Research Report

Relationships Between Standing Balance and Symmetry Measurements in Patients Following Recent Strokes (≤3 Weeks) or Older Strokes (≥6 Months)

Background and Purpose. The Functional Standing Balance (FSB) Scale was designed to obtain measurements of standing balance and to identify the problems typically faced by people with stroke. The purpose of this study was to investigate the validity of measurements obtained with the FSB Scale for use in the acute and chronic phases of stroke by comparing the measurements obtained with the FSB Scale with those obtained for postural sway and lateral symmetry by use of a force platform. Subjects and Methods. Measurements were obtained for 26 people with recent strokes (ie, strokes within 3 weeks of data collection) and for 28 people with long-standing strokes (ie, strokes of 6 months' duration or older). The FSB Scale consists of 3 components: weight distribution, balance without movement, and balance with movement. Measurements of balance performance were compared with measurements of anteroposterior and lateral sway velocity obtained on a force platform. The weight distribution on 2 digital scales was compared with the lateral symmetry measured on the force platform. Results. The highest correlations were found between the FSB Scale balance measurements and the measurements of anteroposterior sway velocity obtained on the force platform with feet apart and eyes open. The correlations (r) were −.68 and −.67 for the group with recent strokes and −.74 and −.91 for the group with long-standing strokes. The correlations (r) between weight distribution measured on the digital scales and lateral symmetry measured on the force platform were .44 for the group with recent strokes and .52 for the group with long-standing strokes. Discussion and Conclusion. The subjects whose results on the FSB Scale were poor had higher sway velocities on the force platform than the subjects whose results on the FSB Scale were good. The results of this study suggest that the FSB Scale provides the same kind of information as that obtained for sway velocity and lateral symmetry as measured with the use of force platforms in both patients with recent strokes and patients with long-standing strokes. [Pyöriä O, Era P, Talvitie U. Relationships between standing balance and symmetry measurements in patients following recent strokes (≤3 weeks) or older strokes (≥6 months). *Phys Ther*. 2004;84:128–136.]

Key Words: *Balance measurements, Standing balance, Stroke, Weight distribution.*

Outi Pyöriä, Pertti Era, Ulla Talvitie

The assessment of balance is an integral part of the examination of patients with stroke because of the various balance impairments that can follow a stroke. The standing balance problems of patients following a stroke are often related to uneven weight distribution[1–3] and difficulties in muscle use,[4] which increase postural sway during standing.[5,6] Patients with recent strokes have been shown to exhibit problems with postural control, which can hamper their movements.[7] Balance status is also one of the predictors of length of stay in inpatient rehabilitation facilities[8,9] and of the outcome of stroke rehabilitation.[10,11] Patients with balance problems appear to take longer to reach the same level of functional gain than do patients without balance problems.[10]

People who have had strokes have been shown to use compensatory strategies for deficient postural control; however, these strategies are not always optimal.[12] The use of compensatory strategies may be related to the degree of motor impairment. Cirstea and Levin[13] found that people with moderately to severely impaired balance used additional ways of performing tasks to compensate for motor deficits and that people with mild impairment tended to have ways of performing tasks similar to those of people without impairments who have normal movement patterns. Stepping and grasping movements of the limbs also appear to play an important functional role in maintaining upright stance.[14]

A variety of balance scales have been developed for the examination of aspects of postural control. Some balance tests are used to measure the ability of a person to maintain the body's center of gravity within the base of support and to maintain stance when his or her balance is not perturbed. Other tests, often referred to as "dynamic tests," are used to assess balance in response to either self-initiated movements or external perturbations.[5]

Bernhardt et al[15] measured changes in balance without any requested movement and during locomotion of people with recent strokes. They found that, during the 4-week experimental period, the balance tests that did not require the subjects to move exhibited ceiling effects, whereas the tests of balance and gait that required movement exhibited floor effects. Bernhardt et al, therefore, recommended a combination of the tests to avoid these problems.

Recovery and improvement of function following a stroke vary very much during the first year after the stroke.[16–18] In many people, the ability to utilize sensory information effectively, particularly in the early stage of illness, is impaired (unstable).[19] For patients with recent

O Pyöriä, PT, MSc, is a doctoral student in the Department of Health Sciences, University of Jyväskylä, Jyväskylä, Finland, and Physiotherapist, Physical Therapy Services, Central Hospital of Savonlinna, Keskussairaalantie 6, 57179 Savonlinna, Finland (outi.pyoria@isshp.fi). Address all correspondence to Ms Pyöriä.

P Era, PhD, is a docent in the Brain Research and Rehabilitation Center Neuron, Kortejoki, Finland.

U Talvitie, PT, PhD, is a lecturer in the Department of Health Sciences, University of Jyväskylä.

Dr Talvitie provided concept/research design and project management. All authors provided writing. Ms Pyöriä provided data collection, and Dr Era provided data analysis.

This study was approved by the Human Research and Ethics Committee of Central Hospital of Savonlinna.

This article was received February 7, 2003, and was accepted September 4, 2003.

strokes, Bohannon and Leary[20] developed a test of standing balance that contains items with increasing levels of difficulty. They found a strong relationship between balance tasks and the transfer, walking, and stair-climbing tasks of the Functional Independence Measure (FIM).

Daleiden[21] and Shepherd[22] suggested that the sensory and motor processes involved in the control of balance are task specific. A measure that may reflect this is the Berg Balance Scale (BBS),[23] in which the balance tasks are task specific, such as changing position from sitting to standing or picking up an object from the floor or in front. The BBS was originally developed for use with elderly people, but the reliability and validity of measurements obtained with the BBS have also been demonstrated in patients with stroke.[24–27] The scoring system of the BBS is based on the length of time a position can be maintained or the time taken to complete a task and on the amount of assistance required for effective balance control.[23]

The Functional Standing Balance (FSB) Scale is a part of the Postural Control and Balance for Stroke (PCBS) Test. The PCBS Test contains items relating to postural changes, sitting balance, and standing balance. The FSB Scale contains items designed to reflect postural symmetry and standing balance with or without movement. The purpose of our study was to examine the criterion validity of measurements obtained with the FSB Scale by comparing measurements obtained using the FSB Scale with measurements of postural sway and lateral symmetry obtained using a force platform in patients with recent strokes (ie, strokes within 3 weeks of data collection) and long-standing strokes (ie, strokes of 6 months' duration or older). The objectives of our study were (1) to examine the relationship between standing balance with and without movement and postural sway velocity and (2) to examine the correlation between the symmetry of weight distribution measured using digital scales and lateral symmetry as measured with a force platform.

Sway velocity as measured with a force platform has been widely used in balance research. Postural sway velocity has been found to increase during aging[28] and to correlate with difficulties in activities of daily living[29] and musculoskeletal disability in elderly subjects.[30] Research indicates that sway velocity is correlated with risk of falling[31] and that it increases in multitask test conditions (during the balance task, the subject is given an additional task, such as a mathematical problem, to perform), especially in people with a history of falls.[32]

Table 1.
Subject Characteristics, Side of Lesion, and Stroke Characteristics

	Subjects With Recent Strokes (n=26)	Subjects With Long-standing Strokes (n=28)
Age (y)		
$\overline{X}$	65	60
SD	10.0	8.0
Range	49–84	46–77
Sex		
Male	19	17
Female	7	11
Lesion side, left	7	17
Infarct	20	23
Hemorrhagic stroke	4	3
Subarachnoid hemorrhage	2	0

Method

Subjects

Fifty-four patients took part in the study. The inclusion criteria for admission to the to the study were a primary diagnosis of cerebrovascular accident, symptoms of stroke lasting over 24 hours, the ability to maintain a standing position for 30 seconds without support, and the ability to understand simple instructions.

The subjects were recruited from inpatients with recent strokes (1–3 weeks poststroke) at the Department of Neurology and outpatients with long-standing strokes (6 months–13 years poststroke) on the patient register of the Department of Neurology of Central Hospital of Savonlinna, Savonlinna, Finland. The demographic data of the subjects are shown in Table 1. The functional capacity (ie, balance performance in the standing position without movement) of 52 patients with recent strokes was measured, but only 26 patients were able to meet the criterion of maintaining a standing position for 30 seconds. These 26 patients formed the group with recent strokes. Thirty patients with strokes of at least 6 months' duration were initially drawn from the patient register, but 2 of these patients did not meet the inclusion criteria; consequently, 28 patients were selected to form the group with long-standing strokes. Forty-five (83%) of the 54 patients had a first stroke. Eight (15%) of the 54 patients also felt dizzy, which interfered with their ability to maintain a standing position, especially with their eyes closed. All patients had undergone computed tomography to determine the cause of stroke.

Participation in the study was voluntary, and no one who met the criteria refused to take part in the study. All of the participants gave informed consent prior to commencement of the study in accordance with the requirements of the institution's Human Research and Ethics Committee.

Balance Measures

The FSB Scale consists of 3 components: weight distribution, balance with movement, and balance without movement (Appendix). These 3 factors were chosen because studies[1–3,15,20] and clinical experience have shown that these components pose balance problems for patients with stroke. The balance without movement component of this test consisted of 3 tasks, and the balance with movement component consisted of 9 tasks. The symmetry of weight distribution was measured (in kilograms) using 2 digital bathroom scales. The balance tasks without movement were used to evaluate the subjects' ability to maintain positions of increasing difficulty by diminishing the base of support from standing with feet apart to standing with feet together and finally to standing on one leg. The score is based on the length of time the subject can maintain the stance under each condition.

Table 2.
Frequency Distribution of Performances of Balance Tasks With and Without Movement for Subjects With Recent Strokes[a]

		Classification			
Balance Without Movement	**n**	**1**	**2**	**3**	
Standing with feet together	26	4	1	21	
Standing on right leg	26	18	1	7	
Standing on left leg	26	19	1	6	
		Classification			
Balance With Movement	**n**	**1**	**2**	**3**	**4**
Picking up an object from the floor	26	1	3	10	12
Placing an object with right arm					
Onto a chair on the right side	23	0	3	7	13
Onto a chair on the left side	23	1	1	9	12
Placing an object with left arm					
Onto a chair on the right side	26	0	1	9	16
Onto a chair on the left side	26	0	2	12	12
Reaching up for an object					
In walking position, right foot in front	26	5	7	7	7
In walking position, left foot in front	26	3	6	10	7
Turning 360°					
To the right	26	1	7	5	13
To the left	26	1	5	7	13

[a] Balance without movement classification: 1=can maintain the position for 0–5 seconds, 2=can maintain the position for 6–10 seconds, 3=can maintain the position for 11–15 seconds. Balance with movement classification: 1=unable to control balance, 2=difficulties in controlling balance, 3=moderate control of balance, 4=good control of balance.

The balance tasks with movement were used to evaluate balance ability in the context of the performance of movements. The purpose of the 4-point classification is to obtain information on how people with stroke use compensatory postural strategies during tasks that require the center of mass to be moved toward the edge of the base of support. Observation of difficulties and unsteadiness in initiating and performing movements are the elements used to rate performance. For examination of postural control, the rater observes how much patients expand their base of support during tasks by counterbalancing with the arms and legs or how they control the instability they exhibit in lifting and reaching tasks by using compensatory movements of the trunk, arm, or leg. The tasks and classification are described in the Appendix.

Postural sway velocity and lateral symmetry during normal standing were measured using the Good Balance force platform.* The force platform is an equilateral triangle (800 mm) that is connected to a 3-channel DC amplifier. Signals from the amplifier are converted into digital form using a 12-byte converter (sampling frequency=50 Hz) and stored on the hard disk of a personal computer. The X and Y coordinates of the center of pressure (COP) are defined on the basis of the data. The following variables are calculated: the extent of the mediolateral movement of the COP (X movement), the extent of the anteroposterior movement of the COP (Y movement), and the mean value of all of the measurement points in relation to the midline of the platform (lateral displacement). When the subject stands on the footprints marked symmetrically in relation to the midline of the force platform (feet 20 cm apart and feet together), the mean value (positive or negative) indicates the relative loading of the left and right legs. A negative mean value indicates a higher loading on the left leg, and a positive mean value indicates a higher loading on the right leg. The mean velocity of the X and Y movements of the COP is achieved by dividing the extent of the X and Y movements by time (in seconds).[33]

Procedure

Standardized conditions for the FSB Scale and the use of the force platform were set up in the laboratory of the Central Hospital of Savonlinna. The FSB Scale scores and force platform measurements were obtained on the same day. The force platform measurements were

* Metitur Ltd, Jyväskylä, Finland.

Table 3.
Frequency Distribution of Performances of Balance Tasks With and Without Movement for Subjects With Long-standing Strokes[a]

		Classification			
Balance Without Movement	**n**	**1**	**2**	**3**	
Standing with feet together	28	2	3	23	
Standing on right leg	28	15	2	11	
Standing on left leg	28	18	3	7	
		Classification			
Balance With Movement	**n**	**1**	**2**	**3**	**4**
Picking up an object from the floor	28	2	1	15	10
Placing an object with right arm					
Onto a chair on the right side	25	0	2	9	14
Onto a chair on the left side	25	1	1	14	9
Placing an object with left arm					
Onto a chair on the right side	23	2	1	8	12
Onto a chair on the left side	22	2	1	8	11
Reaching up for an object					
In walking position, right foot in front	27	1	8	11	7
In walking position, left foot in front	27	2	11	10	4
Turning 360°					
To the right	27	3	4	12	8
To the left	27	3	0	16	8

[a] Balance without movement classification: 1=can maintain the position for 0–5 seconds, 2=can maintain the position for 6–10 seconds, 3=can maintain the position for 11–15 seconds. Balance with movement classification: 1=unable to control balance, 2=difficulties in controlling balance, 3=moderate control of balance, 4=good control of balance.

obtained first with every other subject, and the FSB Scale was administered first to the other subjects. The FSB Scale was administered in the following order: standing on the digital bathroom scales, balance tasks involving no movement, and balance tasks involving movement. The test took approximately 15 minutes to complete. Between the test items, the subjects were allowed to sit and rest.

The bathroom scales were calibrated prior to use by loading with certified weights. Adjoining (ie, side by side) scales were built into a frame. Each scale had a footprint silhouette on its surface to ensure consistent foot placement by the subjects. The subjects were instructed to "step onto the scales" and stand with their feet 20 cm apart on the footprints and with their arms in front of their body with one hand gripping the wrist of the other hand. They were told to direct their gaze at a fixed point at eye level on the opposite wall. After placing their feet on the silhouettes, they were given the instruction "Stand as straight as possible for 30 seconds." During the last 5 seconds, the load on each of the scales was recorded. The subjects then were asked to do the balance tasks that did not require movement and, finally, the balance tasks with movement (Appendix). The instructions were the same for all subjects and took the form of simple and short verbal directions. One physical therapist who had 2 years of experience in the use of the FSB Scale and the sway measures tested all of the subjects.

The first test of postural sway on the force platform was during standing with eyes open. The subject stood on the platform with feet 20 cm apart on the footprints and with the position of the arms and direction of gaze the same as in the weight-bearing test on the bathroom scales. The second test was conducted in the same way except that the subject's eyes were kept closed throughout the test. Both tests were carried out for 30 seconds and commenced only after the subject had achieved a relaxed stance. In the third test, the subject stood on the platform with feet together and with arms and hands held in same manner as the first and second tests. The fourth test was conducted in the same way as the third test except that the subject's eyes were kept closed throughout the test. In the third and fourth tests, the measurements were obtained for 15 seconds. Lateral symmetry (mean X movement value) was analyzed only for the first test.

Data Analysis

The validity of the FSB Scale scores was examined by comparing them with the measurements of postural sway and lateral symmetry obtained using the force platform. The relationships between the FSB Scale scores and the measurements of postural sway were analyzed by means of the Spearman rank-order correlation. Symmetry of weight distribution on the digital scales and lateral symmetry on the force platform was compared using the Pearson product moment correlation. Statistical analyses were carried out using SPSS 8.0 for Windows.[†]

Results

Relationship Between Balance Task Performance and Sway Speed

The sum variables for the balance tasks without movement (the possible scores range from 3 to 9) and the balance tasks with movement (the possible scores range from 9 to 36) were used separately in our analysis. The mean score for the balance tasks without movement was

[†] SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

Table 4.
Force Platform Anteroposterior Sway Velocity (Mean Y Movement Velocity in Millimeters Per Second) and Mediolateral Sway Velocity (Mean X Movement Velocity in Millimeters Per Second) Results for Subjects With Recent and Long-standing Strokes in Eyes-Open, Eyes-Closed, Feet Together/Eyes Open, and Feet Together/Eyes Closed Conditions

	Eyes Open			Eyes Closed			Feet Together/ Eyes Open			Feet Together/ Eyes Closed		
	$\overline{X}$	SD	Range	$\overline{X}$	SD	Range	$\overline{X}$	SD	Range	$\overline{X}$	SD	Range
Anteroposterior sway velocity												
Subjects with recent strokes	10.6	5.1	4.0–22.4	17.4	9.3	8.4–46.2	14.5	8.6	7.0–33.3	22.5	8.5	14.1–49.3
Subjects with long-standing strokes	8.9	4.7	3.7–23.1	15.9	6.3	7.5–31.4	12.9	10.0	4.9–56.7	26.4	12.7	10.3–57.6
Mediolateral sway velocity												
Subjects with recent strokes	6.8	4.1	2.5–18.7	9.5	6.4	3.6–23.1	15.9	9.1	5.5–36.5	26.5	8.9	14.2–45.6
Subjects with long-standing strokes	5.8	4.0	2.4–19.6	8.6	6.2	3.0–28.1	13.6	7.4	4.9–38.8	26.7	11.2	10.6–49.1

5.6 (SD=2.0, range=3–9) for the subjects with recent strokes and 6.1 (SD=1.9, range=3–9) for the subjects with long-standing strokes. The mean score for the balance tasks with movement was 27.3 (SD=4.3, range=19–32) for the subjects with recent strokes and 26.4 (SD=5.9, range=11–32) for the subjects with long-standing strokes. Six subjects with long-standing strokes and 3 subjects with recent strokes were unable to perform the task of placing an object with the left or right arm onto a chair because of an unusable upper extremity, and 1 subject with long-standing stroke interrupted the test because of chest pains. The frequency distributions of the scores for both types of balance are shown in Tables 2 and 3. The postural sway velocity values with the mean scores in the 4 test positions are given in Table 4.

The relationship between the results of the balance tests and sway velocity on the force platform was analyzed with the Spearman rank-order correlation (Tab. 5). A negative correlation was found between the sum variables for the balance tasks and mediolateral and anteroposterior sway velocity, especially with the subjects' feet apart and eyes open. The correlations r ranged from .53 to −.70 for the subjects with recent strokes and from −.44 to −.91 for the subjects with long-standing strokes. The highest negative correlations were found between the FSB Scale scores and the measurements of anteroposterior sway velocity in the subjects with long-standing strokes when their feet were apart and their eyes were open (r=−.74 to −.91). This negative correlation means that the lower the scores for the subjects on both types of balance tests, the higher their sway velocity on the force platform.

In the subjects with recent strokes, the correlation between the results of the balance tasks and lateral sway velocity on the force platform when measured with the feet together and eyes closed was lowest (r=−.04). Seven subjects with recent strokes and 6 subjects with long-standing strokes were unable to maintain a stable stance on the force platform in the feet together/eyes closed condition without grabbing the handrail or moving the position of their feet or opening their eyes, and these subjects' measurements in this position had to be interrupted.

Relationship Between Weight Distribution and Lateral Symmetry

The relationship between measurements of weight distribution obtained using 2 digital scales and measurements of lateral symmetry (mean X movement value) obtained on the force platform was analyzed with the Pearson product moment correlation. The total weight of each subject was divided by 2, and the weight distribution recorded on the scales was compared with that value. The difference between the values was converted to a percentage. The correlation between the measurements of weight distribution and lateral symmetry was .44 for the subjects with recent strokes and .52 for the subjects with long-standing strokes. The more weight a subject maintained on the left or right leg on the digital scales, the greater the mean left or right value on the force platform.

Discussion

The main purpose of our investigation was to explore the validity of data obtained with the FSB Scale in people with recent and more long-standing strokes. The FSB Scale differs in the classification of balance from other balance scales that focus on the assessment of strategies. Evidence suggests that the sensory and motor processes involved in control of balance are to some extent task specific.[21,22] Tasks demanding variable amplitude of center of pressure in relation to the base of support and movement strategies to control instability were developed for the FSB Scale.

Our results suggest that the FSB Scale provides the same kind of information as that obtained from measurement of postural sway velocity on a force platform in both

Table 5.
Relationship Between the Sum Variables of the Balance With and Without Movement Tasks and Anteroposterior Sway Velocity and Mediolateral Sway Velocity for Subjects With Recent and Long-standing Strokes in Eyes-Open, Eyes-Closed, Feet Together/Eyes Open, and Feet Together/Eyes Closed Conditions Analyzed Using Spearman Rank-Order Correlation

Sum Variables	Eyes Open			Eyes Closed			Feet Together/Eyes Open			Feet Together/Eyes Closed		
	n	Medio-lateral Sway Velocity	Antero-posterior Sway Velocity	n	Medio-lateral Sway Velocity	Antero-posterior Sway Velocity	n	Medio-lateral Sway Velocity	Antero-posterior Sway Velocity	n	Medio-lateral Sway Velocity	Antero-posterior Sway Velocity
Balance without movement												
Subjects with recent strokes	24	−.63	−.68	24	−.53	−.59	20	−.64	−.52	20	.08	−.41
Subjects with long-standing strokes	27	−.52	−.74	27	−.54	−.44	25	−.52	−.69	21	−.59	−.62
Balance with movement												
Subjects with recent strokes	21	−.70	−.67	21	−.68	−.68	20	−.51	−.66	18	.04	−.46
Subjects with long-standing strokes	18	−.66	−.91	18	−.76	−.47	17	−.34	−.63	16	−.70	−.73

people with recent and long-standing strokes. Some of our subjects, however, were unable to stand on the force platform with their feet together and their eyes closed. In addition, under the same conditions, there was a low correlation for the subjects with recent strokes between the scores obtained for the 2 types of balance and measurements of sway velocity on the force platform. Postural control requires the ability to generate and apply forces to control the body's position in space.[12] Very old people (aged 85 years or older) seem to rely on visual control of posture, and visual deprivation has an effect on postural stability.[34] Similarly, it has been suggested that people with neurological problems rely predominantly on vision during the early stages of recovery from neural insults, but they are better able to use somatosensory inputs as motor control is regained.[19] It is possible that the feet together/eyes closed position was too difficult for many of our subjects with recent strokes, when the nervous system had no choice but to use somatosensory and vestibular information. In the eyes-closed condition, the subjects with recent strokes might not yet have acquired a consistent ability to use somatosensory information effectively in controlling the motion of their center of mass relative to their limited base of support.

One component of the FSB Scale is the measurement of body weight distribution using 2 digital scales. The aim of our study was to explore the relationship between weight distribution as measured with the FSB Scale and lateral symmetry (mean value in millimeters) on a force platform. A moderate correlation was found between weight distribution as measured with the FSB Scale and lateral symmetry as determined with the force platform in both the groups of subjects, but the correlation was stronger in the subjects with long-standing strokes. The subjects stood on the digital scales for 30 seconds and the weight distribution values were recorded during the last 5 seconds, whereas on the force platform the lateral mean value was measured for 30 seconds. A more reliable result might be obtained by recording the weight distribution values more than once during the 30 seconds spent standing on the scales. Bohannon and Waldron[2] demonstrated good reliability in measurements of weight bearing on digital scales used to weigh the paretic and nonparetic lower extremities. More research is needed, however, to clarify the accuracy of measurements obtained with digital scales, especially during the acute phase of stroke.

The tasks that involved lifting an object proved to be limited in testing individuals with affected upper extremities. We found that the lifting tasks were more effective for assessing the ability of people with strokes to grasp an object than for assessing trunk control during reaching for an object.

One of the inclusion criteria for admission to our study was the ability to maintain the standing position for 30 seconds without support. We are planning to use this task as a threshold-level task before testing other scale items in future testing of the FSB Scale. Smith and Baer[35] used simple standardized tests of mobility in an effort to provide a detailed representation of the recovery profile for clinically identifiable subgroups of people who have had strokes. The measures they used were maintaining sitting balance for 1 minute, maintaining standing balance for 10 seconds, taking 10 steps, and walking 10 m. The number and percentage of patients who achieved each milestone were recorded. Achievement of these mobility milestones appeared to provide a useful means of monitoring patients' recovery. The ideal measure of stroke recovery may be a battery of items of increasing levels of difficulty together with measurement milestones, which function as the inclusion criteria for the more exacting tasks.

Conclusion

The FSB Scale is designed to obtain measurements of standing balance and to identify the problems typically faced by people with stroke. In particular, the scale was developed to measure peoples' postural control during the performance of tasks. The correlation between the FSB Scale scores and measurements of postural sway velocity and lateral symmetry obtained with a force platform in people with recent and long-standing strokes indicated that the FSB Scale may be useful for measuring balance during different phases (time periods) after stroke. We believe the FSB Scale offers clinicians a different approach from that of more traditional balance measures, which are based solely on time counts or the amount of assistance needed. We contend that there is a need in physical therapy for clinical balance assessment tools that can be used to measure patients' balance skill from the acute to chronic phases of stroke. Before the FSB Scale can be recommended for wide clinical use, the lifting task part of the FSB Scale that requires the use of an affected upper extremity needs further development. Only then can the FSB Scale be used to characterize patients' trunk control during the performance of tasks.

References

1 Sackley CM. The relationships between weight-bearing asymmetry after stroke and the function and activities of daily living. *Physiotherapy Theory and Practice*. 1990;6:179–185.

2 Bohannon RW, Waldron RM. Weightbearing during comfortable stance in patients with stroke: accuracy and reliability of measurements. *Australian Journal of Physiotherapy*. 1991;37:19–22.

3 Gruendel TM. Relationship between weight-bearing characteristics in standing and ambulatory independence in hemiplegics. *Physiotherapy Canada*. 1992;44:16–17.

4 Badke MB, Duncan PW. Patterns of rapid motor responses during postural adjustments when standing in healthy subjects and hemiplegic patients. *Phys Ther*. 1983;63:13–20.

5 Dickstein R, Dvir Z. Quantitative evaluation of stance balance performance in the clinic using a novel measurement device. *Physiotherapy Canada*. 1993;45:102–108.

6 Dickstein R, Ablaffio N. Postural sway of the affected and nonaffected pelvis and leg in stance of hemiparetic patients. *Arch Phys Med Rehabil*. 2000;81:364–367.

7 Wade D, Collen F, Robb G, Warlow C. Physiotherapy intervention late after stroke and mobility. *Br Med J*. 1992;304:609–613

8 Brosseau LB, Philippe P, Potvin L, Boulanger YL. Post-stroke inpatient rehabilitation, I: predicting length of stay. *Am J Phys Med Rehabil*. 1996;75:422–430.

9 Wee JY, Bagg SD, Palepu A. The Berg Balance Scale as a predictor of length of stay and discharge destination in an acute stroke rehabilitation setting. *Arch Phys Med Rehabil*. 1999;80:448–452.

10 Franchignoni FP, Tesio L, Ricupero C, Martino MT. Trunk control test as an early predictor of stroke rehabilitation outcome. *Stroke*. 1997;28:1382–1385.

11 Juneja G, Czyrny JJ, Linn RT. Admission balance and outcomes of patients admitted for acute inpatient rehabilitation. *Am J Phys Med Rehabil*. 1998;77:388–393.

12 Shumway-Cook A, Woollacott M. *Motor Control: Theory and Practical Applications*. 2nd ed. Baltimore, Md: Williams & Wilkins; 2001.

13 Cirstea M, Levin M. Compensatory strategies for reaching in stroke. *Brain*. 2000;123:940–953.

14 Maki M, McIlroy W. The role of limb movements in maintaining upright stance: the "change-in-support" strategy. *Phys Ther*. 1997;77:488–506.

15 Bernhardt J, Ellis P, Denisenko S, Hill K. Changes in balance and locomotion measures during rehabilitation following stroke. *Physiother Res Int*. 1998;3:109–122.

16 Kotila M, Waltimo O, Niemi M, et al. The profile of recovery from stroke and factors influencing outcome. *Stroke*. 1984;15:1039–1044.

17 Thorngren M, Westling B, Norrving B. Outcome after stroke in patients discharge to independent living. *Stroke*. 1990;21:236–240.

18 Ferrucci L, Bandinelli S, Guralnik J, et al. Recovery of functional status after stroke: a postrehabilitation follow-up study. *Stroke*. 1993;24:200–205.

19 Mulder T, Berndt H, Pauwels J, Nienhuis B. Sensorimotor adaptability in the elderly and disabled. In: Stelmach G, Homberg V, eds. *Sensorimotor Impairment in the Elderly*. Dordrecht, the Netherlands: Kluwer; 1993:413–426.

20 Bohannon RW, Leary KM. Standing balance and function over the course of acute rehabilitation. *Arch Phys Med Rehabil*. 1995;76:994–996.

21 Daleiden S. Weight shifting as a treatment for balance deficits: a literature review. *Physiotherapy Canada*. 1990;42:81–87.

22 Shepherd RB. Adaptive motor behavior in response to perturbations of balance. *Physiotherapy Theory and Practice*. 1992;8:137–143.

23 Berg K, Maki BE, Williams JI, et al. Clinical and laboratory measures of postural balance in an elderly population. *Arch Phys Med Rehabil*. 1992;73:1073–1080.

24 Stevenson TJ, Garland SJ. Standing balance during internally produced perturbations in subjects with hemiplegia: validation of the Balance Scale. *Arch Phys Med Rehabil*. 1996;77:656–662.

25 Liston RA, Brouwer BJ. Reliability and validity of measures obtained from stroke patients using the balance master. *Arch Phys Med Rehabil*. 1996;77:425–430.

26 Berg K, Wood-Dauphinee S, Williams JI, Gayton D. Measuring balance in the elderly: preliminary development of an instrument. *Physiotherapy Canada*. 1989;41:304–310.

27 Berg K, Wood-Dauphinee S, Williams JI. The balance scale: reliability assessment with elderly residents and patients with an acute stroke. *Scand J Rehabil Med*. 1995;27:27–36.

28 Era P, Heikkinen E, Gause-Nilsson I, Schroll M. Postural balance in elderly people: change over five-year follow-up and its predictive value for survival. *Aging Clin Ex Res*. 2002;14(suppl 3):37–46.

29 Era P, Avlund K, Jokela J, et al. Postural balance and self-reported functional ability in 75-year-old men and women: a cross-national comparative study. *J Am Geriatr Soc*. 1997;45:21–29.

30 Thapa P, Gideon P, Fought R, et al. Comparison of clinical and biomechanical measures of balance and mobility in elderly nursing home residents. *J Am Geriatr Soc*. 1994;42:493–500.

31 Fernie G, Gryfe C, Holliday P, Llewellyn A. The relationship of postural sway in standing: the incidence of falls in geriatric subjects. *Age Ageing*. 1982;11:11–16.

32 Shumway-Cook A, Woollacott M, Kerns K, Baldwin M. The effects of two types of cognitive tasks on postural stability in older adults with and without a history of falls. *J Gerontol A Biol Sci Med Sci*. 1997;52:M232–M240.

33 Era P, Schroll M, Ytting H, et al. Postural balance and its sensory-motor correlates in 75-year-old men and women: a cross-national comparative study. *J Gerontol A Biol Sci Med Sci*. 1996;51:M53–M63.

34 Pyykkö I, Aalto H. Postural control in elderly subjects. *Age Ageing*. 1990;19:215–221.

35 Smith T, Baer G. Achievement of simple mobility milestones after stroke. *Arch Phys Med Rehabil*. 1999;80:442–447.

Appendix.
Functional Standing Balance Scale

Weight distribution		
Standing on digital scales for 30 seconds		
Right leg		. . . kg
Left leg		. . . kg
Balance without movement		
Standing with feet apart for 30 seconds	1=cannot stand	. . . points
	2=can stand	. . . points
Standing with feet together (maximum=15 seconds)	1=0–5 seconds	. . . points
	2=6–10 seconds	. . . points
	3=11–15 seconds	. . . points
Standing on one leg (maximum=15 seconds)	1=0–5 seconds	
Right leg	2=6–10 seconds	. . . points
Left leg	3=11–15 seconds	. . . points
Balance with movement		
Bending down to pick up an object from the floor		
With the better hand		. . . points
Placing an object with the right arm onto a chair		
On the right side		. . . points
On the left side		. . . points
Placing an object with the left arm onto a chair		
On the left side		. . . points
On the right side		. . . points
Reaching up for an object with the better arm, feet in walking position		
Right foot in front		. . . points
Left foot in front		. . . points
Turning 360 degrees on the spot		
Right side leading		. . . points
Left side leading		. . . points

4=good control of balance
Control of balance during performance as demanded by the task. The performance is fluent and economic.
3=moderate control of balance
Can perform the task, but the control of the movement and the fluency of the performance is insufficient. Compensatory movement of trunk.
2=difficulties in controlling balance
Difficulties in controlling balance during the task (lurches, extra footsteps, grips support at some stage during performance), compensatory movement of upper limbs and/or trunk.
1=unable to control balance
Difficulties in settling in the start position demanded by the task and maintaining balance during performance without the risk of falling.