. Factor loading borne on the second factor showed higher values of .41 for "Stepping forward tandem," .41 for "Stepping backward tandem," .21 for jumping," and .21 for Stepping laterally over the obstacle." The second selection criterion of unidimensionality selected these 4 items as omission candidates.

2. Completion of the SMS

Application of the 2 item selection criteria to data of measurements by the preliminary scale resulted in selection of 6 items as omission candidates. We considered comprehensively items of the whole SMS and thus completed the SMS consisting of 20 items after omitting a total of 5 items

of the above omission candidates except for " Stepping forward tandem" as selected by the second selection criterion. The SMS was therefore a scale with the full score of 60 points and was composed of 13 standing items and 7 ambulation items.

We reanalyzed the results of measurements by the preliminary scale with the use of the completed SMS. Confirmatory factor analysis extracted only one factor with an eigenvalue not less than 1, confirming unidimensionality of the SMS. The proportion of variance explained of the first factor was 77.8%. The factor loading values of each SMS item ranged from .79 to .93 (Table 3).

3. Reliability and validity of the SMS

The mean score on the SMS was 37.5 (SD=20.1), the FIM-M was 69.9 (SD=16.4), the FR was 20.9 cm (SD=8.0), the TUG was 28.4 seconds (SD=26.0), and the MWS was 40.9 seconds (SD=24.9). Chronbach's coefficient alpha for internal consistency was .98. The ICC for interrater reliability was .96 in total SMS scores, .94 in standing items and .96 in ambulation items. The kappa values for interrater agreement of each SMS item ranged form .68 to .85 (Table 3).

The correlations between the SMS and the FIM-M, FR, TUG, MWS are presented in Table 4. Significant correlations ($P< .05$) were found between all of the scales evaluated. The SMS correlated with the criterion related scales: the FR ($\rho= .61$), TUG ($\rho= -.77$) and MWS ($\rho= .78$). The correlation of the SMS with the FIM-M ($\rho= .74$) was greater than that of the other three scales.

Discussion

The SMS was completed unidimensional scale that consists of the appropriate items for targeted sample population. The SMS presents good reli-

Table 3. Factor loading value and kappa statistic of the SMS item.

NO.	Standing item	Factor loading value	Kappa statistic
		Factor 1	
1	Sitting and standing	0.82	0.75
2	Turning the trunk	0.79	0.76
3	Reaching forward	0.91	0.85
4	Reaching laterally	0.88	0.79
5	Touching the floor	0.87	0.77
6	Stepping forward	0.93	0.77
7	Stepping laterally	0.93	0.75
8	Stepping backward	0.93	0.76
9	Raising the toe	0.90	0.78
10	Raising the heel	0.83	0.84
11	Standing on the affected foot	0.89	0.81
12	Standing on the unaffected foot	0.84	0.72
13	Stepping forward Tandemly	0.79	0.68
	Ambulation item		
14	Walking forward	0.91	0.81
15	Walking laterally	0.92	0.80
16	Walking backward	0.89	0.77
17	Turning forward	0.92	0.85
18	Turning backward	0.86	0.72
19	Stepping forward over the obstacle	0.91	0.81
20	Rapid turning while walking	0.92	0.82

SMS: Stroke Mobility Scale.

ability and validity. Especially in Japan, there is a lack of the standard scale to assess physical performances in patients with stroke. The SMS can be valuable as the standard scale in clinical use and for clinical research. The SMS is characterized by the following: this scale is the comprehensive scale to evaluate physical performances that is necessary for the physical therapist to analyze performances in detail; validity in ADL was tried to be augmented from the stage of its development; Features of post-stroke hemiplegic patients were taken into consideration; this scale was composed of items helpful for evaluating risks of falls; it is good in reliability and validity.

Although the concept of functional limitation is not distinguished from disability in International Classification of Functioning, Disability and Health, [12] it is important for physical therapist to distinguish functional limitation and disability in clinical practice. Physical therapists analyze in the evaluation process what functional limitation causes disability including that of ADL and furthermore what impairment is responsible for the functional limitation. In order to improve disability, they make physical therapeutic interventions not only in disability per se but also in impairment as well as functional limitation that causes disability. Since it is thus necessary for the physical therapist to analyze performances in detail, a classification method, that distinguishes ADL abilities and physical performances composing ADL, is suitable to the physical therapist' s evaluating/therapeutic processes for the purpose to acquire the impairment structure. The SMS is composed of scores of physical performances in standing/ambulation, so that we consider the scale as comprehensive rating that evaluates this very functional limitation, contributing to physical therapeutic evaluation as well as therapeutic outcomes. This is justified by the fact that the SMS is compatible with other scales of functional limitation such as FR, TUG, and MWS.

In general, conventional scales were established by items of previously developed scales or items that were selected after discussion among experts. [5] It is, however, not guaranteed that items of previous scales are superior and that such results are obtained from subjects as anticipated by experts. In selection of items for the preliminary scale in this study, we did not simply rely on comments of experts but attempted to choose physical performances which were really needed for ADL through observation of ADL scenes of post-stroke hemiplegic patients. The result of this study that the SMS was more compatible with FIM-M than other scales may be caused by this process.

Moreover, introduction of performance observation in item selection for the preliminary scale had an advantage of reflecting better performance features of post-stroke hemiplegics in items to be selected. For example, such patients are prone to turn around the leg on either side during walking due to asymmetric motor neuropathy. From this observation, we defined "Turning forward" and "Turning backward" items as turns around the affected and unaffected legs, respectively. In other

Table 4. The association of the SMS with the FIM-M, FR, TUG and MWS.

Measure	SMS	FIM-M	FR	TUG
FIM-M (n= 114)	.74 *			
FR (n= 100)	.61 *	.56 *		
TUG (n= 94)	-.77 *	-.55 *	-.58 *	
MWS (n= 94)	.78 *	.55 *	.53 *	-.95 *

Values are Spearman correlation coefficients.
*: $p < .05$
SMS: Stroke Mobility Scale.
FIM-M: the motor items of the Functional Independence Measure.
FR: Functional Reach test.
TUG: Timed "Up and Go" test.
MWS: the maximum walking speed of a 10m walkway.

items also, affected and unaffected sides were distinguished as seen in items"Reaching laterally," "Standing on the unaffected foot," and"Standing on the affected foot" (Appendix 1).

Physical performances during standing/ambulation compose the SMS so that it can be useful for evaluation of risks for falls. Of ADL, eating and dressing themselves are performances that are at a low risk of falls because they are conducted in a safe environment like in a sitting position. The SMS does not include such physical performances as maintenance of a sitting position and moving upper limbs since these performances rarely precipitate falls. Therefore, assessment and practice of physical performances, particularly weak ones, that are included in the SMS, are possibly related to risk assessment and prevention of fall risks in ADL. In order to demonstrate features specific for the SMS, we need to conduct further study to examine whether the scale is valid in predicting independence in walking or in foreseeing falls.

The reliability and validity of SMS investigated in this study were validity of rating scale category, internal consistency, interrater reliability and concurrent validity. There are an extremely small number of observations in individual rating scale categories, which indicate the presence of categories that involve none of subjects. For instance, light assistance scoring 1 point and modified assistance scoring 2 points observed in the item of " Extending and flexing the trunk" compose 5.1% of the whole, respectively. This item could not be classified into 4 categories of subjects' physical performances, indicating lack of validity in setting these categories. This was why 4 items were removed from 25 items of the preliminary scale.

Scale unidimensionality means a degree to which the scale measure single latent trait. The unidimensionality in this study was therefore to verify that the SMS was composed of scales of a single trait defined by 'physical performances in standing/ambulation required to execute ADL in post-stroke hemiplegic patients,' which were to be measured by the SMS. Verification of scale unidimensionality is likely to be done by a procedure to select one factor using exploratory factor analysis. [13,14] In this study, factor analysis of the preliminary scale resulted in the selection of 2 factors and there was a tendency that an abundance of the second factor was included in items "Stepping forward tandem," "Stepping backward tandem," "jumping," and "Stepping laterally over the obstacle". Of these items, an item "stepping forward tandem" was adopted because of its importance, while other 3 items were discarded. Ultimately, the SMS was composed of 20 adopted items and repeated factor analysis confirmed that the scale was composed of one factor.

After the development of the SMS, the reliability and validity of SMS were assessed. Internal consistency is an index of strength of correlations between items included in the scale. As to the SMS, Cronbach's coefficient alpha was .98, indicating good internal consistency. Interrater reliability is an index of stability of measurements among different raters. ICC (2, 1) of the SMS was .96, showing a strong correlation. Concerning the interrater agreement of individual items, the kappa statistics value ranged from .68 to .85. Since these values of .60 or above were considered evidence of high agreement[15], the interrater reliability was acceptable. It was presumed that there were two reasons for the good interrater reliability and agreement. One is that the raters had sufficient practice according to the clearly-documented measurement manual, which enhanced the accuracy of their evaluation. The other reason was that since 3 consecutive successes were required in rating the scale categories of an item, variation of measurements by the subjects due to a random error was unlikely.

The SMS is composed of such a variety of physical performances as enable detailed assessment and scoring of performances in post-stroke hemiplegic patients. This scale, however, does not suppose that subjects are all post-stroke hemiplegic patients but expects those capable of standing/ambulating in daily living. Eligibles for this study were patients who could keep standing with light assistance, so that the SMS was could

not be applied to patients with severe chronic stroke who could not maintain a standing posture. Of 118 participants in this study, 7 (6%) were scored as minimum (0 point). These subjects with low physical performance should be assessed by other scales including easy-to-perform items like mRMI. Of 11 subjects (9%) who were graded as maximum score (60 points), 10 were independent in ADL. Since the SMS consists of rates of physical performances necessary for ADL, the scale has its limitations that it cannot be applied to mild post-stroke patients who have no problem with ADL. Although unidimensionality, interrater reliability and agreement, and concurrent validity were verified for the SMS in this study, there is room for further study of other scale properties like predictive validity or responsiveness.

Conclusions

The SMS is unidimensional scale to measure physical performance related to ADL in patients with stroke. The SMS presents good interrater reliability and concurrent validity. It can be valuable for clinical use and clinical research.

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Appendix 1. Evaluation and measurement guidelines of SMS

Stroke Mobility Scale (SMS)

NO.	Item	Description	Score(0- 3)
1	Sitting and standing	Standing up from a bed or chair, then sitting down back down.	
2	Turning the trunk	Turning trunk 45 degrees with feet fixed in both directions.	
3	Reaching Forward	Reaching forward more than 15 cm with feet fixed.	
4	Reaching Laterally	Reaching for the unaffected side more than 15 cm with feet fixed.	
5	Touching the floor	Touching the floor while standing.	
6	Stepping forward	Stepping both feet forward alternately.	
7	Stepping laterally	Stepping both feet laterally alternately.	
8	Stepping backward	Stepping both feet backward alternately.	
9	Raising the toe	Raising the toe of the unaffected side for 1 second while standing.	
10	Raising the heel	Raising the heel of the unaffected side for 1 second while standing.	
11	Standing on the affected foot	Standing on the affected foot during 1second.	
12	Standing on the unaffected foot	Standing on the unaffected foot for 1second.	
13	Stepping forward Tandemly	Stepping with one foot in front of the other foot alternately.	
		Standing item score (/ 39)	
14	Walking forward	Walking forward 10m.	
15	Walking laterally	Walking laterally 3 steps in both directions.	
16	Walking backward	Walking backward 5 steps.	
17	Turning forward	Turning forward 180 degrees with one foot fixed using alternating feet.	
18	Turning backward	Turning backward 180 degrees with one foot fixed using alternating feet.	
19	Stepping forward over the obstacle	Stepping forward over the cane.	
20	Rapid turn while walking	Turning to opposite direction rapidly according to rater's cue while walking.	
		Ambulation item score (/ 21)	
		SMS total score (/ 60)	

Requirements: a bed (or chair).
a marked 10m walkway.
a marked 15cm cane.

Rating scale categories

0 = firm assistance or impossible: requires moderate assistance or unable to perform.
1 = light assistance: requires light assistance to perform.
2 = modified independence: able to perform with a cane.
3 = complete independence: able to perform without a cane.

Notice

1. It is necessary to perform each physical performance 3 times continuously.
2. The use of a leg brace is permitted, if the patient uses it in daily living.
3. Item 3, 4, 5 are not rated "complete independence (3)", if the item 14 is not "complete independence (3)".