Usefulness of the Berg Balance Scale in Stroke Rehabilitation: A Systematic Review

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Background. In a recent study of 655 physical therapists working with a stroke population, the Berg Balance Scale (BBS) was identified as the most commonly used assessment tool across the continuum of stroke rehabilitation. Given the widespread popularity of the BBS, it is important to critically appraise the BBS for its use with a stroke population.

Objective. The purposes of this study were to conduct a systematic review of the psychometric properties of the BBS specific to stroke and to identify strengths and weaknesses in its usefulness for stroke rehabilitation.

Results. Twenty-one studies examining the psychometric properties of the BBS with a stroke population were retrieved. Internal consistency was excellent (Cronbach alpha=.92–.98) as was interrater reliability (intraclass correlation coefficients [ICCs]=.95–.98), intrarater reliability (ICC=.97), and test-retest reliability (ICC=.98). Sixteen studies focused on validity and generally found excellent correlations with the Barthel Index, the Postural Assessment Scale for Stroke Patients, Functional Reach Test, the balance subscale of Fugl-Meyer Assessment, the Functional Independence Measure, the Rivermead Mobility Index (except for weight shift and step-up items), and gait speed. Berg Balance Scale scores predicted length of stay, discharge destination, motor ability at 180 days poststroke, and disability level at 90 days, but these scores were not predictive of falls. Eight studies focused on responsiveness; all reported moderate to excellent sensitivity. Three studies found floor or ceiling effects.

Discussion and Conclusion. The BBS is a psychometrically sound measure of balance impairment for use in poststroke assessment. Given the floor and ceiling effects, clinicians may want to use the BBS in conjunction with other balance measures.

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Stroke often results in impaired balance. Balance is essential for optimal functioning of the locomotor system and the performance of many activities of daily living.[1] Accurate evaluation of balance is important for prescribing appropriate mobility aids, determining the most effective treatment interventions, and identifying safe and unsafe activities after stroke. Because balance changes over time after stroke, it also is important to have a quantifiable measure that clinicians can use to monitor these changes and adjust treatment accordingly. The Berg Balance Scale (BBS) was originally designed to quantitatively assess balance in older adults.[2] In a recent study of 655 physical therapists working in stroke rehabilitation, the BBS was identified as the most commonly used assessment tool across the continuum from acute care to community-based care.[3] Given the widespread use of the BBS after stroke, a good understanding of its value in examining this population is important. Therefore, we conducted a systematic review to examine the psychometric properties of the BBS and its acceptability (strengths, weaknesses, and so on) when used specifically in individuals with stroke.

Method

Search Strategy

A comprehensive review of the English-language rehabilitation literature was performed covering the period from 1966 to July 2007 using electronic databases (MEDLINE, CINAHL, EMBASE, HealthSTAR, PsycINFO, and Health and Psychosocial Instruments). We searched for articles related to psychometric testing of the BBS using the following key terms: Balance Scale, Berg Balance Scale, psychometric properties, measurement properties, reliability, repeatability, validity, responsiveness, and appropriateness. The Cochrane Library was explored for systematic reviews using the same key terms. Reference sections of all journal articles retrieved were reviewed in search of other pertinent articles. All major authors involved with testing the psychometric properties of BBS also were searched according to their citation indexes using the ISI Web of Science database to verify that all relevant publications were obtained.

What Is the BBS?

The BBS is a 14-item scale that quantitatively assesses balance and risk for falls in older community-dwelling adults through direct observation of their performance.[2] The scale requires 10 to 20 minutes to complete and measures the patient's ability to maintain balance—either statically or while performing various functional movements—for a specified duration of time. The items are scored from 0 to 4, with a score of 0 representing an inability to complete the task and a score of 4 representing independent item completion. A global score is calculated out of 56 possible points. Scores of 0 to 20 represent balance impairment, 21 to 40 represent acceptable balance, and 41 to 56 represent good balance. The BBS measures both static and dynamic aspects of balance. The ease with which the BBS can be administered makes it an attractive measure for clinicians; it involves minimal equipment (chair, stopwatch, ruler, step) and space and requires no specialized training. It is noted, however, that the BBS should only be administered by health care professionals with knowledge of how to safely mobilize patients with stroke.[4,5] A copy of the BBS can be obtained online from the Internet Stroke Center Web site (http://www.strokecenter.org/Trials/scales/berg.html) and at the StrokEngine-Assess Web site (http://www.medicine.mcgill.ca/strokengine-assess/module_bbs_intro-en.html).

Results

We identified 21 studies that met our inclusion criteria in that they examined the psychometric properties of the BBS in patients with stroke.[2,6–25] A summary of these studies is shown in Table 1. Of these studies, 4 examined reliability, 16 studied validity, and 8 examined responsiveness. We interpreted each study's psychometric data based on the statistical evaluation criteria for examining assessment tools for disability outcomes research as developed by Andresen[26] (see Tab. 2 for details).

Does the BBS Have Internal Consistency in Patients With Stroke?

Three studies[6–8] examined the internal consistency of the BBS in patients with stroke: all found excellent consistency. Berg et al[6] assessed 70 patients at 2, 4, 6, and 12 weeks poststroke. At each evaluation, Cronbach alphas were greater than .97. Mao et al[7] examined the internal consistency with 112 patients at 14, 30, 90, and 180 days poststroke. Again, excellent Cronbach alphas, ranging from .92 to .98, were achieved at all 4 measurement times. Similarly, when assessing internal consistency with 113 patients at 14 days poststroke, Chou and colleagues[8] found an alpha of .98.

Is the BBS a Reliable Measure for Patients With Stroke?

Two studies[6,7] examined interrater reliability, 1 study[6] examined intrarater reliability, and 1 study[9] examined test-retest reliability of the BBS when used with a stroke population. All reported excellent reliability. Mao et al[7] found excellent interrater reliability (intraclass correlation coefficient [ICC]=.95) in 123 patients studied at 14 days poststroke. Berg and colleagues[6] assessed interrater reliability in 35 patients with stroke. Clinicians' scores were compared with those of the gold standard independent rater. Again, interrater reliability was excellent (ICC=.98). In addition, to assess intrarater reliability, 6 patients with

Table 1.
Berg Balance Scale (BBS) Evaluation Summary

Criterion	Result
What does the tool measure?	Balance in older adults
What types of clients can the tool be used for?	The BBS was developed for use with community-dwelling elderly individuals. It also can be used in patients with stroke.
Is this a screening or assessment tool?	Assessment
Time to administer	Approximately 10–15 minutes to complete by direct observation.
Measurement properties	
Reliability	Three studies examining internal consistency[6–8] reported excellent internal consistency.
	Excellent reliability reported for 2 studies examining interrater reliability,[6,7] 1 study examining intrarater reliability,[6] and 1 study examining test-retest reliability.[9]
Validity	Content validity: The items were selected based on interviews with 12 geriatric clients and 10 professionals. The list of items was revised following a pretest of all preliminary items.
	Criterion validity: Predicted length of stay in rehabilitation unit, discharge destination, disability level, and motor ability 180 days after stroke.[7,8,11,18–21]
	Construct validity: Excellent correlations with Barthel Index, Postural Assessment Scale for Stroke Patients, and Functional Reach Test. Adequate to excellent correlations with balance subscale of Fugl-Meyer Assessment, Functional Independence Measure, and Rivermead Mobility Index (except for weight shift and step-up tests).[2,7–15]
Floor/ceiling effects	Two studies detected a significant floor effect[7,8] and 1 study[23] detected a significant ceiling effect in the BBS.
Does the tool detect change in patients?	Out of 8 studies examined, all reported moderate to excellent sensitivity to change.[7,8,16,19,22–25]
Acceptability	This direct observation test is not suitable for severely affected patients as it assesses only one item related to balance while sitting. Active individuals will find it too simple. The scale is not suitable for use by proxy.
Feasibility	The BBS requires no specialized training to administer; however, the BBS should only be administered by individuals with knowledge of how to safely manage those with stroke as it is a risky assessment during which a patient could fall if not supervised by someone with expertise in stroke rehabilitation. Relatively little equipment or space is required.

stroke were assessed 1 week apart by the same rater.[6] Intrarater reliability was excellent (ICC=.97). Liston and Brouwer[9] found excellent test-retest reliability (ICC=.98) in 20 patients with chronic stroke assessed by a rater on 3 occasions at 1-week intervals.

Is the BBS a Valid Measure in Patients With Stroke?

Six studies examined the convergent construct validity of the BBS and reported excellent correlations with other measures of impairment.[2,7–11] Berg and colleagues[2] examined 70 patients with acute stroke using the BBS, the Barthel Index,[27] and the balance subscale (FM-B) of the Fugl-Meyer Assessment[28] at 4, 6, and 12 weeks poststroke. Correlations between the BBS and the Barthel Index were excellent (r=.80 to .94), and correlations between the BBS and the FM-B ranged from adequate to excellent (r=.62 to .94). In the study by Chou et al,[8] excellent correlations were found between the BBS and the Barthel Index (r=.88) and between the BBS and the motor functioning subscale of the Fugl-Meyer Assessment (r=.71) at 14 days poststroke.

Wee et al[10] administered the BBS and the Functional Independence Measure (FIM)[29] to 128 patients admitted to an inpatient stroke rehabilitation unit. The researchers found an excellent correlation between admission BBS scores and admission FIM scores (r=.76). Similarly, Juneja et al[11] administered the BBS and the FIM to patients with various diagnoses, including stroke (n=15), traumatic brain injury (n=19), and other impairments (n=11), who were admitted for acute inpatient rehabilitation. Adequate to excellent correlations were reported between BBS and FIM scores for the group as a whole (r=.57 to .70). In the study by Liston and Brouwer,[9] BBS scores were found to be related to various dynamic measures on the Balance Master* (r=−.48 to −.67). Mao et al[7] reported excellent correlations between the BBS and the FM-B (r=.90 to .92) and between the BBS and the Postural Assessment Scale for Stroke

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Table 2
Statistical Evaluation Criteria for Examining Assessment Tools for Disability Outcomes Research

Psychometric Property	Level
Reliability	
Cronbach α or split-half statistics	
Excellent	≥.80
Adequate	.70–.79
Poor	<.70
Test-retest or interrater reliability (intraclass correlation coefficient [ICC] or kappa statistics)	
Excellent	≥.75
Adequate	.40–.74
Poor	<.40
Validity	
Construct/convergent and concurrent correlations	
Excellent	≥.60
Adequate	.31–.59
Poor	≤.30
Receiver operating characteristic analysis—area under the curve	
Excellent	≥0.90
Adequate	0.70–0.89
Poor	<0.70
Responsiveness	
Sensitivity to change (standardized effect sizes)	
Small	<0.5
Moderate	0.5–0.8
Large	≥0.8
Floor/ceiling effects	
Excellent	No floor/ceiling effects
Adequate	≤20% of patients attain either the minimum or maximum score
Poor	>20% of patients attain either the minimum or maximum score

Patients (PASS)[30] (r=.92 to .95) at 14, 30, 90, and 180 days poststroke.

Tyson and DeSouza[12] assessed the concurrent validity of various tests of functional balance (supported sitting balance, sitting arm raise, sitting forward reach, supported standing balance, standing arm raise, standing forward reach, static tandem standing, weight shift, timed 5-m walk with and without an aid, tap, and step-up tests) by comparing them with established measures of balance, including the sitting section of the Motor Assessment Scale,[31] the BBS, and the Rivermead Mobility Index,[32] in 48 patients with poststroke hemiplegia. The sitting and standing tests showed stronger relationships with the BBS (Spearman rho=.36 to r=.70) than the step-up test and the weight shift test (r=.19 and r=.26, respectively).[12]

Smith et al[13] administered the BBS and the Functional Reach Test[33] (a single-item assessment measuring how far an individual can reach forward from a normal relaxed stance) to 75 patients with stroke whose stroke severity ranged from mild to severe. The BBS had an excellent correlation with the Functional Reach Test (Spearman rho=.78). When examining the relationship between the 2 measures for subjects with similar motor impairments (based on 4 categories of stroke severity from the motor section of the Fugl-Meyer Assessment, as suggested by Duncan et al[33]), higher correlations were found for patients with moderate motor impairments (a score of 56–79 on the Fugl-Meyer Assessment; r=.80) compared with the correlations for those with moderately severe motor impairment (a score of 36–55 on the Fugl-Meyer Assessment; r=.24).[13]

Hsueh et al[14] found excellent correlations between the BBS and the Barthel Index (Pearson r≥.78) at 14, 30, 90, and 180 days poststroke. Richards et al[15] administered the BBS and a test of gait speed to 18 patients with a first-ever acute stroke at 6 weeks poststroke. Using Pearson correlations, an excellent relationship was found between BBS scores and gait speed (r=.60).

Three studies examined known-groups construct validity of the BBS.[2,16,17] In a study by Berg et al,[2] BBS scores were found to discriminate between groups based on their location at follow-up evaluation (home, rehabilitation program, acute care hospital) 12 weeks poststroke. Stevenson[16] administered the BBS to 48 individuals receiving poststroke rehabilitation (16 required physical assistance, 17 required stand-by assistance, and 15 were independent for ambulation) and found that the BBS discriminated between functional subgroups at the time of study

enrollment. Au-Yeung et al[17] administered the BBS to 20 patients within 12 months after a first-ever stroke (7 who walked with physical assistance, 13 who walked independently with assistive devices) and to 13 control subjects who were healthy. Berg Balance Scale scores were found to discriminate among the 3 groups.

Does the BBS Have Predictive Validity in Patients With Stroke?

Seven studies examined the predictive validity of the BBS.[7,8,11,18–21] In the study by Juneja et al,[11] admission BBS was predictive of length of stay such that higher scores on the BBS were associated with a shorter length of stay (negative correlation $r=-.39$). Wee et al[18] examined whether the BBS could be used to predict length of stay and discharge destination in 313 patients admitted to a stroke rehabilitation unit. Admission BBS scores had an adequate negative correlation with length of stay ($r=-.53$), controlling for age. Logistic regression revealed that the admission BBS score was an independent predictor of being discharged home rather than to an institution (odds ratio [OR]=1.09, 95% confidence interval [CI]=1.04–1.13). Other independent predictors were age and presence of family support.

Mao et al[7] found that the ability of the BBS at 14, 30, and 90 days poststroke to predict scores on the Motor Assessment Scale[31] at 180 days poststroke was excellent (Spearman correlations ranging from .82 to .91). Wang et al[19] examined whether the BBS and a shortened version of the BBS—the BBS-3P—predicted disability level as measured by the Barthel Index when administered to 226 patients at 90 days poststroke. Berg Balance Scale scores at both 14 and 30 days strongly predicted disability level (Spearman rho=.76 and $r=.81$, respectively) at 90 days poststroke as did the shortened version ($r=.75$ and $r=.81$, respectively). Likewise, Chou et al[8] found that BBS scores at 14 days predicted disability level at 90 days poststroke as measured by the Barthel Index ($r=.62$).

In contrast, the BBS has not been found to be predictive of either single or repeat falls in a study of 99 community-dwelling individuals with chronic stroke[20] or in the acute care period.[21] In the study by Andersson et al,[21] patients were assessed with the BBS at a median of 8 days poststroke and then followed at either 6 or 12 months. The positive predictive validity of the BBS for predicting falls was 58%.

Does the BBS Detect Change in Patients With Stroke?

Eight studies examined the responsiveness of the BBS.[7,8,16,19,22–25] All reported moderate to excellent sensitivity to change in the early poststroke period. In a study by Mao et al,[7] responsiveness of the BBS was assessed in 123 patients with stroke at 14, 30, 90, and 180 days by calculating effect size (ES). The BBS was moderately responsive in detecting changes within 90 days poststroke, with ES greatest in the interval between 14 to 30 days (ES=0.80), decreasing from 30 to 90 days (ES=0.69), and poor at 90 to 180 days (ES=0.40). To determine whether the responsiveness of the measure varies depending on initial deficits, patients were stratified into 1 of 3 groups on the basis of their FM-B score: 0 to 35 indicating severe impairment, 36 to 79 indicating moderate impairment, and ≥80 indicating mild impairment. The responsiveness of the BBS at different times for individuals with different levels of stroke severity (ES=0.21 to 1.28) suggests that it is generally sensitive to change over time after stroke. Chou et al[8] also examined the responsiveness of the BBS in 81 patients assessed at 14 days poststroke and again at 90 days poststroke. The BBS was found to be highly sensitive to change between these 2 time periods (ES=0.85).

In a study by Stevenson,[16] the responsiveness of the BBS was examined by assessing patients at the time of study recruitment and 1 to 2 weeks later using 2 different raters. A statistically significant increase in BBS scores was observed—from an average BBS score of 43 at time 1 versus a score of 46 at time 3 (Wilcoxon signed rank statistic=774.0, $P<.001$)—suggesting that the BBS is sensitive to change. The authors also calculated the minimal detectable change, which is the amount of change in a given measure that must occur in order to conclude that a "true" clinical change has occurred, accounting for "noise" due to interrater and intrarater variability. A difference of 5.8 points on the BBS was required to conclude with 90% certainty that patients receiving stroke rehabilitation underwent a real change in balance, based on findings of the interrater reliability when a patient was assessed by 2 different clinicians within 24 hours.

The responsiveness of both the BBS and BBS-3P were examined by Wang et al.[19] Between 14 and 30 days poststroke, the standardized response means (SRM) for the BBS and the BBS-3P were 0.79 and 0.82, respectively, showing moderate to large sensitivity to change. Between 30 and 90 days, the SRMs were 0.69 and 0.70, respectively, demonstrating moderate sensitivity to change. Between 14 and 90 days, the SRMs were 1.07 and 1.11, respectively, showing significant sensitivity to change in both the BBS and the BBS-3P.

Wood-Dauphinée and colleagues[22] administered the BBS to 70 patients at 2, 6, and 12 weeks poststroke and reported a moderate ES of 0.66 for the initial 6-week poststroke period,

a small ES of 0.25 from the 6- to 12-week assessment, and an overall large ES of 0.97 from 2 to 12 weeks, suggesting that the BBS is responsive to change. Salbach et al[23] estimated the responsiveness of the BBS in 50 patients with residual gait deficits after a first stroke. Based on evaluations conducted an average of 8 to 38 days poststroke, the SRM for the BBS was 1.04, again suggesting responsiveness.

Vos-Vromans et al[24] examined the responsiveness of the BBS in 19 acute patients with hemiparesis resulting from stroke (n=15) or cerebral tumor (n=4). The ES was 0.59 and the SRM was 0.99, indicating moderate to excellent responsiveness. Similarly, English et al[25] investigated the responsiveness of the BBS in 78 patients receiving inpatient rehabilitation following a first or recurrent stroke. Participants were assessed within 1 week of admission and 1 week of discharge. The BBS was sensitive to change (only 2 patients showed no change) and demonstrated a large ES of 1.01.

Ceiling and Floor Effects of the BBS

Although our review indicates that the BBS generally has strong psychometric properties for the assessment of balance poststroke, 3 studies[7,8,23] demonstrated floor and ceiling effects in patients with stroke. Mao et al[7] reported a significant floor effect at 14 days poststroke. Chou et al[8] observed a large floor effect (23.9%), but no ceiling effect (2.7%), when the BBS was administered 14 days after stroke onset. In contrast, Salbach et al[23] found a large ceiling effect (26%) by 38 days poststroke; the presence of a floor effect was not calculated.

The concern regarding the potential ceiling effects of the BBS, and the lack of a meaningful interpretation of a score indicating a specific functional level, has led to its further investigation using Rasch analysis.[34] Specifically, Kornetti and colleagues[34] explored the benefit of rescoring the items. Given that the BBS currently has different operational definitions for rating categories from one item to another, using Rasch analyses, they found that, with rating scale rescoring, person ability and item difficulty were better matched along the continuum of distribution. Although this analysis was performed in 100 veterans with balance deficits and not specifically in those with stroke, it did reveal that the revised scoring method covered a larger range of item difficulty, thus decreasing the tendency for ceiling effects.[34] Rasch analyses also may prove useful in future studies of the BBS if new items are added in an attempt to raise its "ceiling."[35]

Potential Contribution of Other Balance Measures

A number of balance measures, including the FM-B,[28] the PASS,[30] and the Activities-specific Balance Confidence (ABC) Scale,[36] have been developed, each potentially adding a unique contribution to the assessment of balance. Given the interplay between trunk performance poststroke and functional outcomes, the Trunk Impairment Scale (TIS)[37] also might be of interest to clinicians who are attempting to measure trunk-specific impairments in balance.

The FM-B is 1 of 6 subscales of the Fugl-Meyer Assessment of Motor Recovery, which is a stroke-specific, direct-observation, performance-based impairment index.[28,38] The FM-B contains 7 tests, 3 of which are performed while sitting and 4 of which are performed while standing. The total score ranges from 0 to 14 points: 6 points for sitting and 8 points for standing. After the publication of a report of poor validity in the items measuring sitting balance,[39] Hsueh et al[40] proposed slight modifications to the scoring for 2 of the 3 items. The validity of this modified FM-B was found to be excellent (r=.84). Like the BBS, however, the FM-B has been found to have a significant floor effect in patients at 14 days poststroke, as well as an ES that decreases during the progression of stroke recovery.[7] Therefore, the FM-B may not be appropriate for use in patients who are severely affected or to detect improvement in those who are initially quite high functioning.

The PASS[30] is derived from the Fugl-Meyer Assessment of Motor Recovery and contains 12 items of varying difficulty that assess performance while maintaining or changing a lying, sitting, or standing position. The total score ranges from 0 to 36. Benaim et al[30] examined the psychometric properties of the PASS in 100 participants (30 control subjects and 70 patients with stroke). In this study, the PASS was found to have excellent correlations with both the FIM (r=.73) and a clinical index of lower-limb strength (force-generating capacity) (r=.78), as well as adequate correlation with an instrumental measure of postural stability (r=.48). Scores on the PASS at 30 days poststroke were predictive of 90-day FIM scores (r=.75). The PASS also had excellent internal consistency and test-retest and interrater reliability (Cronbach alpha=.95, kappa [κ]=.72, κ=.88, respectively).

Unlike the BBS, the PASS was developed specifically for use in patients with stroke. This tool includes items that are not assessed by the BBS, such as the ability to roll into a lying position, so it is less likely to have a floor effect. Indeed, Benaim et al[30] reported that approximately 30% of patients could not roll to the affected side and approximately 40% could not roll to the less-affected side, suggesting that these activities should be assessed early after stroke. When

the psychometric properties of the BBS were compared with those of the FM-B and the PASS in a study involving patients with severe stroke impairments,[7] the BBS was the least sensitive to change at 14 to 30 days poststroke. The PASS showed slightly better psychometric properties, with no notable floor or ceiling effects.

The ABC Scale[36] is a 16-item self-report questionnaire that asks individuals to rate, on a numerical rating scale, their balance confidence in performing specific ambulatory activities (eg, walk around the house, walk on icy sidewalk, and so on). This tool includes items with a wider range of difficulty compared with the BBS. A score of 0 represents no confidence, whereas a score of 100 represents complete confidence in performing the activity. Botner et al[41] examined the psychometric properties of the ABC Scale in a sample of 77 community-dwelling individuals who had experienced a stroke at least 1 year earlier. Both the internal consistency and test-retest reliability of the ABC Scale were excellent (Cronbach alpha=.94, ICC=.85, respectively). An adequate correlation between the ABC Scale and the BBS was found (r=.36). Unlike the reports of floor or ceiling effects found with the BBS,[7,8,23] only minimal floor and ceiling effects were found with the ABC Scale.[41] However, to date, the ABC Scale has only been tested for use in community-dwelling individuals with stroke who are ambulatory[41]; therefore, unlike the BBS, the ABC Scale may not be suitable for use in those with more severe stroke or those who are receiving inpatient care.

The TIS[37] is a measure that was developed to assess motor impairment of the trunk after stroke. The scale has 3 items assessing static sitting balance, 10 items assessing dynamic sitting balance, and 4 items assessing coordination. The full TIS takes 2 to 18 minutes to complete, and items are scored as 0 to 1, 0 to 2, or 0 to 3. The TIS has demonstrated excellent test-retest reliability (ICC=.91 for static sitting balance and .94 for dynamic sitting balance) and interrater reliability (ICC=.99 for static sitting balance and .98 for dynamic sitting balance), as well as excellent internal consistency (alpha=.79 for static sitting balance and .86 for dynamic sitting balance).[37] The TIS has no reported ceiling effects.[42]

Discussion

We performed a systematic review of the literature to examine the psychometric properties of the BBS for use in stroke rehabilitation. The results suggest that the BBS has strong reliability, validity, and responsiveness to change, and the test is useful and easy to administer without the need for expensive equipment or prolonged assessment time. Furthermore, it has excellent predictive validity for important outcomes such as discharge disposition, with the notable exception of falls[20,21] where it has not been shown to be predictive.

Of some concern is the evidence that the BBS has floor and ceiling effects, suggesting that the BBS may not detect meaningful changes when used to assess patients who have severe balance impairment or those who have mild impairment. One possible explanation for the floor effect is that the least demanding item in the BBS is sitting independently. Patients with severe impairments may be unable to sit independently and perform other items of this tool (eg, stand on one foot); therefore, they will receive a low score on the BBS. Although these patients may experience some meaningful clinical improvements, the BBS will not capture these changes. The BBS also has a significant ceiling effect for patients with mild stroke impairments when administered at 90 and 180 days, so it may miss significant gains in balance that are critical for community reintegration and leisure participation.

The PASS has been reported to have slightly better psychometric properties than the BBS and the FM-B, and it does not demonstrate the significant floor or ceiling effects reported with the other measures.[7] In addition, the ABC Scale has a wider range of items than the BBS, with only minimal floor and ceiling effects, but the tool has only been tested in a community-based population.[41] Also, the TIS may be a promising alternative for those patients with stroke who find the easiest items of the BBS challenging, as the TIS has 13 items assessing sitting balance with or without support, and has no reported ceiling effects.[42] However, the ability of the TIS to detect clinically meaningful clinical improvements has not been reported.[42]

Clinical Implications

The results of this systematic review have important clinical implications. Overall, the BBS has strong psychometric properties and is valuable in assessing clinical change in balance after stroke. However, caution should be exercised when electing to use the BBS to measure change in patients who are at either end of the impairment spectrum—severe or mild. Clinicians may want to familiarize themselves with other balance measures, such as the PASS or the ABC Scale, that provide additional information on balance throughout the continuum of stroke recovery. Furthermore, there is no evidence to date that the BBS is predictive of a patient's fall risk poststroke.

Conclusion

The strong psychometric properties of the BBS demonstrated by this systematic review suggest that it is an effective and appropriate assessment of balance in patients with stroke. Importantly, it is responsive to change and, therefore, should be considered for use in measuring outcomes of various stroke rehabilitation interventions. We recommend

that clinicians consider the use of other balance measures in conjunction with the BBS to address its floor and ceiling effects.

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